Human Capital and Economic Growth in India, Indonesia and Japan

A quantitative analysis, 1890-2000

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ISBN: 978 90 8891 003 6

Printed in the Netherlands

Human Capital and Economic Growth in India, Indonesia, and Japan

A quantitative analysis, 1890-2000

Menselijk kapitaal en economische groei in India, Indonesië en Japan
Een kwantitatieve analyse, 1890-2000

(met een samenvatting in het Nederlands)

Proefschrift

ter verkrijging van de graad van doctor aan de Universiteit Utrecht op gezag van de rector magnificus, prof. dr. W.H. Gispen, ingevolge het besluit van het college voor promoties in het openbaar te verdedigen op donderdag 14 juni 2007 des middags te 4.15 uur

door

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geboren op

27 april 1978

te

Utrecht

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Dit proefschrift werd mogelijk gemaakt met financiële steun van het Van Winterfonds.

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Preface and acknowledgements

When I started to work on this thesis the topic was broadly defined as the 'standard of living in India and Indonesia in the twentieth century'. It soon turned out that this topic was both too broad and too narrow. It was too broad in the sense that the 'standard of living' comprises of al sorts of measures, ranging from GDP, to food consumption, health, and education. In order to narrow this down the choice fell on 'human capital' since this is a key variable in explaining economic development and it is strongly related to other variables such as health and education. Human capital, in the form of education, was clearly less developed in India and Indonesia compared with many European countries as was their economic development. This made it necessary to broaden the initial research topic to include an Asian country that experienced the same development of educational institutions but was successful in economic development. Japan was a natural choice.

While reading the literature on human capital and economic growth, four questions came to mind. A first and foremost question was what human capital actually is. Most studies include proxies such as 'average years of education in a population' without clarifying how they relate to human capital. The second question that came to mind was how institutional development in different countries affects the accumulation of human capital. The third question was how human capital relates to economic growth while the fourth question related to the strength of the relation between human capital and growth.

The last two questions are extensively treated in the economic literature. Many studies are available on growth theories, describing the theoretical effect of human capital on growth. Equally, many studies exist that use human capital proxies to estimate the strength of the relation between human capital and growth. However, the situation is that most empirical studies still have difficulties with determining which growth theory is the most applicable. Another problem is that the effect (if any) of human capital on growth generally found in the literature is much lower than is expected on the basis of micro studies, which makes it likely that there are still too many unknowns in the relation between human capital and growth.

Given my background in economic history, my focus was thus more on the first two questions which I hoped could explain some of the inconsistent results in the relation between human capital and growth. Indeed, probably no one would doubt that the impact of the choice of human capital variable on the results and interpretation is crucial. Equally, the importance of institutional development for the existence of the relationship between human capital and growth is also rarely disputed. In fact, the use of dummies and fixed-effect panel regressions in empirical estimates of the role of human capital is a confirmation of its country-specific development. Indeed, Eicher, García Peñalosa, and Teksoz (2006), using a simple extension of the Solow model, show that institutions mainly work through the factors of production.

The last two questions, on growth theory and empirical estimates, are only touched upon in this thesis as far as their results are affected by the answers on the first two questions. Although this thesis certainly does not provide (or aims to provide) definitive answers, we hope to show that it is fruitful to pay more attention to the construction of human capital and the way in which human capital accumulation is affected by institutions. In addition, without arguing that this road is the only, or even a right, one, we hope to show that a stronger focus on the first two questions may also have an impact on both theoretical and empirical studies on human capital and growth.

During the process of writing on such a broad topic, I inevitably incurred large debts which are impossible to all mention here. Yet, there are some persons I would like to thank explicitly. Foremost I would like to thank Prof. Jan Luiten van Zanden, my supervisor, for his patience and for the many times he supplied me with advice and suggestions. An equal debt goes to Dr. Wolter Hassink, my co-supervisor with whom I spent much time discussing econometric problems. Much gratitude also goes towards my other supervisors, Prof. Lex Heerma van Voss and Prof. Willem van Schendel, who were always open for discussions and patiently answered all my questions.

I further would like to thank Rob Alessie, Steve Broadberry, Harry Garretsen, Maarten Prak, and Bart van Ark for the effort they put in reading this thesis and providing constructive comments. Also many thanks go to Péter Földvári, not only for reading the manuscript and suggesting improvements and additions, but also for his friendship and collegiality both at the International Institute of Social History and during our common stay at the University of Warwick. I would also like to thank all my colleagues at the IISH who not only were always open for stimulating discussions, but foremost for the friendly and collegial atmosphere. Therefore, I would also like to express my thanks to the IISH itself for hosting this research and providing me with a friendly and stimulating place to work. During the process of writing, the author often forgets that his topic is not the sole important thing in the world. Therefore, I would like express thanks to my parents Piet van Leeuwen and Thea Wieland and my aunt, Corry van Leeuwen, for their forbearance and encouragements. Finally, I would like to thank the Van Winter Fonds for financially supporting this research without which support nothing of this would have been possible.

1. Problems in analyzing economic development[1]

1. INTRODUCTION

Why are some countries rich and others poor? This is has been one of the grand questions in economic and historical research over the last five decades. The question was explicitly asked when many former colonies became independent after World War II (Easterlin 2001). These newly independent countries tried to develop policies that were intended to promote an economic development that would bring them at par with the Western countries. With this in mind, it was not more than natural that researchers started a quest for factors of economic growth. However, the routes they were taking depended strongly on their own scientific background. Economists started to work on growth theory (see for example Solow 1956; Swann 1956) which resulted in quantifiable models from which policy measures could be distilled. Yet, an important drawback of their models was that, in the absence of increasingly improving technology, economic growth should tend to zero. As economic growth did not tend toward zero, this means that technological development had to be present which, however, could not be measured directly. Despite this deficiency, these models were empirically used in growth accounting exercises in which economic growth was divided in several factors, most notably labour and physical capital. The residual, Total Factor Productivity (TFP), was interpreted as the growth of efficiency (containing among others the effect of technology) causing long-run GDP growth (examples are Denison 1962; Mankiw, Romer, and Weil 1992).

These growth accounting analyses were often done for a set of heterogeneous countries for which they calculated the effect of some variables, like physical capital, the labour force, natural resources, and TFP, on economic growth. As a consequence, (institutional) differences among countries could have a serious impact on the estimated parameters. For example, it is hardly imaginable that capital accumulation was equally efficient in Sudan as in the USA. This may lead to different coefficients. However, cross-country regressions assume the same coefficients among countries. This led other economists to put more emphasis on cross-country differences. A famous example is Kuznets (1966) who tried to quantitatively compare the economic development of several developed (and developing) countries. Yet, his analysis remained largely confined to within-country development. His main conclusion was that there was a shift from unskilled labour to (skilled)

[1] This chapter is intended as an introduction to the topic of human capital and growth and is in no way intended to provide a comprehensive overview of Solowian growth, factor accumulation, or other research.

blue-collar and, especially, white-collar employees. This went hand in hand with a shift from agriculture to industry and services. This development was by some growth accounting economists translated in a shift in the importance of the factors of production for economic growth. For example, Abramovitz (1993), argued that in the USA the importance of physical capital for economic growth declined in favour of TFP in the mid-nineteenth century. Consequently, although scholars were aware of the importance of cross-country differences in economic growth, it was not often accounted for in empirical research. This was largely caused by lack of data, especially for developing countries.

This situation changed in the 1960s when scholars stopped seeing development solely in terms of physical capital and GDP. This increased the importance that was placed on factors as consumption, life expectancy, health, and human capital (see for example Schultz 1961; Seers 1969). Side by side with the broadening interpretation of 'development', also more data became available. It had already been acknowledged in the 1940s and 1950s that the availability of more internationally comparable data was needed. Therefore, international organisations such as the International Monetary Fund (IMF), the International Labour Organization (ILO), and the United Nations Economic and Social Committee (UNESCO) started to collect data on their member states on a large scale. It was a matter of time before these data became available in more or less coherent datasets. The most famous example is the Heston-Summers dataset, which consists of a large set of national time series on aspects such as GDP, physical capital, interest rates, and population.

The situation in the 1980s was thus that all ingredients were available to move up the growth analysis ladder: a growth theory that explained everything except long-run growth, the awareness that it takes more than just physical capital to have economic growth, and the increased availability of data to facilitate empirical analysis. This made it possible to bring human capital in growth theory with the view to endogenise economic growth: long-run growth is determined *within* the model rather than being exogenously determined as in the neo-classical Solow growth model.

In this chapter, following the path from growth accounting with solely physical capital, to the inclusion of social indicators, and to the new growth theories, we will try to determine to what extent these methods can explain the causes of long-run growth. To this end, we start in section 2 by outlining the geographical and time scope of our research. Then, we move on in section 3 to a brief description of growth accounting. In section 4, we also look at other factors, besides physical capital, influencing GDP. Here we extend our view on economic growth by including social factors such as literacy and life expectancy. Combining physical capital and the social factors, we arrive at a brief description of the new growth theories in section 5. This brief tour through the recent history of development economics once more confirms the importance of country-specific research into human capital as an important factor in economic growth. In section 6 this results in the main question: to what extent recent development economics can explain the economic success and failure of countries.

2. GEOGRAPHICAL AND TIME SCOPE OF THE STUDY

As outlined in the introduction, it is important that the analysis why some countries experience strong economic growth while others do not, has both country-specific and quantitative components. The quantitative aspects are well treated in the many available cross-country growth analyses. These generally analyze economic growth over one or two decades for a large sample of countries. However, we will also focus on the country-specific aspects which require a historical analysis of the growth path and the underlying causes of growth in the different countries. As this sort of analysis takes more variables into account and stretches over a longer time, it requires us to set limits to our study both in time and place.

Our focus will be on India, Indonesia and Japan in the twentieth century. This is the period when the largest divergence in income took place. Or, to speak with Pritchett (1997, 9): 'Divergence, Big Time'. In addition, data limitations make it often hard to go further back in time than the late nineteenth century. The choice of these Asian countries is, first, because all three took over exogenous educational institutions. This could be either by adopting foreign technology or by creating a new education system. They thus represent the small (technology) or the broad (technology, capital, social factors) vision on economic development. Second, where Japan is considered a successful developer, India and Indonesia lagged behind. Did these (exogenous) factors have a different effect in Japan than in India and Indonesia? Indeed, a third reason to choose these three countries is that the educational institutional development, even in the latter two developing countries, was different, which might explain a part of the economic divergence. Fourth, in those studies stressing the importance of physical (and human) capital accumulation as well as the studies pointing at the importance of technology for economic growth, the Asian countries are often cited as proof. Therefore, a more historically oriented study in the factors of economic growth might provide alternative insights in the development of these countries.

3. FACTOR ACCUMULATION AND ECONOMIC GROWTH

Based on the initial model of Solow (1956) and Swan (1956), growth accounting analyses became increasingly popular from the 1960s onwards. Even after the construction of the new growth theories it is still used extensively today due to its relative simplicity. Initially mainly physical capital was inserted to obtain the residual, TFP, which was an indication of all factors causing long-run growth. Later, additional variables were inserted. Yet, the basic equation was, and is, with physical capital.

Generally, this literature decomposes economic growth in the effect of physical capital (*K*) and a residual, the Total Factor Productivity (*TFP*). This is often done in per capita or per labourer terms where economic growth ($\dot{y}/y$) is decomposed in the growth of physical capital ($\dot{k}/k$) and the growth of *TFP*. A factor share of each factor of production is determined, which is often set at 0.3 for physical capital. The residual ($\hat{g}$) is interpreted as the growth of TFP. We then arrive, under the assumption of constant returns to scale, at the equation:

$$\hat{g} = \dot{y}/y - s_K \left(\dot{k}/k\right) \qquad (1.1)$$

Equation (1.1) says that the growth of TFP, $\hat{g}$, is equal to the growth of per capita/labourer GDP minus the factor share of physical capital multiplied by the growth of per capita/ (or per labourer) physical capital.

Although many studies have used growth accounting for the period after World War II[2], this method is much less applied to earlier periods. For India, however, Mukerjee (1973) did a growth accounting exercise for the period prior to 1947. This was based on earlier GDP estimates which since then have considerably been revised resulting in an overestimate of the GDP growth rates. Using an updated series, Sivisubramonian (2000, 484) shows that TFP growth in the first half of the twentieth century explained about 56% of GDP growth. For Indonesia, even less data are available. However, based on our approximation of the physical capital stock (see appendix A.2.), we can carry out a growth accounting exercise for the period 1900-1940 (see table 1.1). Using GDP and gross fixed non-residential capital stock per labourer as inputs (the share of physical capital is set at 0.3), we arrive at a share of TFP growth in GDP growth of around 24%. This indicates that in the first half of the twentieth century Indonesia experienced mainly growth through physical capital accumulation. In Japan pre-World War II data are available from Hayami and Ogasawara (1999). They find TFP

[2] See for example Ikemoto (1986), and Young (1995) on several Asian economies.

Table 1.1: Per labourer growth accounting exercise for India, Indonesia, and Japan 1900-2000

		Literature				**Our estimates**			
		Per labourer growth *GDP*	Per labourer Growth *K*	Share *K* in per labourer *GDP* growth	Share *TFP* in per labourer *GDP* growth	Per labourer growth *GDP*	Per labourer Growth *K*	Share *K* in per labourer *GDP* growth	Share *TFP* in per labourer *GDP* growth
1900-1940	India	0.92%*	1.98%*	41%*	56%*	0.6%	1.0%	47.8%	52.2%
	Indonesia	n.a.	n.a.	n.a.	n.a.	1.2%	3.1%	76.0%	24.0%
	Japan	2.57%**	3.26%**	56%**	44%**	2.8%	3.7%	39.7%	60.3%
1950-2000	India	2.92%***	1.62%***	22%***	78%***	2.6%	3.7%	43.3%	56.7%
	Indonesia	4.12%***	2.88%***	28%***	72%***	3.0%	4.1%	40.8%	59.2%
	Japan	5.97%**	7.95%**	43%***	57%**	4.8%	6.0%	37.9%	62.1%

* Not in per capita terms, the share of L in GDP growth is 33%
** Private gross non-primary product.
*** 1960-1992.
Note: The factor share of physical capital is set at 0.3.
Source: India: Sivisubramonian (2000, 484) and Bosworth *et al.* (1995); Indonesia: Bosworth *et al.* (1995); Japan: Hayami and Ogasawara (1999, 9). The remaining estimates are on the basis of the data in appendix A.2.

growth to explain 44% of GDP growth.

Based on the estimates from the literature and our own estimates in table 1.1, we may draw two tentative conclusions. First, in confirmation of the work of Abramovitz (1993) and Hayami and Ogasawara (1999), we find that the share of TFP growth in economic growth appears to increase over time.[3] Although this is true for all estimates in table 1.1, the increase in India and Japan was much smaller than in Indonesia. Second, in the second half of the century the differences in the effect of TFP growth on economic growth are much more equal. Indeed, our estimates show that Indonesia, with a share of TFP growth in GDP growth of only 24% until 1940, came with 59% at par with Japan and India after World War II.

The main implication is thus that physical capital growth declined in importance to TFP growth in explaning economic growth. However, it remains unclear what TFP is. Should we interpret it as technological growth as is often done in the neo-classical Solow model or in some branches of the new growth theories? Or should we interpret it as the effect of human capital accumulation as is argued by some other branches of the new growth theories?

[3] This differs from the results in the literature (see table 1.1). The figures for India from Sivasubramonian give a larger share of TFP growth. However, he included labour in TFP, thus artificially increasing the share of TFP growth.

4. ECONOMIC DEVELOPMENT: A CHANGING FOCUS

4.1 Introduction

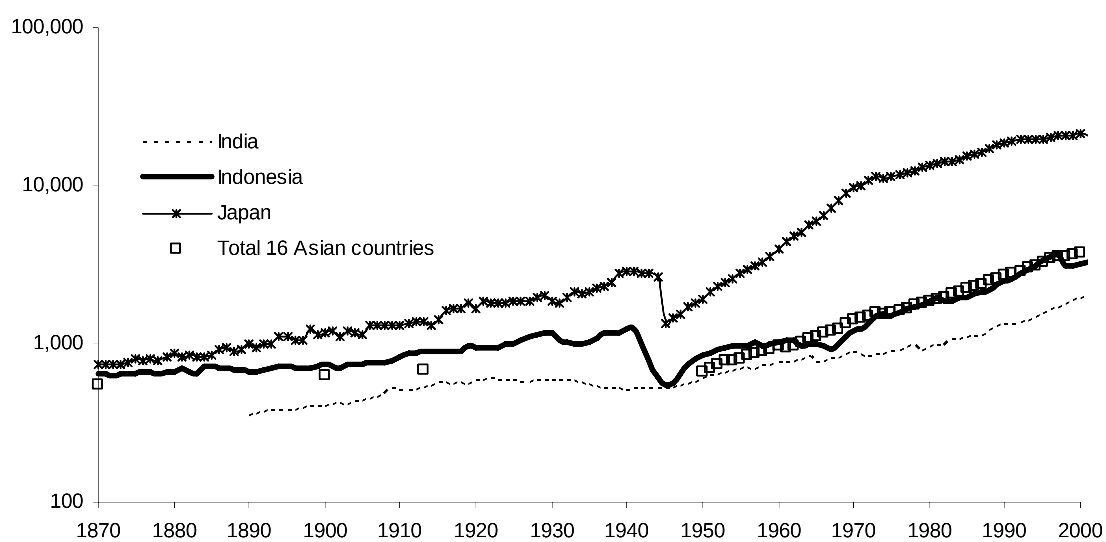
The large impact of TFP growth on economic growth (on average 56.5%) found in the previous section provides a sign that there were also other factors, besides physical capital, which were important for economic growth. However, because TFP growth is calculated as a residual, it is unclear which factors are captured by TFP growth. Whether this was technology, as was often assumed, or whatever other factor, could not be decided based on this evidence. This was less a problem in early development economics when development was looked upon as (lack of) physical capital accumulation (see for example Lewis 1955). As physical capital accumulation was inserted in the growth accounting exercise, the TFP growth could simply be interpreted as technological growth. Yet, with the rising importance of other, social, indicators such as health, literacy, and human capital, the growth of TFP could reflect the growth of these social indicators as well.

4.2 A classic view: GDP and physical capital

On the basis of per capita GDP data provided by Maddison (2003), we may conclude that the

Figure 1.1

Logarithm of per capita GDP in Japan, India, Indonesia, and the Asian average in 1990 International USD, converted at PPP, 1870-2000



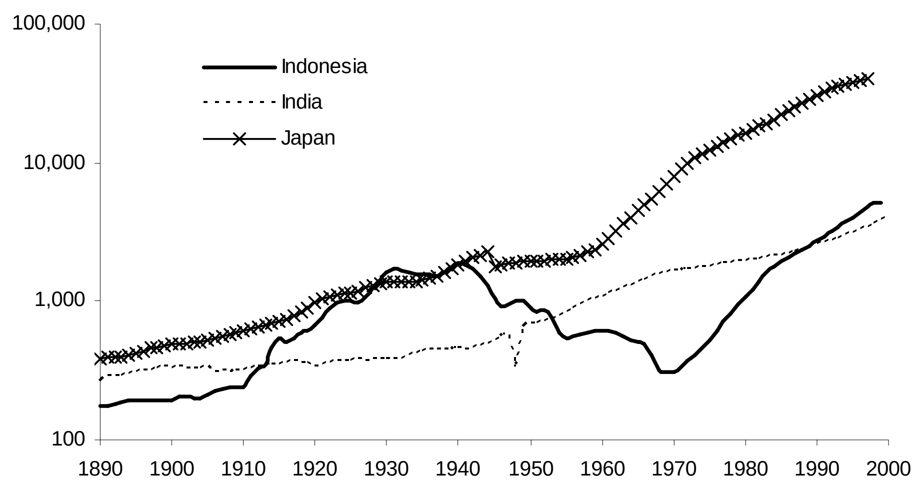
Note: the Indian GDP is for the Indian Union only (thus excluding Pakistan and Bangladesh)

Source: appendix A.2 and Maddison (2003) levels of per capita GDP were about equal in India, Indonesia, and Japan around 1800. However, in the course of the nineteenth century they started to diverge. In 1890 Japan was already clearly ahead, having a gap in per capita GDP of 35% with Indonesia and 65% with India (see figure 1.1). Indeed, figure 1.1 shows that from 1870 onward there was a strong divergence in per capita GDP between on the one hand Japan and on the other hand India and Indonesia.[4] This divergence accelerated after World War II. A second finding from figure 1.1 is that the Indian GDP is somewhat below the Asian average since as early as 1890. Although this gap closed slightly during the 1940s, mainly because India was far less hit by the War than most other Asian countries, it widened again in the second half of the twentieth century. Indonesian GDP was near the Asian average.

But what are the underlying reasons of these developments? In the previous section we already pointed out that in essence there are two sources of growth, i.e. (physical) capital accumulation and TFP. In addition the share of TFP growth in economic growth increased over time thus decreasing the effect of physical capital. In this sub-section we start with a brief look at physical capital accumulation. Figure 1.2 plots the development of the per capita

Figure 1.2

Log of per capita gross fixed non-residential physical capital stock in Japan, India, Indonesia, 1890-2000, in 1990 Int. USD converted at PPP



Source: Appendix A.2.

[4] The data for India only start in 1890.

gross fixed non-residential physical capital stock. We notice that the amount of per capita physical capital in Indonesia and Japan peaks in the 1930s and early 1940s. Because these countries were hit hard by the Second World War, we see a strong decline thereafter. However, whereas in Japan per capita physical capital started to recover almost immediately after the War, in Indonesia it declined until around 1970. This suggests that in Indonesia also other factors played a role such as, for instance, the Dutch police actions after the War and the initially unfavourable investment climate. This was different for India, which had not suffered from Japanese occupation. Therefore, we see a steady increase of the per capita physical capital stock with a minor increase in the growth rate as from the 1940s. Thus, whereas Japan and Indonesia experienced a relatively strong growth in per capita physical capital until the 1940s and an even faster growth after 1950 and 1970 respectively, India had a relatively small growth until the 1940s and a somewhat faster, but still relatively slow, growth after 1940.

Comparing figure 1.2 with figure 1.1 suggests that the per capita gross fixed non-residential physical capital stock moves up and down with the development of per capita GDP. In other words, the development of per capita GDP strongly resembles that of per capita physical capital. This suggests a relationship between both variables.

4.3 Broadening the scope: other factors influencing economic development

The findings in section 3 and 4.2 confirm that physical capital plays an important role in economic growth. However, this does not explain the large share of TFP. In Indonesia, physical capital increased strongly in the post-War period as did TFP growth. In Japan, which showed a similar large increase in physical capital, the share of TFP growth in economic growth rose far less. The situation that Indonesia lagged behind to India and Japan in terms of TFP cannot explain this difference completely.

Other factors thus may explain (part of) the differences. These other factors are captured with social data, often shared under the common term 'human capital'.[5] Unfortunately, these data are even harder to collect than those on physical capital. Therefore,

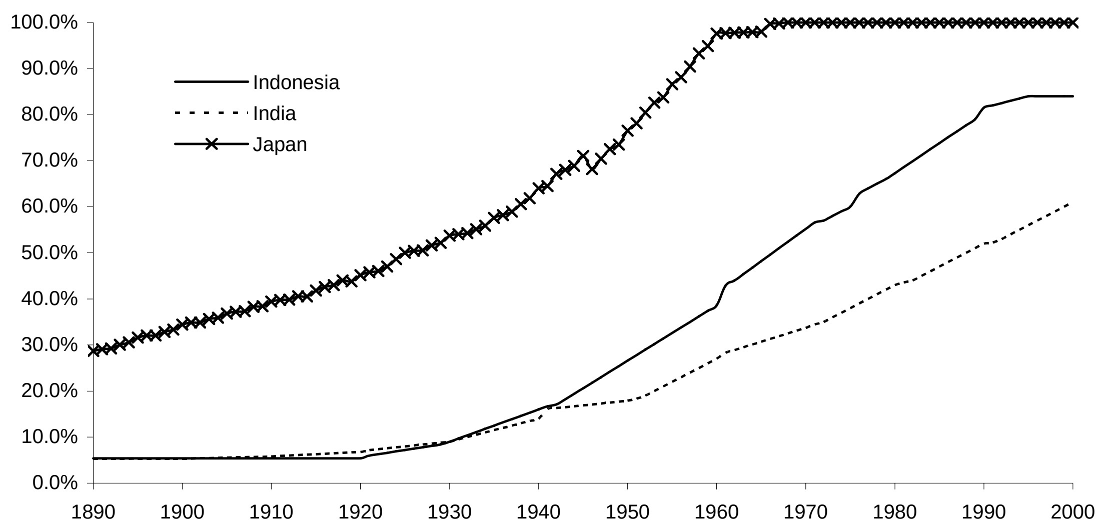
[5] This siding of variables such as literacy and life expectancy under a common denominator 'human capital' is obvious when considering studies of human capital. For example, many studies use adult literacy rates (often defined as the ability to read and write) as proxies for human capital (Azariadis and Drazen 1990; Romer 1990). Admittedly, this variable only captures the effect of human capital on economic growth up to a certain threshold. The reason is that, when everyone is literate, secondary and higher education may still expand without being visible in the literacy rate. Nevertheless, certainly in the nineteenth and start of the twentieth century and in the less developed countries, literacy is a relatively good indicator of human capital. The same can be said for life expectancy. There are numerous papers in which the decision to invest is based on life expectancy (Castelló-Climent and Doménech 2006). Equally, a higher life expectancy is associated with better health and some papers associate health with human capital. Hence life expectancy, just as health in general, is directly interpreted as human capital (Newland and San Segundo 1996; Sachs and Warner 1997; Arora 2001).

a whole range of social indicators has been used to reflect human capital. Mostly these are literacy rates and life expectancy. The results for these variables are presented in figures 1.3 and 1.4. Although the data are of limited quality, especially for the first half of the twentieth century, they do show the familiar logistic pattern that can be found in many developing (and developed) economies. These figures show that the fastest growth of these social indicators reflecting human capital took place between 1920 and 1960 (Japan) or 1980 (India and Indonesia). It is interesting that, contrary to physical capital, the gap in the human capital indicators between, on the one hand, Japan, and, on the other, India and Indonesia, declined.

The development of the human capital indicators in figures 1.3 and 1.4 reflects that of per capita GDP in figure 1.1. Just as for physical capital, this suggests a relation between these variables and GDP. If we now combine the economic and the social indicators, we get

Figure 1.3

Percentage literacy in Japan, India, Indonesia, 1890-2000



*Source: US Census Bureau (International Programs Centre) (*www.census.gov*); Statistical Abstract of British India* (various issues), *Volkstelling 1930* and *Colonial Reports* (various issues). For Japan, literacy data were harder to obtain. Because Japan was further developed we used our estimates of educational attainment (chapter 3 and appendix A.7) to proxy for literacy.

the Historical Living Standard Index (HLSI) used by Crafts (2002) and Astoraga, Berges, and Fitzgerald (2005). The human development index is a weighed index of literacy (E), life expectancy (L) and per capita GDP (Y). We use a theoretical benchmark country with a per capita income of 40,000 USD in 1990 prices[6], a life expectancy of 85 years[7], and a literacy rate of 100%. If a country would satisfy these requirements, the index value would become unity:

$$H_{it} = \frac{1}{3}\left[\left(\frac{\log Y_{it} - \log 100}{\log 40{,}000 - \log 100}\right) + \left(\frac{L_{it} - 25}{85 - 25}\right) + \left(\frac{E_{it} - 0}{100 - 0}\right)\right] \quad (1.2)$$

The results are presented in figure 1.5.[8] Where we saw in figure 1.3 and 1.4 that the gap between on the one hand India and Indonesia and on the other hand Japan started to decline as

Figure 1.4

Life expectancy at birth (years) in Japan, India, Indonesia, 1890-2000

Source: UN, Demographic Yearbook: Historical Supplement; *Demographic Yearbook 1948.*

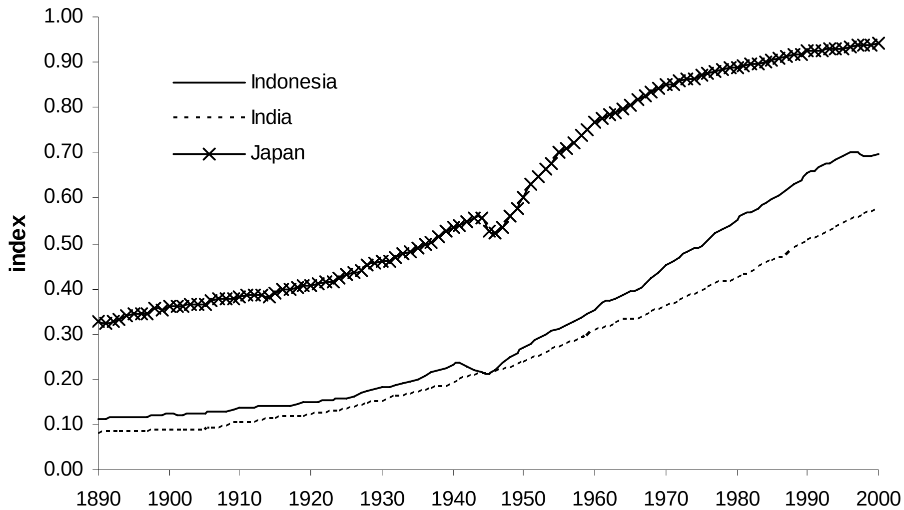
from the 1960s, we notice the same in figure 1.5. Between 1960 and 1995, the gap between Japan and India declined with 20% and that between Japan and Indonesia with 50%.

The analysis of this section leads to the conclusion that, besides physical capital, social indicators are also important for economic development. As the gap in the historical living standard index diminished while that in physical capital (proxied by GDP)[9] remained,

[6] Crafts (2002) and Astoraga, Berges, and Fitzgerald (2005) used 1970 prices.
[7] We are aware that a life expectancy of 85 years is rather high, epecially for the early twentieth century. However, this makes the result more comparable to the Historical Living Standard Index for other countries.
[8] An interesting feature is that both in Japan and in Indonesia we see a dip around the War in the HLSI. This is, however, not the case in India. The reason is of course that India did not participate in the War directly.

Figure 1.5

Historical Living Standard Index (HLSI) for Japan, India, Indonesia, 1890-2000



Source: see under figure 1.1, 1.3 and 1.4. Construction as described in the text.

the social indicators must have had an important effect on the standard of living. However, it is unclear what the importance of each factor is for economic growth. Both literacy and life expectancy, or more general: human capital, do have an impact on economic growth. However, whether this is in the form of capital accumulation as is the case for physical capital, or by way of facilitating technological growth, remains unclear.

5. THEORY BEFORE EMPIRICS: THE NEW GROWTH THEORIES

5.1 Introduction

The role of the social factors was thus important. However, it was unclear whether they had an impact on economic growth through capital accumulation or through facilitating the adoption of technologies. The first step in solving this puzzle was to search for a comparable indicator of social developments. Following Theodore W. Schultz (1961) and Gary Becker (1964), the obvious candidate was human capital. As they defined human capital as a kind of 'capital' it was obvious to use this non-physical capital to extend capital in growth accounting exercises. In this way, it was hoped that the residual TFP could be reduced.

[9] We used GDP to keep the Historical Living Standard Index comparable to the one used in the literature. As GDP also includes the social factors, we are somewhat biasing our results toward the social factors. However, in our opinion this does not drastically alter the result.

Many growth accounting studies that inserted human besides physical capital, used proxies of human capital such as ‘average years of schooling of the population’. Some examples are Bosworth, Collins, and Chen (1996), Young (1995), and Dougherty and Jorgenson (1996). All authors arrive at human capital shares in GDP growth of around 20% while TFP shares in economic growth are around 30%.[10] Compared with regressions without human capital, this is a strong reduction in the effect of TFP.

Yet, although reduced by the inclusion of human capital indicators, the share of TFP growth in economic growth remained large. We cannot interpret this as evidence that human capital as a factor of production is of little importance.[11] For this to be the case, too many problems plague this sort of growth accounting approaches. For example, the quality of the human capital data is generally low, thus reducing[12] the effect of human capital if directly inserted as a factor of production. In addition, there are some strong assumptions underlying this model, most importantly constant returns to scale. However, if there are decreasing returns, TFP growth would be underestimated. Finally, no matter how correct TFP growth is estimated, it still comes like some sort of manna from heaven, i.e. is exogenous. In other words, even measured perfectly, it is unclear what TFP growth is and how it influences GDP growth.

These problems make the results difficult to interpret and therefore the discussion goes on whether capital growth (physical, human or both) or technology causes economic growth.[13] A clear example is that the assimilists[14] (arguing that economic growth is mainly caused by the assimilation of technology) and the accumulists (those arguing that economic growth is largely caused by the accumulation of capital) both point at the Asian countries to strengthen their point. The assimilists argue that TFP increased over time. As TFP is an indicator of technological assimilation, and because after World War II most Asian countries experienced strong economic growth, this growth should primarily be driven by the

[10] Obviously, there are many cross-country differences in the shares of each of the factors. However, on average we may conclude that the inclusion of ‘human capital’ or ‘the quality of labour’ decreases TFP. See Bosworth, Collins, and Chen (1995, table 6), Young (1995), tables VVIII), Dougherty and Jorgenson (1996, table 2).

[11] As a facilitator of technology, human capital can still work through TFP.

[12] Random measurement error in the independent variable causes a bias towards zero in the coefficient in a bivariate regression.

[13] Another problem is that it is possible that capital investment is correlated to economic growth. In other words, it is endogenous. Some examples of this are the large increases in physical capital growth after World War II. Indeed, Alwyn Young (1994) argues that after World War II capital accumulation in Asian countries was the cause of growth and not TFP. As a consequence, there seems to be a clear endogenous relation between economic development and investment in physical capital. This is also remarked by Krueger and Lindahl (2001) who estimated that this creates an overestimation of the share of physical capital in growth of about 50% when using a regression analysis.

[14] See for example Easterly and Levine (2002).

assimilation of technology. Equally, the accumulists argue that TFP shares in Asian countries are large, but they are by no means much larger than in other countries (Young 1995; Bosworth, Collins, and Chen 1995). As Asian countries after World War II nevertheless did experience strong growth, this suggests that rapid capital accumulation is the main reason for Asian economic development.[15]

The only way to give definite proof for either the accumulists or the assimilists is to endogenise long run growth. That is, either technological growth or (human) capital accumulation has to be inserted in the growth model in order to explain long-run growth. This is done by the new growth theories. In this way the validity of both arguments can be tested directly.[16]

5.2 The new growth theories

It was in the 1980s, with the creation of large cross section datasets and the dissatisfaction with the unexplained long-run growth that the new growth theories came into existence. As indicated, the main difference with the Solowian, neo-classical, growth model was that growth rates were now determined within the model, i.e. were endogenous. Two strands of new growth theories arose. Both made use of this additional ‘capital’ to relax the diminishing returns in the neo-classical model and thus create endogenous growth. Yet, they viewed human capital in a very different way.

In the first model, pioneered by Lucas (1988), human capital was inserted as a factor of production. This had three consequences. First, the empirical equation remained similar to the Solow model, augmented with human capital. However, in contrast, he argued that the formation of human capital was subject to constant, or increasing, marginal returns in human capital accumulation. This means that, even without the existence of positive external effects, endogenous growth was possible. Second, a logical consequence of this extension of the Solow growth model with human capital was that the growth of human capital positively

[15] For an excellent discussion of the debate between the accumulist and the assimilist theories, see Timmer (2002).

[16] Human capital, for example proxied by variables such as life expectancy and literacy, can pick up a large part of long-run growth as we will point out in the description of the new growth theories in chapter 2. This also means that human capital is to a large extent correlated with TFP growth which is, as indicated, the source of long-run growth in the neoclassical Solow model. Indeed, if we perform a simple canonical correlation between, on the one hand, TFP growth and, on the other hand, the growth rate of indicators of human capital such as life expectancy, literacy, and the share of females in total educational enrolments, we get a relatively high correlation of 0.25 for Indonesia, 0.19 for India, and 0.21 for Japan, all highly significant. Given the fact that we are correlating growth rates (which generally result in lower correlation coefficients), the correlation coefficients found are relatively high. This is especially true because, as we will argue in chapter 2, these variables are only limited proxies of human capital.

influenced the growth of GDP. The third consequence of inserting human capital as a factor of production was its definition. Human capital used in this way exemplifies skills embodied in a worker. Consequently, human capital is a rival good (its use in one job precludes the use in another job) and it is excludable (people have property rights over their own labour) (Barro and Sala-i-Martin 2004, 239-240).

In the second model, pioneered by Romer (1990), the neo-classical growth model is followed in the sense that technological change (and possibly some other, less explicitly stated, factors) causes long-run growth. This effect of technological growth works on GDP growth through the level of human capital, either because human capital produces new technologies directly or because it is used as an input in R&D related activities (Sianesi and Van Reenen 2003, 163). This has two consequences. First, it is the level of human capital that has an effect on GDP growth.[17] Second, whereas in the theory of Lucas human capital is seen as the skills embodied in a worker, in the theory of Romer it is seen as knowledge and ideas. Consequently, in the latter case human capital is non-rival and partly-excludable.

Both new growth theories, each in several forms, have been estimated extensively. A few important studies are Barro (1991); Hanushek and Kim (1995); Gundlach (1995); De la Fuente and Doménech (2000). A clear finding is that the effect of the level of human capital on economic growth is small with around 3% on average while the effect of the growth of human capital is rarely significant. Partly, this can be attributed to the use of unsuitable human capital proxies because they only to a limited extend reflect the definitions of human capital as used by Lucas and/or Romer. In addition, these variables are often constructed with considerable error which is exacerbated when using growth rates. This might be an important reason why often an insignificant effect of the growth of human capital on economic growth is found as we will argue in the next chapter.

However, probably the most important problem is that these estimates are often done using cross-section or panel analyses. These analyses are less suited to answer our research questions. For example, often very dissimilar countries are pooled together in order to arrive at a sufficiently large sample (Tallman and Wang 1992, 9). As these models often assume the impact of human capital to be homogenous across countries, they hide large parameter heterogeneity. Equally, the relation between human capital and economic growth may be non-linear, i.e. for example depending on the level of human capital already attained. In addition,

[17] Because the level of human capital influences GDP growth, this implies that a one-time rise in the level of human capital has a permanent influence on GDP growth.

it is likely that other, institutional factors influencing human capital formation change over time causing a change in coefficient over time.

These problems make it difficult to analyze the results. Are they reliable or are they caused by bad data, parameter heterogeneity, non-linearities, or country-specific changes over time? This is the reason why, for example Pack (1994, 70) argues that '[t]he challenge for empirical work is to test the implications of the new theory more directly. In practice, this means testing its insights against the economic evolution of individual countries using time series data.' Equally, Temple (1999, 119-120) argues that 'it is important to remember that growth regressions will never offer a complete account of the growth process, and that historical analyses must have an important complementary role.'

6. RESEARCH QUESTIONS

The main advantage of the new growth theories is that they incorporate explanations for long-run growth (human capital and technological growth) into the model. In this way it became theoretically possible to determine the importance for growth of technology and human capital accumulation. Yet, the empirical estimates suffer from two important drawbacks. First, there is the problem of the human capital data. Both branches of the new growth theories use human capital in their empirical work. However, while in the Lucas (1988) model human capital is inserted as a factor of production, in the Romer (1990) model it is used as a facilitator of technological growth. The definitions of human capital are different in the two theories, making a comparison using the same data difficult. In addition, most human capital proxies suffer from large measurement errors. Second, even if we had the correct data, we still have to interpret our findings and find out how the country-specific educational institutions affect the growth path.

These two problems will be in the centre of this study as they 1) make it possible to quantify the process of economic growth, and 2) determine part of the cross-country differences in growth. In other words, they allow to test whether the different growth experiences of Japan, India, and Indonesia are caused by technology and/or human capital as suggested by the new growth theories. Consequently, the question this book aims to answer is whether the new growth theories explain why Japan was a relatively successful economic developer compared with India and Indonesia.[18] This requires a historical and data-related

[18] One could see this solely as a study into long-run economic growth. Hence, the focus on the new growth theories would be redundant. However, as our point of departure is the current (new) growth theories and as their empirical application is related to the choice of data and institutions, it is important to first study how the choice

analysis to allow us to estimate and interpret the quantitative findings resulting from the new growth models. We will therefore focus on human capital as this is crucial in empirical estimates of both branches of the new growth theories.

7. CONCLUSION

Since in the 1950s development economics got a boost with the decolonization wave, research in this field has had problems in bringing theory and practice together. The neo-classical growth model of Solow in the 1950s offered a way to empirically test the role of physical capital in economic growth, but did not explain the sources of long-run growth. Yet, analyses of the effect of the growth of physical capital and TFP on economic growth over the twentieth century have shown that the share of physical capital in economic growth reduces in favour of TFP. The same pattern, although less pronounced, can be observed in developing economies such as India and Indonesia. Indeed, we find that Japan both in physical and human capital related variables exceeded, and continued to exceed, India and Indonesia as from the 1890s.

The finding of a large and increasing effect of TFP growth and the importance of social indicators for growth tells us that there is some other factor besides physical capital that is crucial for understanding growth. Indeed, this was also the conclusion of much research in the 1960s. But, as this research still largely took place within neo-classical boundaries, the best one could say was that these other factors reduced TFP. As TFP growth remained the source of long-run growth, what caused this growth still remained a mystery.

The attempts to bring long-run growth in the model combined with the increasing availability of large international datasets, was partly the reason for the formulation of the new growth theories. Two branches arose, both using human capital. The first branch saw human capital as a factor of production, while the second branch interpreted it as a facilitator of technology. Although it created the possibility to theoretically distinguish between human capital and technology as the main source of growth (the two branches of the new growth theories), the empirical distinction remained difficult. The available human capital data are unsuited to distinguish between the two theories and the lack of country specific studies make it difficult to interpret the empirical results. For example, does a significant country dummy tell us that there are institutional differences or that there is a difference in the level of human capital development?

of data and educational institutions modify the empirical estimates of the growth theories before turning to the final empirical results.

Consequently, we need both new data on human capital and a historical analysis resulting in testable implications for growth regressions. To this end, we start in chapter 2 with an overview of the use of human capital. Both historians and economists have proposed several ways to estimate human capital. The most often used indicator is the panel dataset of Barro and Lee (1993; 2001) which consists of five-yearly country-level data on average years of schooling in the population. These data are used in many empirical applications of the new growth theories, with the growth of per capita GDP as the dependent variable, but generally result in implausibly low human capital coefficients.[19] More interestingly, these analyses generally find that it is the level and not the growth of human capital that yields a slightly positive and significant coefficient. This points to the theory of Romer (1990) in which human capital is seen as a facilitator of technology. Yet, many problems have to be solved before arriving at this conclusion. First, one needs a valid definition of human capital. Second, the data on human capital must be improved. Many of the current proxies are based on educational enrolments and therefore exclude the quality of human capital. As the quality is likely to have increased over the twentieth century, this is crucial in analyzing the effect of the growth of human capital on economic growth. Third, more attention must be given to country specific aspects. Most models are based on the assumption of perfect markets. Therefore, they encounter difficulties in explaining differences in the relation between education and growth between countries. Yet, looking at the country specific development of education, one may find patterns that explain part of these differences.

Consequently, first we must create a set of estimates of the human capital stock that conform to a standard definition and look how it relates to changes over time in the educational structure. This is the topic of chapters 3-5. In chapter 3 we start by collecting the available data on education. These are mostly data on enrolment and educational expenditure. Especially in Indonesia and India these data are often difficult to collect. The resulting time series are interpreted in chapter 4. In chapter 5 we combine these analyses of the educational structure and the data in alternative estimates of the human capital stocks for India, Indonesia, and Japan between 1890 and 2000. We try to use all available data without restricting ourselves in the possibility to bring the series back in time. The results seem fairly consistent, also when compared with physical capital and GDP.

The second step is to use the new human capital estimates and the interpretation of educational development to distinguish between two branches of the new growth theories.

[19] This is especially true if these results are compared with micro studies on the same topic.

This is done in chapter 6. Although this tells us something about the theoretical and empirical applicability of these growth theories on economic development in India, Indonesia, and Japan, it still does leaves open the question how to interpret the cross-country differences. This is the topic of chapter 7 where we use the hypotheses derived from our analysis of the educational structure in chapter 4 to interpret the estimation results.

In chapter 8, we bring all these facets together. The main conclusion is that the new growth theory is to a large extent capable of analyzing the relation between human capital and economic growth when account is taken of institutional differences among countries, *ceteris paribus*. Equally, it explains a large part of divergence in per capita GDP. Therefore, it is crucial that historical country-specific analyses are performed in order to arrive at hypotheses which can be tested with the use of the new growth theories. Without these analyses, it remains virtually impossible to estimate, let alone interpret, any changes in the relation between human capital and growth, be it over time or among countries.

2. Literature on the relation between human capital and economic growth: definitions and problems

1. INTRODUCTION

Human capital is one of the big unknowns of research on the determinants of economic development. The majority of empirical and theoretical literature suggests the existence of a relationship between social indicators and economic growth. Human capital is deemed an important and special component of social development, which can be accumulated and probably has external effects. Another important aspect of human capital is that it can be quantified.

For any empirical research into the relationship between human capital and economic development, one needs to assess the possibilities of gaining knowledge about human capital either by using proxies or by estimation methods. These options will be discussed in section 2. Even when one has the necessary data, it remains an important question how to use these in empirical specifications, that is, how they can be related to theoretical constructions. This is what we focus on in section 3. In section 4, we offer a definition of human capital that we will adhere to in the rest of this thesis. Finally, section 5 deals with the effect of institutional changes on the relationship between human capital and economic growth.

2. AN OVERVIEW OF HUMAN CAPITAL MEASURES

2.1 Broad measures of human capital in economic historical research

The notion of human capital arose out of the awareness that physical capital alone was not enough to explain long run growth. Many social indicators such as educational enrolments and life expectancy became combined in a common term: human capital. Often, human capital is implicitly referred to as formal and informal education. Yet, it can also contain factors such as the costs of raising children, health costs, and ability.

Human capital became especially popular in historical research after the rise of growth theory in the 1950s and the human capital theory advocated by Becker (1964) and Schultz (1961). Yet, historians already used human capital, education, or skills in their work before that period. As Nakamura (1981, 263) remarks: ‘Historians, from the time that they began to ply their trade, have tended to feature the human factor as the central and critical instrument for the achievement of progress and the betterment of life.’ Yet, in the period before the 1950s, historians generally included human capital in a very general way in their research. In these works it is often referred to as either literacy or skills (see for example Cipolla 1969; Houston 1983).

Following the human capital revolution in the 1960s, however, a dichotomy took place in historical research. Historians researching pre-modern economies remained with their old proxies[20] because no better were available. In research focusing on modern economies (the late nineteenth and the twentieth centuries), historians and economist used mostly the same proxies.

The definitions of human capital applied by historians of pre-modern economies remained very broad. For example Nakamura (1981, 265), for pre-modern Japan, defines human capital broadly as ‘labor skills, managerial skills, and entrepreneurial and innovative abilities-plus such physical attributes as health and strength’. Newland and San Segundo (1996, 699) also use several measures as indicators of human capital of slaves in Peru and La Plata in the eighteenth century such as physical strength and skills. As such they see human capital on the one hand as ability and education of an individual and, on the other, as the costs of physically raising a child or its health. Some exceptions to this broad definition of human capital in historical research for the pre-modern period come from more quantitatively oriented economic historians (Sandberg 1979; Rosés 1998; Van Zanden 2004; Reis 2005). For example Van Zanden (2004, 11-15) measures the price of human capital as the relative wage of skilled labourers such as carpenters and bricklayers compared with unskilled labour. This measure, which includes factors such as on the job training and experience is the same as used by Rosés (1998) while Reis and Sandberg (1979, 225) restrict their definition largely to literacy thus also ignoring for example ability and experience.[21]

After the rise of the growth theory and the human capital proxies in the 1950s and 1960s, in much historical research focusing on the late nineteenth and early twentieth century models including human capital in some form were also estimated. These studies tend to narrow[22] the scope of human capital proxies, first to better resemble the ones used by economists and, second, to make appropriate use of the available data. There are many examples of such analyses. To name just a few, Ljungberg (2002) uses enrolment and expenditure on education to look at the causality between education and growth in Sweden

[20] Of course, literacy is still much used as more comprehensive human capital measures are still hard to get by.

[21] It is interesting that many studies which, before the 1970s used terms like ‘literacy’ and ‘skills’, started to use the term ‘human capital’ for the same variables. Examples before 1965 are Smith (1952, 7) who points at the importance of education for the richer peasants in Japan during the Tokugawa period and Eckaus (1961, 291). The same vision that literacy is important for economic and social development is given by De Vries and Van der Woude (1997, 169) although they phrase the same variables in terms of human capital.

[22] They are called ‘narrow’ because they exclude the costs of raising a physical person.

between 1867 and 1995, Nunes (2003) considers the cyclical behaviour of government expenditure on education in Portugal between 1852 and 1995, and Marchand and Thélot (1997) estimated an index of human capital for France for over 200 years using the number of economically active persons and an indicator of the quality of labour based on the productivity by years of schooling. Yet, although these estimates constitute an improvement over earlier, often broader defined measures of human capital, they still are only to a limited extent connected with economic theory. For example Broadberry and Crafts (1992, 543) used earnings per operative to proxy for human capital per worker. They also treat the question of a possible endogenous relation (higher productivity means higher wages, but higher wages indicate a higher productivity) and of distortions in the wage structure by trade union bargaining by saying that these factors outweigh each other. However, it is not perfectly clear how to interpret this variable. Can we, for example, treat it as a proxy for a stock or a flow variable? According to human capital theory this should be seen as a flow variable since it neither keeps track of all investments in human capital nor of all possible future extra earnings. Nevertheless, it also encompasses education, ability, and on the job training which also affect wage. In the same line of reasoning, however, one may argue that it ignores the costs of raising a child and is thus a much narrower definition of human capital than the one used by Nakamura (1981) and Newland and San Segundo (1996).

2.2 Education stock[23]

Compared to most historians (maybe with the exception of economic history research on the nineteenth and twentieth century after the human capital revolution in the 1960s), economists are somewhat more restrictive in their definitions of human capital. This is partly because they work with relatively recent data and partly because economists often focus on the relation between two variables while historians tend to look at a broad spectrum of factors influencing a certain development.

But even when a narrow definition of human capital is used, calculating a human capital stock series in monetary terms is very data- and time intensive. As economists generally work with datasets that consist of a large number of countries, they prefer to use relatively easy collectable data that reflect the movement of the human capital stock over time. Therefore, the most popular method to proxy the human capital stock is the educational stock-approach. In essence it is an umbrella term for proxies of human capital, variables supposed

[23] Sections 2.2 and 2.3 are largely based on Le, Gibson, and Oxley (2003) and Wößmann (2003).

to reflect the fluctuations of human capital. These proxies are based on formal education such as enrolment ratios and literacy rates.

One of the earliest forms in which human capital proxies were included in growth theories was in growth accounting exercises. Labour inputs were augmented by such categories as age and education (Denison 1967) to account for the heterogeneity of labour. However, these studies are restricted both in the time period and the number of countries under study. With the availability of the Penn World Tables (Summers and Heston 1988; 1991) it became possible to perform cross-country analyses which required a large human capital database. Therefore, human capital was proxied by easily accessible variables such as adult literacy ratios and school enrolment ratios (Azariadis and Drazen 1990; Romer 1990). These proxies, however, have some disadvantages. First, the enrolment ratios are flow, and not stock, variables. Second, school enrolment is a measure of the number of students (who do not take part in the labour force yet) only, while adult literacy, by definition, only focuses on one effect of primary education and ignores other components of knowledge and human capital. Therefore, these variables were soon replaced with proxies that better conformed to the development of human capital, most notably 'average years of education' in the adult population. This is at the moment the state of art (Benhabib and Spiegel 1994; Islam 1995; Barro and Sala-i-Martin 1995; Barro 1997, 2001; Temple 1999; Krueger and Lindahl 2001).

'Average years of schooling' can be estimated in three different ways. The first way (Lau *et al.* 1991; and Nehru *et al.* 1995) is to use a Perpetual Inventory Method (PIM). Factors as enrolment, mortality and repeaters are aggregated to obtain estimates of 'average years of education'. The second method is the projection method (Kyriacou 1991). Here the 'average years of schooling' from the mid-1970s censuses is used as a benchmark. Data on lagged enrolment ratios are then used to project average years of schooling in the labour force for further countries and years. Kyriacou (1991) estimates the regression:

$$S_t^{PRO} = \alpha_0 + \alpha_1 e_{pri,t-15} + \alpha_2 e_{\sec,t-5} + \alpha_3 e_{high,t-5} + \varepsilon \,, \qquad (2.1)$$

where S_t^{PRO} is the projected average years of schooling in time *t*, $e_{a,t}$ is the enrolment ratio per level a (primary, secondary, higher) at time *t*. Next, he uses the estimated relation to estimate 'average years of schooling' for other years. Although he finds a strong relationship between 'average years of schooling' and lagged enrolment rates, his assumption that this relationship is stable remains doubtful. The third, and most comprehensive, method is the attainment census method. In this method attainment figures are directly taken from censuses (Psacharopoulos and Arriagada 1986). On this basis the 'average years of education' in the labour force is calculated. Yet, the number of censuses is limited, being generally available only once every 10 years. Because the attainment census method thus suffers from lack of data, Barro and Lee (1993) developed a method to interpolate the census data to obtain estimates of 'average years of education' for every fifth year.[24]

There are serious limitations to this proxy, though. For example, Portela *et al.* (2004, 5) have argued that the PIM using enrolment ratios underestimates attainment due to the assumption that mortality is not correlated with education. Yet, results from analyses based on proxies should be interpreted with great care since, even though proxies are related with the unobserved human capital, they are by no means identical.

If we want to capture all forms of gathering knowledge, whose efficiency may even change over time, 'average years of education' can hardly suit our needs. For example, it is possible that an extra year in higher education raises the human capital stock more than an extra year in primary education. Also, because these proxies are not expressed in monetary units, it is difficult to compare them with physical capital or to include them in the national accounts.[25] Parallel to the educational-stock method, alternative methods have been developed for the estimation of human capital stock. Although these are frequently in monetary units, they are often so data intensive that up till today no large dataset has been created. These alternatives will be discussed more in detail in section 2.3.

2.3 Pro and retrospective methods

Parallel to the educational stock method, other, more comprehensive, methods for estimating the stock of human capital have also been developed. Traditionally, these can be divided into two main categories: the income based approach (prospective) and the cost-based approach (retrospective).

We start with the cost-based approach. This method takes all costs of forming human capital into account retrospectively. Since this means that almost every aspect of human capital has to be calculated separately (education finance, food, health, etc.) this method is often far less broad than the prospective method. Engel (1883) was the first to apply a cost-based method when he estimated human capital from the costs of rearing a child. He argued that since it is difficult to anticipate future earnings, the production costs of human capital can be better sources of the estimation. The retrospective method remained very popular up to the

[24] For the data between two census or survey points, they used a weighted average of the forward flow and an interpolation between the two data points. For the points estimated before the first or after the last census point, they used the perpetual inventory method (PIM) to calculate the backward and forward flow respectively.
[25] An exception to the rule of using a non-money variable is Judson (1995, 16) who uses spending on education.

1930s (Dagum and Slottje 2000, 75). As a weakness, however, it should be noted that this method excludes social costs and the depreciation (or appreciation) of the human capital investments.[26]

In the 1960s Schultz (1961) and Machlup (1962) extended Engel's approach. They calculated human capital so that 'the depreciated value of the dollar amount spent on those items defined as investments in human capital is equal to the stock of human capital' (Le, Gibson, and Oxley 2003, 274). A more popular application (see for example Pyo and Jin 2000) of the cost-based approach is developed by Kendrick (1976). Kendrick estimated the human capital for the United States in the period 1929-1969 by estimating the tangible costs (rearing a child until age 14) and the intangible costs (health, safety, education, and the opportunity costs of students attending school).

A second method is the income-based approach (prospective method), which is based on future earnings. This is the oldest of all methods, starting with Petty (1690) who calculated the human capital of England as the difference between his estimates of the national income and property income, capitalized in perpetuity at a 5% interest rate (Dagum and Slottje 2000, 72). The basic idea behind the income-based approach is that human capital embodied in individuals is valued as the total income that could be generated in the labour market over a lifetime (Le, Gibson, and Oxley 2003, 273). This method was applied by Farr (1853) who created a formula to calculate the stock of human capital. The method was popular in the first half of the twentieth century (De Foville 1905; Barriol 1910; Dublin and Lotka 1930), but lost its popularity in favour of the cost-based approach after the 1940s. Two notable exceptions are the studies of Jorgenson and Fraumeni (1989) and Macklem (1997) about the USA and Canada respectively.

In general the income based methods produce somewhat higher estimates than the cost-based methods. This is largely because cost-based methods sum all investments in human capital whereas income-based methods sum all the extra earnings caused by human capital. Not only does the latter method in generally includes more aspects of human capital (for example ability) but it is also doubtful of all extra earnings are generated by human capital and not, for example, by class difference. However, more important is that these methods suffer from some weaknesses if one wants to insert them in growth regressions as is the aim of this thesis. First, in the retrospective method there is no necessary relation between the investment in human capital and the quality of output. This is the same in physical capital

[26] Of course, most studies make assumptions about this.

stock estimates, as the cost-based approach is based on investments and not on the market value of the output. Second, especially in the prospective method, also factors such as 'health' are included. These costs are, however, only important when one wants to calculate the money value of the labour force. Though, in a large part of the empirical applications of the new growth theories, the human capital stock is inserted next to the labour force. As a consequence, the broader definition of human capital as consisting of the total value of an individual cannot be used when one wants to insert a human capital variable besides labour in a regression equation. Third, the prospective method also rests on the assumption that wage differentials reflect differences in productivity. Fourth, data on earnings are not as widely available as data on investments, i.e. expenditure on education (Le, Gibson, and Oxley 2003, 281-283).

2.4 Combined approaches

Both the income- and the cost-based approach have their advantages and disadvantages. Therefore some authors have tried to integrate these two approaches. Besides computational ease, it also has the consequence of arriving at a measure of human capital that generally is more extended than those of the cost-based, but smaller than the income-based methods. Therefore, and because these methods are generally capable of getting round the main obstacles in both the cost- and income based measures, we elaborate on these methods in this section.

An important example of the combined method is Dagum and Slottje (2000). They equate the 'monetary value of a person's human capital with the average lifetime earnings of the population, weighted by the level of human capital that he has relative to the average human capital of the population' (Le, Gibson, and Oxley 2003, 293). By using a latent variable approach Dagum and Slottje (2000) try to remove the omitted variable bias, which plagues the income approach, i.e. ignoring the education of the parents (e.g. innate ability). Because people with more ability are less costly to educate, and because people with more ability generally earn more irrespective of their human capital, this might create a bias in the human capital estimates.[27]

[27] An ability bias is likely to occur for people with only lower or no education and people with higher education. The main idea is that people with only lower education either are not stimulated or do not have enough income to pursue more education irrespective of their ability. However, people in secondary education generally have the means to pursue further education, but, if they do not, are less likely to have an ability that exceeds their education level.

Another important example is Tao and Stinson (1997). The underlying idea in their work is that investments in human capital determine the human capital stock (cost-based method), while human capital determines earnings for individuals through the income based approach (Le, Gibson, and Oxley 2003, 290). They first establish an earnings function:

$$E_{i,j}^{s} = w_t h_{i,j}^{s}, \qquad (2.2)$$

where *s*, *i*, and *j* indicate sex, age, and educational level of and individual. Furthermore, w_t is the human capital rental rate (i.e. the returns to human capital) in year *t* and *E* are the earnings. As both the rental rate and human capital are unobservable, Tao and Stinson standardize the human capital stock of the base entrants. As they enter the labour force after completing college they still do not have experience or on-the-job-training affecting their human capital. After correcting for ability, for which they use the SAT score (a voluntary test for students which they use to reflect ability), it is possible to use the cost-based approach to estimate their human capital stock which is assumed to be the accumulated real expenditure on all education. As now for the base entrants both *h* and *E* are known, it is possible to estimate the rental rate, *w*, which is assumed to be constant across cohorts. Together with the earnings equation, the human capital for other groups can then be estimated.

The advantage of the Tao and Stinson (1997) method is that the cost method is only used to estimate the human capital of the base entrants; using this to estimate the other cohorts avoids the problem of what defines investment in human capital. Second, this method does not require an assumption of depreciation or appreciation of human capital. The method, however, also has some disadvantages. Because we want to use human capital in growth regressions, we would like to omit ability because it is no part of formal learning. Yet, in both combined methods ability is only to a limited extent treated. Dagum and Slottje (2000) try to correct using a latent variable estimation while Tao and Stinson (1997) use a SAT score which might be an imperfect measure of ability. In addition, both methods are very data demanding.[28] Therefore, if we want to estimate time series of the stock of human capital for the use in growth regressions, the combined approach is the best alternative but needs to be modified to become less data demanding and to avoid the inclusion of innate ability.

[28] A simplified method of Dagum and Slottje (2000) was applied in some cases. For example Wei (2001) applied it to Australia, Oxley and Zhu (2002) to New Zealand, and Földvári and Van Leeuwen (2005) to several Eastern European countries.

3 HUMAN CAPITAL IN GROWTH REGRESSIONS

3.1 Introduction

Even when a comprehensive stock of human capital is available, the question remains how to insert it in growth regressions. This is by no means easy to answer as it depends both on the theoretical specification used and on the empirical problems encountered. Human capital is inserted differently in empirical specifications depending on the theory. For example, as we will see in section 3.2, in the theory of Romer (1990) the growth of GDP is regressed on the level of human capital while in the theory of Lucas (1988) the growth of GDP is regressed on the growth of human capital. Equally, the effect of human capital on growth depends strongly on the empirical specification, a topic treated in section 3.3. For example, the inclusion of physical capital in the equation may structurally lower the human capital coefficient.

3.2 Theoretical use of human capital in growth regressions

3.2.1 Exogenous growth: the augmented Solow-Swan model[29]

The Solowian exogenous growth theory that was developed in the 1950s, at the height of the wave of newly independent countries, can be considered the immediate predecessor of the new growth theories that emerged in the 1980s and 1990s. Originally, it only included labour, *L*, physical capital, *K*, and technology, *A*, the latter exogenously explaining long-run growth. However, with the human capital revolution also human capital was augmented to this model. Yet, because also for human capital diminishing returns were assumed, no real difference took place in the structure of the theory.

The standard Solow-Swan model (Solow 1956; 1957; Swan 1956), augmented with human capital and starting with a Cobb-Douglas production function, can be written as:

$$Y_t = K_t^{\alpha} H_t^{\beta} \left(A_t L_t\right)^{1-\alpha-\beta} \tag{2.3}$$

Here, *Y* is GDP, *K* is physical capital and *AL* is effective labour, and $0 < \alpha < 1$ and $0 < \beta < 1$ are the given capital intensities of physical- and human capital which have decreasing returns.

Now, we can postulate that *Y* is either used for consumption or investment in human- and physical capital:

$$Y_t = C_t + \dot{K}_t + \delta_k K_t + \dot{H}_t + \delta_h H_t \tag{2.4}$$

[29] This section is based on Mankiw, Romer, and Weil (1992).

Here, δ is depreciation and C is consumption. As one may notice, A-type capital (technology) does not use Y. Hence, just as labour, it is exogenous. We assume that technology and labour grow at a constant rate g and n:

$$A_t = A_0 e^{gt} \tag{2.5}$$

$$L_t = L_0 e^{nt} \tag{2.6}$$

Per capita physical (k) and human (h) capital accumulation is endogenous (it depends on Y) and can be written as:

$$k_{t+1} - k_t = s_k y_t - (\delta + g + n) k_t \tag{2.7}$$

$$h_{t+1} - h_t = s_h y_t - (\delta + g + n) h_t \tag{2.8}$$

Here, s is the saving rate of physical capital, k, and human capital, h, and δ is the depreciation (assumed equal for physical and human capital).

Based on (2.7) and (2.8), inserting the per capita production function, and assuming that $s_k / s_h = k / h$, we arrive at the steady states of k and h:

$$k^* = \left(\frac{s_k^{1-\beta} s_h^{\beta}}{n + g + \delta} \right)^{1/(1-\alpha-\beta)} \tag{2.9}$$

$$h^* = \left(\frac{s_k^{\alpha} s_h^{1-\alpha}}{n + g + \delta} \right)^{1/(1-\alpha-\beta)} \tag{2.10}$$

If we substitute (2.9) and (2.10) in the production function and take the logs, we derive the steady state level of per capita GDP:

$$ln\left(\frac{Y_t}{L_t}\right) = ln\, A_0 + gt - \frac{\alpha+\beta}{1-\alpha-\beta} ln(n+g+\delta) + \frac{\alpha}{1-\alpha-\beta} ln(s_k) + \frac{\beta}{1-\alpha-\beta} ln(s_h) \tag{2.11}$$

We obtain the following for the growth rate of the steady-state per capita income:

$$ln\left(\frac{Y_t}{L_t}\right) - ln\left(\frac{Y_{t-1}}{L_{t-1}}\right) = g \tag{2.12}$$

However, this exogenous growth model is only to a limited extent suited to answer our main question how long-run growth takes place in India, Indonesia and Japan and how this affects cross country growth divergence. First, the exogenous growth theories do not explain long-run growth as it is determined exogenously. For example Bernanke and Gurkaynak (2001, 15) point out that '"explaining" growth by assuming that growth rates differ exogenously across countries is not particularly helpful. Once it is allowed that long-run growth rates differ across countries, we are naturally pushed to consider explanations for these differences, as offered by endogenous growth models.' Second, the exogenous growth theories also do not explain economic divergence, which did to some extent take place.[30] Third, there is plenty of evidence against the exogenous theories. Bernanke and Gurkaynak (2001) argue, based on the characteristics of the Solow model, that endogenous growth theories explain long-run growth better. Equally, there exist a large literature that shows that permanent changes in government policy have a permanent effect on national income growth, which is characteristic for the new growth theories (see for example Kocherlakota and Yi 1996; 1997). In addition, we estimated equation (2.11) and (2.12) jointly for India, Indonesia, and Japan using a Seemingly Unrelated Regression (SUR)[31]. The growth of per capita GDP (equation (2.12)) should not be determined by population growth, and investments in physical- and human capital. Therefore, we test of the sum of these coefficients in this equation is zero. This is rejected, which means that, under the assumption of a steady state, exogenous (thus Solowian) growth is rejected.[32] Therefore, we further focus solely on the new (endogenous) growth theories.

3.2.2 The new growth theories

In the neo-classical growth model from the 1950s (Solow 1956; 1957) no special attention was given to human capital. Basically, it was argued that the growth of physical capital had an effect on the growth of GDP while the unexplained residual, labelled Total Factor Productivity (TFP), explained economic growth in the long-run. The rise of human capital theory (Schultz 1961; Becker 1964) led to the inclusion of human capital. Yet, although this reduced TFP, still long-run growth was completely explained by this unobserved component. The growing awareness that the neo-classical growth theory was not able to explain long-run

[30] Of course one can modify exogenous growth theories to such as extent that one includes endogenous human capital growth a la Lucas. This sort of model can explain divergence among groups of countries (such as developed and developing countries) and, at the same time, convergence in countries with comparable levels of human capital. However, as our aim is mainly directed at the between group properties, there is here no direct need to make things more difficult and we remain with the endogenous theories.
[31] Because both equations have the same independent variables, the errors may be correlated.
[32] In Indonesia and Japan the null hypothesis is rejected. This is not the case for India. However, it is possible that no steady state is present. In addition, in chapter 6, section 3, we found that for extensive periods there are constant marginal returns to human capital accumulation which also points to the rejection of exogenous growth.

growth led to the introduction of the new growth theories. In these theories, human capital was (in a direct or indirect way) modelled as a factor of long-run growth.

One of the first main new growth theories is the Romer (1986) model. However, this model is less suited to answer our main question on long-run growth and the role of human capital. Basically, this model looks at non-decreasing returns to scale in capital alone which makes it difficult to study differences among countries. However, the currently much used theories of Lucas (1988) and Romer (1990) have the rate of technological progress determined endogenously. This can differ permanently across countries reflecting structural differences.[33] To see this lets start with the Romer (1986) model. The standard production function is:

$$Y_i = F\left(K_i, A_i L_i\right) \tag{2.13}$$

Here, Y is GDP, K is physical capital, A is technology, and L is labour in firm i. Based on Arrow (1962), Romer (1986) made two assumptions about productivity growth. First, 'learning by doing' works through investments by firms. This means that an increase in a firm's capital stock, K_i, leads to a simultaneous increase in its stock of knowledge, A_i. Second, each firm's knowledge is free available to all other firms. This means that the increase in one firm's technology, $\dot{A}_i$, is equal to the development of the knowledge in the entire economy, $\dot{A}$. This, in turn, is equal to the change in the capital stock in the economy, $\dot{K}$. This means that we can replace A_i is equation (2.13) with K_i:

$$Y_i = F\left(K_i, KL_i\right) \tag{2.14}$$

We now also use the assumption of constant returns, which means that if each factor doubles, output doubles. As technology grows proportionally with capital, an increase in physical capital leads to knowledge, which leads to a proportional increase in technology. Hence, a doubling of physical capital leads to a doubling of technology and hence, due to constant returns, a doubling a GDP. In this way, endogenous growth is achieved.

Yet, as indicated, this model is less suited to answer our main question. Therefore, we focus on the two main branches of the new growth theories that are used today, namely the Lucas (1988) and the Romer (1990) model. The first branch, pioneered by Uzawa (1965) and Lucas (1988), sees human capital as a factor of production. Consequently, human capital was defined as the skills embodied in a labourer. As each person is the master of his or her own

[33] In addition, it is a razor blade model. Only if physical capital grows exactly proportionally with knowledge, there is endogenous growth. In the other cases growth is either explosive or tends to zero in the long-run (Diebolt and Monteils 2000, 17). Endogenous growth is thus only one out of many possibilities in this model.

skills and the use in one occupation precludes the use in another occupation: these skills are rival and excludable. The basic difference from the neo-classical growth theory is that the Lucas (1988) model has two sectors. In the first sector, human- and physical capital is used to produce output, leading to the following production function:

$$Y = AK^{\alpha}\left(uhL\right)^{1-\alpha} h_a^{\gamma} \tag{2.15}$$

where A is the level of technology, K is physical capital, u is the time devoted to productive activities, h is per capita human capital, L is the size of the labour force, and h_a^{γ} is the average positive external effect of human capital. If we rewrote (2.15) in terms of a growth rates, we would, just as in the neo-classical growth theory, arrive at an equation where the growth of GDP is explained by the growth of physical and human capital. The difference between his branch of the new growth theories and the neo-classical thus arises out of the main source for endogenous growth: the second sector.

In the second sector, a share of human capital that is not utilized in the productive sector is used to produce extra human capital.[34] Only if this exhibits non-diminishing returns there is endogenous growth. This can be written as:

$$\dot{h}_t = h_t B\left(1-u_t\right) - \delta h_t \tag{2.16}$$

, where δ is the depreciation of human capital, $\left(h\right)$, $B\left(1-u_t\right)$ indicates the increase in the amount of human capital. In other words, B is a technical parameter determining at what rate investments in the second sector are converted to a growth of human capital, and $\left(1-u_t\right)$ is the share of human capital that is devoted to human capital formation. Equation (2.16) has constant marginal returns because the growth of human capital is independent of its level, i.e. an increase in human capital for a higher educated person requires the same effort as for someone at primary school. Consequently, the growth of human capital can be written independent of its level:

$$g_h = \dot{h}_t / h_t = B\left(1-u_t\right) - \delta \tag{2.17}$$

From equation (2.15) and (2.17) we can obtain the growth rate of GDP. We can rewrite equation (2.15) as:

$$Y = AK^{\alpha}\left(uL\right)^{1-\alpha} h^{1-\alpha+\gamma} \tag{2.18}$$

Now rewrite equation (2.18) in growth rates:

[34] One could argue that human capital formation needs both physical and human capital inputs although its formation is generally human capital intensive. However, we are inclined to say that all spending (so also spending on school buildings etc) can be argued to be human capital investments. Under this assumption the accumulation of human capital depends solely on human capital investments.

$$\frac{\dot{Y}}{Y}=\frac{\dot{A}}{A}+\alpha\frac{\dot{K}}{K}+\left(1-\alpha\right)\left(\frac{\dot{u}}{u}+\frac{\dot{L}}{L}\right)+\left(1-\alpha+\gamma\right)\frac{\dot{h}}{h} \tag{2.19}$$

Now assuming *A* and *u* constant, equation (2.19) becomes:

$$\frac{\dot{Y}}{Y}=\alpha\frac{\dot{K}}{K}+\left(1-\alpha\right)\frac{\dot{L}}{L}+\left(1-\alpha+\gamma\right)\frac{\dot{h}}{h} \tag{2.20}$$

Now assuming no depreciation in equation (2.17) $\left(\dot{h}_t/h_t=B\left(1-u_t\right)\right)$, and a balanced growth path $\left(\frac{\dot{K}}{K}=\frac{\dot{Y}}{Y}\right)$, equation (2.20) becomes:

$$\frac{\dot{Y}}{Y}-\alpha\frac{\dot{Y}}{Y}=\left(1-\alpha\right)\frac{\dot{L}}{L}+\left(1-\alpha+\gamma\right)B\left(1-u\right) \tag{2.21}$$

We can write this in per capita terms as:

$$\frac{\dot{y}}{y}\left(1-\alpha\right)=\left(1-\alpha+\gamma\right)B\left(1-u\right) \tag{2.22}$$

Rewriting:

$$\frac{\dot{y}}{y}=\frac{1-\alpha+\gamma}{1-\alpha}B\left(1-u\right)=\frac{1-\alpha+\gamma}{1-\alpha}\cdot\frac{\dot{h}}{h} \tag{2.23}$$

This is exactly the result obtained by Diebolt and Monteils (2000, 9). Growth can thus be caused by the effectiveness of human capital accumulation, *B*, the positive externalities of human capital, γ, and the share of human capital devoted to human capital accumulation, *1-u*. All growth in output is thus derived from human capital growth. This means that endogenous growth can only exist if there is a constant growth of human capital, which in turn can only be the case if there are constant or increasing marginal returns to human capital accumulation.[35] As can be seen in equation (2.23), this causes growth in production even without the presence of positive external effects. Positive external effects can accelerate growth, but in itself cannot cause endogenous growth.

The second major branch of the new growth theories is pioneered by Romer (1990). This model has three sectors: a technology producing sector, an intermediate goods producing sector where capital goods are produced, and a final output producing sector. In the first sector, technology is used as targeted knowledge, e.g. a set of institutions that makes it possible to manufacture capital goods for the second sector (Diebolt and Monteils 2000, 13). Hence, 'knowledge' in the definition of Romer (1990) is not a part of the individual as is the case in the theory of Lucas (1988). The part of human capital that is not used directly in the

[35] Then, unlike the physical capital stock which is subject to an upper limit, human capital could grow infinitely.

sector producing final output is used to create new technologies. The level of human capital, *H*, thus has a positive effect on the growth of technology, *A*. The growth of technology in the first sector can thus be given as:

$$\dot{A} = \sigma H_A A \tag{2.24}$$

Here $\dot{A}$ and A are the growth and level of a technology index respectively. H_A is the amount of human capital devoted to the accumulation of technology ($\dot{A}$) and σ is a productivity parameter. Please note that the inclusion of the level of technology (*A*) in above equation is largely a matter of convenience (as Romer (1990, S84) also admits) as it makes the log-linearization easier. Its only effect is that a higher level of technology creates a higher absolute effect of *H* on the accumulation of technology. However, in relative terms (see equation (2.27)) the inclusion of the level of technology has no effect.

In the second sector, each new *A* creates a new intermediate product, *x*., which in turn determine capital, *K*. Hence, K depends on the number of intermediate products, *t=1…A*, and the price of a unit of *x* expressed in consumption, η:

$$K = \eta \sum_{i=1}^{A} x_i \tag{2.25}$$

The function for the third, final output, sector thus becomes:

$$Y = H_Y^{\alpha} L^{\beta} K^{1-\alpha-\beta} \tag{2.26}$$

Here, H_Y is an exogenous variable indicating the amount of human capital not used in the technology producing first sector. In other words, it is the amount of knowledge used to apply technologies to the production process.

In this model, endogenous growth thus stems from the positive effect of research on innovations whereas more innovations increase productivity of researchers in the future. In other words, if we see equation (2.24) in terms of the Lucasian second sector (without depreciation) we can argue that the source of endogenous growth is the existence of constant marginal returns to technology accumulation which is indeed implicitly assumed in equation (2.24). This has the consequence that, on a balanced growth path, the level of human capital increases output growth, i.e.:

$$g = \dot{Y}/Y = \dot{K}/K = \dot{A}/A = \sigma H_A \tag{2.27}$$

It is worth noticing that, because we are looking at the growth rates (hence log-linearizing the equations), the accumulation of technology becomes independent of *A* in equation (2.24) thus arriving at σH_A in equation (2.27).

3.3 Empirical models

Although the theoretical differences between the two models are quite pronounced, it is not as easy to empirically distinguish between them. First, it is difficult to distinguish the new growth theories from the neo-classical theory. As pointed out in the previous sub-section, the Lucas (1988) model predicts that the growth of human- and physical capital determine the growth of GDP. This is the same as in the neo-classical model. Second, it is sometimes argued that the neo-classical growth theory predicts convergence among countries while convergence is not present in the new growth theories. In those cases, often initial GDP is included in regressions. If, when other variables are included to pick up the difference in steady state level, its coefficient is negative, this means that the higher initial GDP is (the more advanced an economy is), the slower its subsequent growth, i.e. conditional convergence.[36] If no (conditional) convergence is found, it is assumed that the new growth theories are applicable and vice versa. Yet, as Pack (1994, 65) argues, even in neo-classical theory sustained differences in economic development can exist if the ability to obtain international technologies varies among countries. On the other hand, convergence is now also possible in the new growth theories. Indeed, as Islam (2003, 311) argues, 'as a consequence of the give and take between the NCGT and NGT, it is now possible, generally speaking, to explain both convergence and non-convergence behavior by appropriately chosen models of growth theory of both these varieties.'

It is also difficult to distinguish between the new growth theories. Although the theoretical differences among the competing models are identified, the lack of data often prevents empirical testing. In addition, the Romer (1990) model does not exclude the Lucas (1988) model, rather complements it. While human capital facilitates technological development, it remains in the model as a factor of production as well. Consequently, finding a positive effect of the level of human capital on growth is in itself not sufficient evidence to reject the Romer (1990) model. Finally, both theories have a different view on human capital. Theories focusing on human capital as a factor of production see human capital as individual

[36] As we have seen in equation (2.11), the steady state relation for per capita GDP in the augmented Solow model depends on the following elements A_0, g, α, β, n, δ, s_k, s_h. Unconditional convergence implies that all these elements are the same for the countries considered. This means that if the level of initial per capita GDP is inserted in an equation with the growth of per capita GDP as the dependent variable, it should always have a negative coefficient (the higher initial GDP, the lower growth) even if no other variable were inserted on the right hand of the equation. Conditional convergence, however, implies the existence of more steady states. This means that the appropriate other elements should be inserted to control for these different steady states. For an excellent description of growth theories and convergence see Islam (2003).

skills of a labourer which are rival and excludable. Yet, if human capital is seen as a facilitator of technology, human capital is viewed upon as 'knowledge' and 'ideas' which are largely non-rival and non-excludable.[37] Given the character of the difference, it is often difficult to directly compare these two theories.

However, these drawbacks did not prevent scholars from performing regression analyses. Two types of estimates can be distinguished. First, the bare model which consist of human capital and GDP alone. This can be traced back to a Macro-Mincer equation.[38] In the original micro equation, as proposed by Mincer (1974), the log wage of an individual is regressed on its education level. Soon this regression was also applied to macro-data. In the latter regressions mostly the growth of per capita GDP was regressed on the growth and level of the stock of human capital. A typical Mincer macro growth regression in a panel is:

$$ln\, y_{it} = \beta_{0,it} + \beta_{1,it} Educ_{it} + \varepsilon_{it}\,, \tag{2.28}$$

where $\ln y$ is the logarithm of per capita GDP[39], and *Educ* are 'average years of education' in country *i* in year *t*. This model is based on empirical microeconomics literature (see for example Psacharopoulos 1994). It is important to note that both the education and GDP variable are in levels. If there are no breakpoints in coefficient of the education variable, this would be equivalent to saying that the growth of per capita GDP is regressed on the growth of education, i.e. the theory of Lucas. However, if a time series component is used, it might be better to take first differences of this model, i.e. regressing the growth of per capita GDP on the growth of per capita human capital, or to estimate a cointegration relation in order to avoid a spurious regression.[40] However, it is doubtful if one can simply use a micro-regression at the macro level. Yet, Heckman and Klenow (1997) and Acemoglu and Angrist (1999) argue that, if they control for life-expectancy to proxy for technological differences in countries, the micro and macro regressions yield similar estimates.

[37] As mentioned in the introduction, often there is a strong correlation between the two forms of human capital. This makes it possible to use either one of them to insert it in a regression in the form of the level and growth in order to test which growth theory seems to best fit.

[38] For example, in the technology models, human capital is seen as 'ideas' which are non-rival and only partly excludable. This makes it difficult to attribute human capital to the individual worker as is done in the micro Mincer equations. Equally, increasing marginal returns to human capital accumulations in the Lucas theory are possible if, for example, the quality of human capital increases or if successive generations inherit human capital accumulated by their parents (L'Angevin and Laib 2005, 7). This effect is unlikely to be picked up by a micro Mincer, except when using monozygotical twins or using panel with more generations. In addition, as generally a Mincer equation is used for individual persons, per definition increasing returns are hard to get. Consequently, in our vision, what is called a 'macro-Mincer' equation is actually a growth equation with solely human capital as the dependent variable. The equation looses its characteristics of the original Mincer equation.

[39] In a micro Mincer equation, this would be replaced by the wage of individual *i*.

[40] As most researchers find it difficult to make an *a priori* distinction between both branches of the new growth theories. They therefore include both the level and growth of education in this model.

The second group of empirical models also includes other variables besides human capital. These can either be structural regressions including human- and physical capital, or *ad hoc* Barro-regressions containing all variables deemed to have an influence on economic growth. Often these are investment ratios, geography dummies, and initial GDP. Yet, the robustness of these variables is doubtful (see for example Levine and Renelt 1992).

3.4 Some results from the literature

The result of the theoretical and methodological problems is that there are many empirical analyses where the growth of GDP is regressed on both the growth and the level of human capital while the main differences between the specifications is in the extra independent variables. Although the augmented Solow model is of less use for this thesis, we will present some of its results in table 2.1 because it is often difficult to disentangle these results from Romerian or Lucasian growth. Because elasticities are generally imposed, we report the

Table 2.1: Overview of the effect of human capital on economic growth in an (Augmented) Solow model *

Author	Output	TFP	Physical capital	Human capital	Comments
Mankiw, Romer, and Weil (1992)	Level accounting: cross-country differences in output per worker, 98 countries in 1985.	22%	29%	49%	K=0.31; H=0.28
Bosworth, Collins, and Chen (1995)	Growth accounting: cross-country differences in 1960-92 growth in output per worker, industrial countries.	44%	43%	13%	K=0.3 (0.4 for developing countries) H= 0.7 (0.6 for developing countries)
Bosworth, Collins, and Chen (1995)	Growth accounting: cross-country differences in 1960-92 growth in output per worker, Asia (excluding China.	26%	62%	12%	
Hall and Jones (1999)	Level accounting: cross-country differences in output per worker, 127 countries in 1988.	61%	17%	22% (educational attainment of the population of 25 year and older.	K=0.3; H= piecewise linear to years of education.
Klenow and Rodriquez (1997)	Level accounting: cross-country differences in output per worker, 98 countries in 1985.	67%	29%	4%	K=0.30 H=0.28
Klenow and Rodriquez (1997)	Growth accounting: cross-country differences in 1960-85 growth in output per worker, 98 countries.	85-90%	3%	6-12%	

* Level and growth accounting n the form Y=AX. Contribution of each factor TFP, human- and physical capital to output.

percentage effect on GDP (growth). Basically, we can see that the more modern the studies are, the higher the effect of TFP growth on per labourer growth is (see also Sianesi and Van Reenen 2003, 172). The role of human capital, however, seems to decline in favour of TFP.

Besides a change in estimation technique, this may be attributed to two developments. First, the effect of TFP growth seems to increase over time (see for example table 1.1 in chapter 1). As later studies generally use samples that shift forward in time (and have a changing and expanding set of countries in their sample), it might be possible that newer studies find a higher effect of TFP growth on GDP growth. Second, older studies often use different human capital variables. As we have seen in the previous sections, originally studies focused on variables such as literacy and enrolment rates. However, in more recent studies the focus has shifted toward 'average years of education'. Yet, with all their problems, literacy and enrolment rates are obvious proxies for the level and growth of human capital respectively. But 'average years of education', as we will discuss in section 5 in chapter 6, although generally used as a proxy of the level of human capital, might also be interpreted as a proxy of the growth of human capital. If the latter is true, this means that, when using the growth rate of 'average years of education' to proxy the growth of human capital, one is actually proxying the growth of the growth of human capital. Obviously this reduces the effect of human capital on growth considerably, even with imposed elasticities.

However, as pointed out in section 3.2.1 in this chapter, Solowian growth is unlikely to have taken place in India, Indonesia, and Japan during the period of our study and, anyway, does not allow directly answering our main question about long-run growth and economic divergence. This has been the field of the new growth theories. As we can see in table 2.2, and as has been indicated in much of the literature (Romer 1990a, 280; Monteils 2002) the effect of the accumulation of human capital on the growth of GDP does not seem to be large. As can be seen from table 2.2, the effect of a 1% increase in the level of human capital results in an increase in the growth of human capital between 5.7 and 0.3 percentage point.[41] The effect of the growth of human capital on economic growth, however, gives an insignificant coefficient, a negative coefficient as in the famous study of Benhabib and Spiegel (1994), or a low positive coefficient.[42]

These results suggest that the model of Romer (1990) seems to fit the data better than does the model of Lucas. However, discussion on both in the specification of the regression and the quality of the underlying data make it difficult to make an objective judgement about

[41] If you have continuous time than a 1% increase in the level of average years of education causes an x percentage point increase in the growth of per capita GDP. However, if you regress the log-level of per capita GDP on the log-level of average years of education, the coefficient indicates that if average years of education increases with 1%, per capita GDP growth increases with x%. A third option is if you regress the growth of per capita GDP on the level (thus not in logarithmic form) of average years of education. In this case a one year increase in average years of education increases the per capita GDP with x percentage points.
[42] An exception is the corrected Barro & Lee data used by Portela *et al.* (2004).

Table 2.2: Overview of human capital coefficients by technique, theory (level or change variable), and type of regression

Author	Human Capital Variable	Technique	Coefficient	HC in regression inserted as:
Krueger&Lindahl (2001)	Log Kyriacou average years of schooling	Pooled OLS, annualized data	0.003	Level
Benhabib and Spiegel (1994)	Log Kyriacou average years of schooling	Pooled OLS, Annualized data	0.010	level
Barro and Lee (1993)	Log of Barro & Lee average years of schooling	Pooled OLS	0.057	Level
Cohen and Soto (2001)	Corrected Barro & Lee average years of schooling	Pooled OLS, Annualized data	0.0032	Level
Portela *et al*. (2004)	Corrected Barro & Lee average years of schooling	Pooled OLS, Annualized data	0.0037	Level
Portela *et al*. (2004)	Corrected Barro & Lee average years of schooling	Pooled OLS, Annualized data	0.0486	Change
Levine and Renelt (1992)	Initial secondary school enrolment rate	Pooled OLS, Annualized data	0.032**	Change
Krueger&Lindahl (2001)	Log change Kyriacou average Years of schooling	Pooled OLS, Annualized data	0.012*	Change
Benhabib and Spiegel (1994)	Log change Kyriacou average Years of schooling	Pooled OLS, Annualized data	-0.072	Change

* Insignificant
** Base estimate

which human capital theory approaches the actual process best. This is also true because even those studies that insert human capital as a level often find human capital coefficients that are lower than might be expected on the basis of micro studies.

Indeed, the specification of the equation may be important for finding these results. First, Topel (1999) argues that Benhabib and Spiegels findings of an insignificant and negative sign of the effect of schooling changes on GDP (see table 2.2) is due to their log-specification of education.[43] The log-log specification follows if one assumes that schooling enters an aggregate Cobb-Douglas production function linearly. Given the success of the Mincer model, however, it is more natural to specify human capital as an exponential function of schooling in a Cobb-Douglas production function, so the change in linear years of schooling would enter the growth equation. Second, in Benhabib and Spiegel's work (just as in most other studies) the education change variable is highly dependent upon physical capital. This is caused by the situation that the education variable conveys almost no signal conditional on the other variables. This is largely due to mismeasurement of human capital and to a possible simultaneity bias in physical capital causing an upward bias in the

[43] Benhabib and Spiegel's (1994) work as indicated in table 2.1, was based on Kyriacou's data which, as we have seen (section 2), is estimated as a stable relation between census data and enrolment figures. This is a serious reason for noise as this stable relation is not sure to hold for all periods or countries.

coefficient of physical capital.[44] Third, put forward by De la Fuente and Doménech (2000, 18), another problem with inserting physical capital in growth equations with human capital is that during periods with declining growth rates of production, physical capital investments also decline. If the human capital stock exhibits a constant growth rate or even an increasing growth rate, it would create an insignificant or even negative human capital coefficient. If taken in levels, inclusion of physical capital in the regression causes the human capital variable to become significant. This becomes especially clear if one looks at the change variable in the Mincer equation. Contrary to the production function specifications that include physical capital, the coefficient here is positive and statistically significant.

Finally, there is the problem of mismeasurement of the human capital proxies (De la Fuente and Doménech 2000; Krueger and Lindahl 2001; Portela *et al*. 2004).[45] In section 2, we already went into the discussion that many of these proxies, also those using average years of schooling, are an imperfect measure of human capital. Krueger and Lindahl (2001, 1117) point to the fact that, of those proxies, the Barro and Lee data convey more signal[46] when expressed in changes than the Kyriacou data. However, we need to be aware that '[d]espite the greater reliability of the Barro-Lee data, there is still little signal left over in these data conditional on the other variables' (Krueger and Lindahl 2001, 1117). One obvious point is that the measurement error in the level of human capital is aggravated when using growth rates.[47] Thus the coefficient of the growth of human capital may be hit harder by measurement errors than does the coefficient of the level of human capital.[48] This means that the low

[44] Richer countries (with more physical capital) invest more in physical capital.

[45] Besides the measurement errors of the underlying data, many criticisms have been raised against the perpetual inventory method which Barro & Lee (1993) used to interpolate the missing years. For example De La Fuente and Doménech (2002) constructed a revised dataset with the Barro and Lee data for 21 OECD countries. They used more data sources and, when more figures were available for the same country and year, they used the most plausible to avoid implausible jumps in the data. Their results show an increase in the coefficients of both the level and the change regressions (De la Fuente and Doménech 2002, 16-17). Furthermore, Cohen and Soto (2001) extend the work of de la Fuente and Doménech (2002), although the former was published earlier, to include 95 countries. They use 10 year intervals and try to minimize the extrapolations as many censuses are at 10 year intervals. They also argue that economic growth is too erratic to be explained by the growth of human capital (Cohen and Soto 2001, 23). From the point of view of human capital this is to some extent accepted by Portela *et al* (2004). They argue that assuming the mortality rate independent of education level creates a serious downward bias in Barro&Lee estimates which accumulates over time as long as there is no other census. As this bias decreases the variance, it increases the human capital coefficient.

[46] Signal indicates how well the data 'signal' the information we want to know, *in casu* the level of human capital.

[47] This is easy to see. If a human capital stock is for example 100 and rises in years t+1 to 120. The measurement error in years t+1 is 10. This means that the measurement error of the level of HC in year t+1 is 10/120= 8.3%. However, the measurement error of the change of human capital is 10/20=50%.

[48] Indeed, given the standard attenuation bias this means that increasing variance causes a lower human capital coefficient in regressions based on changes in education. However, Krueger and Lindahl (2001, 1118) also argue that the serial correlation in the Barro-Lee data is higher. As a consequence, as the serial correlation of the errors

coefficients found in regressions including the change of human capital may to some extent be attributed to this problem.

It is clear that, although some progress is made in data quality leading to improved estimates of change in education on change in growth[49], most regressions still lead to low, insignificant, or even negative coefficients. Nevertheless the data of Barro & Lee (1993) and its derivatives are superior in that they exhibit more signal and produce in general somewhat higher coefficients.[50] Yet, the low coefficients, combined with questionable specifications, still make it difficult to distinguish between the different available growth theories. Therefore, it is necessary to estimate a new stock of human capital, based on the pro- and retrospective methods, that has a clear definition and which may encompass the definitions of human capital from both branches of the growth theories.

4. A DEFINITION OF HUMAN CAPITAL

We are thus in need for a way of estimating a human capital stock that encompasses both the qualitative and quantitative development of skills in the labour force and can be inserted in growth equations. Most of the present proxies only partially conform to these requirements. For example, the databases of Nehru (1995), Kyriacou (1991), and Barro and Lee (1993; 2001), disregarding how they are measured, are all proxies of the average years of education. As we already saw in section 2.2, this approach is based on a very narrow concept of human capital. For one, it excludes experience. Especially for the theories advancing technological development this is worrisome as technology is often implemented within a firm either through experience or 'on the job training'. 'Average years of education' does not reflect the increase in quality of human capita either, which could lead to constant marginal returns to human capital accumulation and, as a consequence, endogenous economic growth. Therefore, 'average years of education' seems to be an imperfect indicator of human capital.

We thus have to look for a definition of human capital that includes both the quantitative and the qualitative aspects of human capital, i.e. all 'educational' and 'experience' components. That is, it has to include all aspects of learning but has to exclude all components associated with the physical body. Costs such as 'raising a child' or 'health' are already accounted for in the data on the labour force. Including them would therefore

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is lower than that of the serial correlation of 'true' schooling, the reliability of first differences of education in the Barro-Lee data will be lower.

[49] In other words, by reducing the measurement error, the bias towards zero in the coefficient is reduced.

[50] Nevertheless, it is important to note that this problem manifest itself in the short-term effect. Portela *et al* (2004) and Teulings and Van Rens (2002) have argued that the short term effect of human capital is small (4%) while the long run effect can be as high as 66%. However it can well take a century to fully materialize.

create double counting in a production function. Therefore we will follow a definition in which human capital consists of all forms of knowledge acquiring which is defined by the OECD (2001, 18) as '**the knowledge, skills and competencies embodied in individuals that facilitate the creation of personal, social and economic well-being**.'[51] This excludes human 'attributes', which is included in the standard OECD definition. The main reason is that innate human characteristics neither have an investment component nor do they increase human capital. They may make investments cheaper as children can study more easily, but do not as such increase the stock of human capital.

This approach has three advantages. First, it leaves a difference between human capital and physical labour. This difference is crucial when human capital is inserted into an equation besides labour. Second, it allows for the possibility of directly comparing the theories of Lucas (1988) and Romer (1990). Admittedly, the definition of human capital used here does conform better to the model of Lucas than to that of Romer. However, as human capital may also be used as an input in the R&D sector, no doubt there is a strong correlation between both forms of human capital.[52] Therefore, it does not seem to be unreasonable to assume that any human capital stock created with this definition may be used to test the differences between both branches of the new growth theories. Third, this definition of human capital avoids the problem, which has plagued the cost-based approach, of determining which expenditures are investments in human capital and which are consumption. These problems mainly arise for goods and services that are intended to sustain a physical person, not for increasing his or her knowledge. For example, are food and clothes consumption investments if you consider raising a child being part of human capital formation? We agree with Bowman (1962) that raising a person is no human capital formation, which corresponds to the above definition.[53]

[51] Laroche *et al*. (1999) further extend this notion to include 'innate abilities'. However, we exclude these. The main reason is that innate ability is no part of the physical body. In addition, its division among groups in society is probably normal. It would be strange to expect ability to be larger or smaller by older or younger persons or by Chinese or Indonesians. As a consequence, ability can be picked up by the labour force or population variables. Therefore, also including it in human capital would create double accounting.

[52] In fact, in chapter 6 and 8, using a correlation with the R&D investments in Japan, we briefly mention that this is indeed the case.

[53] A fourth advantage of this definition could be that, if for example food would be an investment in human capital, we would have to assume that human capital is further extended after pension. This means that investment continues without any chance on returns to this investment. This would be a strange interpretation and also runs counter to the human capital theory as proposed by Becker (1964).

5 DEVELOPMENT OF EDUCATION INSTITUTIONS IN HUMAN CAPITAL FORMATION

5.1 Introduction

So far, we mainly attributed the low human capital coefficient to poor data quality which we dealt with in the previous sections. There were problems as a bad specification of human capital, measurement problems, and low signal. In short, we considered the estimation of human capital and its use in growth regressions with an almost complete disregard for the fact that countries may have different policies and institutions. Yet, human capital coefficients are often estimated with cross-sectional or panel data, consisting of a very heterogeneous set of countries. These cross-country differences and the effect of the changes in institutions and policy remain unobserved. In addition, since little historical research is done into these factors, even when breaks and regime changes are identified, it is difficult to relate them to their causes and offer an interpretation.

5.2 Changes in the effect of human capital on economic growth over time

Many institutional and political developments can be held responsible for changes in the effect of human capital on economic growth. Indeed, one important problem of estimating a stable human capital coefficient is that the effect of human capital on economic growth can change over time. On a more methodological level, the existence of regimes in human capital may lead to parameter inconsistency. Parameter inconsistency means that the human capital coefficient in different periods has structurally different values, which leads to a downward bias in the estimated human capital coefficient. Because the human capital stock used in growth regressions generally does not go further back in time than 1960, and is often estimated on cross-sectional data with the time series aspect neglected, the parameter inconsistency problem is not often dealt with.

Therefore, parameter inconsistency seems to be an important problem in growth regressions, especially if one estimates a cross-section regression with a heterogeneous group of countries, or if one estimates a time series. In the work of Psacharopoulos (1994) and MacMahon (1998), for example, there are indications that the importance of secondary and higher education increases over time. This results in a different rate of return and structurally different human capital coefficient, creating an identification problem.[54] The consequences for the empirical model can be demonstrated as follows.

[54] An identification problem means that there is either more or less than one unique coefficient. If there is more than one structural coefficient, the equation is overidentified.

First, we take a macro-Mincer equation where we used Y to indicate that we are considering the macro level:

$$\ln Y^{g}_{jt} = \beta_{0jt} + \beta_{1jt} Educ_{jt} + \varepsilon_{jt} \tag{2.29}$$

where $ln\,Y^{g}_{jt}$ is the geometric mean wage (or, if you wish, GDP per capita) and $Educ_{jt}$ is mean years of education in country *j* at time *t*. Differencing this equation yields:

$$\Delta ln\,Y^{g}_{jt} = \beta_{1jt} Educ_{jt} - \beta_{1jt-1} Educ_{jt-1} + \Delta\varepsilon_{jt} \tag{2.30}$$

$\Delta ln\,Y^{g}_{jt}$ is the first difference of the geometric mean wage. Differencing removes any permanent effect of differences in technology. If the return to schooling is constant over time, we get:

$$\Delta ln\,Y^{g}_{jt} = \beta_{1j} \Delta Educ_{j} + \Delta\varepsilon_{jt} \tag{2.31}$$

If, however, the return to schooling changes over time, then we obtain:

$$\Delta ln\,Y^{g}_{jt} = \beta_{1jt} \Delta Educ_{j} - \delta Educ_{jt-1} + \Delta\varepsilon_{jt}, \tag{2.32}$$

where δ is the change in the return to schooling $(\Delta\beta_{1j})$ (Krueger and Lindahl 2001, 1110). If the returns to schooling increase over time, the initial level of education will enter positively into the above equation. This would lead to structurally different coefficients in these two periods. However, since after the 1960s the share of secondary and higher education rose sharply, we would expect a decline in the general returns to education because micro-regressions suggest secondary and higher education having lower returns than primary education on average. This means that the initial level of education is likely to be on average negative.

Indeed, this finding of different effects of human capital is also confirmed by Petrakis and Stamatakis (2002, 518-519). They show that each education level has a different effect on economic growth. In addition, they also find that the effect of each level of formal education on economic growth differs among countries of different ‘economic maturity’. In short, the more developed a country is, the more important secondary and higher education become compared with primary education. This means that the coefficients of education are shifting over time, and the positive or negative coefficient of initial schooling reflects exogenous change in the rate of return to schooling. As a consequence, the equations used in this context are likely to be overidentified. Still, in the majority of literature on macroeconomic growth, the rate of return is assumed to be constant over time. This might be valid for constant coefficient panel regressions on a group of relatively homogenous countries, of over a relatively short period of time, but is unlikely to hold even within the same country for an extended period.

5.3 Changes in the effect of human capital on economic growth among countries

Indeed, a more historical oriented research is important if one seeks to identify the institutional and social changes over time that cause a change in the effect of human capital on economic growth. These (and other) factors, however, may cause the relation between human capital and growth to differ across countries as well.

It is not only necessary to look at regimes (and try to correct for their existence by, for example, using dummies or initial GDP), but it is also important to keep account of the country specific factors. Not many studies are available that look thoroughly at the structure of the relation between human capital and economic growth. Some notable exceptions are Azariadis and Drazen (1990), Liu and Stengos (1999), and Kalaitzidakis, Mamuneas, Savvides, and Stengos (2001). Although Azariades and Drazen (1990, 519) point out that they ignore country specific effects and try to explain the differences between countries in terms of their economic structures, they still note that country specific circumstances may alter the relation between human capital and growth as '[i]n reality, other factors could mean that the potential growth benefits of a highly qualified labor force could be "wasted"'. In other words, institutional structures in different countries may cause differences in the effect of human capital on economic growth. Nevertheless, both Azariadis and Drazen (1990) and Liu and Stengos (1999) found evidence that, although there are regimes which they represent with certain threshold levels of human capital, the direct relation between human capital and economic growth seems linear and constant.

Yet, Kalaitzidakis *et al.* (2001) doubt whether the relation between education and growth remains constant even in the same regime. Independently of this, they still assume that there is only one regime for all countries. This may be the cause of the non-constant relationship they find. In other words, because they assume away the existence of regimes, they necessarily find non-linearities in the relationship between human capital and growth. Yet, they are not the only one to argue the existence of non-linearities as well (see for example Henderson and Russell 2005).

As a consequence, neither of these studies seems to disentangle the possible effects of regimes and of country specific effects on the relation between human capital and economic growth. The inclusion of dummies and other variables, intended to capture non-linearities, can generally capture only a part of the effect of regimes and country specific differences. These proxies might even be correlated with human capital formation itself, causing biased estimation. Therefore, more economic historical case studies seem to be necessary in this field.

6 CONCLUSION

The explanation of human capital in growth theory so far has suffered from three main problems. First, there is an enormous variety of human capital variables. Second, there is some controversy how to insert human capital in growth equations. Third, human capital accumulation is most likely subject to (country-specific) developments of education institutions and policy effects. This may have a strong impact on the estimated human capital coefficients.

First, the concept of human capital is abundantly used in both historical and economic research. However, due to the diverse use of human capital in the different fields of research, the lack of data, and theoretical debates, there is no clear consensus of what human capital actually should include.

Second, besides definition issues, numerous problems have plagued the use of human capital in macroeconomic growth regressions. Some are due to empirical specification and the inclusion of further regressors such as physical capital which may cause biased coefficients. An even more serious problem is that there is no appropriate measure of human capital, even if we use the narrowest definition of human capital. As is shown in many studies, the popular proxy 'average years of education' conveys almost no signal conditional on other variables. Another serious omission is that most proxies only reflect a part of the human capital stock as defined. For example, the qualitative aspect of human capital, which becomes more important at the end of the twentieth century, is completely unobserved. This in turn may lead to the rejection of the branch of new growth theories in which human capital is inserted as a factor of production.

Third, there is the problem of the (country-specific) institutional development of human capital accumulation. This may be crucial because most estimates of the relationship between human capital and economic growth are based on cross sectional or panel data of heterogeneous countries with the assumption of a homogenous effect of human capital on growth. Life is generally not this mechanical, however. The relationship between human capital and growth may change over time or across countries, which may bias the estimates of the coefficients. Therefore, the dynamic and cross-country factors should be identified by a historical research.

The next chapters will address these three problems. Chapters 3-5 will deal with the human capital accumulation in both a quantitative and a historical way. In chapter 3 we discuss the data, mostly on formal education, in chapter 4 we offer a historical analysis of human capital accumulation, and in chapter 5 we estimate the stock of human capital. The specification of the growth equation and the estimation results are presented in chapters 6-7.

3. Basic data and measurement issues: standard proxy estimates of human capital

1. INTRODUCTION

It is important, before turning to the historical and economic analyses of education and human capital, to start with brief overview of the available data and problems with their collection, interpretation, and estimation for India, Indonesia, and Japan. The data as treated in this chapter are mainly the basic, non-transformed data. These can essentially be divided in the number of children enrolled in education and the expenditure on education. We will start in the following section with an overview of the enrolment figures. In addition, we will also present the gross enrolment ratio (the number of children enrolled at a certain level of education, divided by the relevant age-group). In section 3 we continue with two related variables, namely attainment (the percentage of the population of 15 years and older with a certain education level) and the average per capita years of education in the population. In section 4 we turn to the government and private expenditure on education. The interpretation of the figures presented here and the more demanding estimation of an alternative stock of human capital that conforms to the definition presented in the previous chapter will be treated in chapters 4 and 5 respectively.

2. ENROLMENT DATA

2.1 Definitions and sources

Educational enrolment figures are at the start of many analyses of education systems. They are also the point of departure for almost all more demanding estimates of indicators of human capital. They indicate the number of persons enrolled at a certain level of education in a certain year. As these figures are of interest for national and international governments from a policy making and a budgetary point of view, these data were among the first ones to be collected when national statistical bureaus started their work. When international organizations such as the United Nations were founded, they also soon started to collect these statistics and make them comparable. Within the United Nations this is specifically done by the UNESCO (United Nations Economic and Social Committee).

These data are thus relatively abundantly available in both national and (since the 1950s) international statistical publications (see table 3.1). However, some

Table 3.1: General sources on educational enrolments used in this study with statistics of Japan, India and Indonesia, 1880-2000*

Organisation	Source	Country	Time
Centraal Bureau voor de Satistiek (CBS)	Jaarcijfers voor het Koninkrijk der Nederlanden: koloniën/Statistisch Jaaroverzicht Nederlandsch-Indië	Indonesia	1893-1930
Centraal Kantoor voor de Statistiek (CKS)	Algemeen Verslag van het Europeesch en Inlandsch Onderwijs	Indonesia	1880-1914; 1915-1938
-	Colonial Report	Indonesia	1880-1929
Centraal Kantoor voor de Statistiek (CKS)	Indisch Verslag	Indonesia	1931-1939
Hollandsch-Inlandsche Onderwijs Commissie (HIS)	Report of the Dutch Indies Education Commission, no.2, 3, and 10.	Indonesia	1930
Badan/Biro Pusat Statistik (BPS)	Statistical Yearbook of Indonesia	Indonesia	1976-2000
Department of Commerical Intelligence and Statistics	Statistical Abstract for British India	India	1880-1945
Central Statistical Organisation (CSO)	Statistical pocketbook India	India	1969-1990
Central Statistical Organisation (CSO)	Statistical Abstract India	India	1950-2000
Bureau of Statistics	Japan Statistical Yearbook	Japan	1980-2000
Statistical Bureau, Japan Statistical Association	Historical Statistics of Japan (vol. 5)	Japan	Circa 1870-1985
UNESCO	UNESCO Statistical Yearbook	International	1964-1999
International Historical Statistics: Africa and Asia	Mitchell	International	Circa 1850-1988

* This excludes stray statistics from individual publications. Those can be found, however, in the references to this chapter.

difficulties remain with their collection. First, during colonial rule, often no statistics on the indigenous education system were collected. Second, private schools which were not eligible for government subsidies were often ignored in the statistics. Of course, in many cases the previous two categories concerned the same schools. Third, there are problems in making the enrolment figures comparable over time and among countries. For example, practical (or vocational) education, if given at all, was often taught at the primary level at the start of the twentieth century while after 1950 it could mainly be found at the secondary level.

To counter the problem of comparability of these data, we took into account for all countries the number of pupils enrolled in the public and the subsidized and/or recognized private schools. This is especially important in India and Indonesia because in those countries there was a difference in education system between the (often subsidized) European private education and the often non-subsidized private indigenous education. In Japan, due to its more homogenous population, this problem was less pressing and all school types were included in the statistics. However, the so-called 'wild' or 'unrecognized private' schools (the non-subsidized non-recognized schools) in India and Indonesia have been left aside. This has two reasons.[55] First, it is almost impossible to get enough data on their numbers. Some very crude estimates are, however, possible. In the next chapter (section 4.1) we argued that in India a literacy rate of 10-20% for men may be acceptable in the 1830s-1840s. Given that in section 3 of this chapter we will estimate attainment in India at 4.3% in 1890 (an average of males and females), given that attainment for males is substantially higher than that of females, and given that European and subsidized education was much lower in 1840 than it was in 1890, the share of indigenous education was probably close to 5-15 percentage points of total literacy around 1840, hence about three times as large as European and sbsidized education. Towards the end of the nineteenth century indigenous education probably declined in line with the rise of European education. In table 3.4 in this chapter we can see that literacy in 1891 according to the census was around 5.3% compared to an attainment of 4.4%. Given that there might have been a relapse into illiteracy after following formal education, this suggests that around 2% of the literates (or around 40% of all schooling) still took place in non-subsidized private schools. This figure, however, dropped fast in the following decennias. The same pattern can we see in Indonesia. Reid (1988, 218) argues that in the Dutch 1930 Census for Indonesia it was especially in those regions such as the Lampung districts of Southern Sumatra where the 'modern' European education was not widespread that the highest literacy was recorded (45% for males and 34% for women). Given that we estimate total attainment in 1930 at 16%, this suggests a share of non-recognised non subsidized education of around 50%. However, in other parts of Indonesia non-recognised education was much smaller. Hence, the total share of non-recognised non-subsidized schools in Indonesia was probably less than 25% and strongly declining towards independence.

Second, the non-recognised, non-subsidized schools were almost all either *madrasahs*, *pesantrens* or Hindu schools and had an almost exclusive religious curriculum. This did not enhance the participation of their students on the labour market, especially on the European one. This was recognised in Indonesia both in the 1950s when the education system of the Republic of Indonesia got shape and also during the 1936 conference at Padang-panjang where Muslim organisations discussed the future structure of religious education. However, the secular changes that were

[55] A third reason may be that it is common in the literature to ignore these schools. See for example Meyer, Ramirez, and Nuhoglu Soysal (1992, 132-133).

enacted in religious education following these conferences took mainly place after independence. In that period, these schools were accounted for in the national statistics anyway so no special modification has to be made. We also left out kindergartens as they are in general either not aimed at the acquiring of human skills or the skills acquired are so basic that they are not regarded as skills anymore in the labour market.

Besides the question of which schools to include, we have to make a division into levels of education. This division into primary, secondary (general and vocational), and higher education is largely made according to the standards of the UNESCO. The UNESCO in the 1970s developed the first International Standard Classification of Education (ISCED), which was revised in 1997. However, these standards were more a reflection of already existing systems. They leave room for national and cultural deviations of educational structures.

The main criterion for primary education as indicated in the ISCED is the 'beginning of systematic apprenticeship of reading, writing and mathematics.' Subsidiary criteria are the 'start of compulsory education', and 'entry in nationally designated primary institutions.' In general it is considered that primary education does not start before age 5 or after age 7. When it forms a part of basic education only the first part (or the first six years) is considered primary education. A final criterion for primary education is that it is program and not subject based. In other words, it is aimed at giving children a comprehensive schooling and laying a basis for possible further subject-oriented education. For India the data on the primary education level correspond simply to primary education as given in its statistical abstracts. This exists of compulsory primary education between 6 and 14 years, which can be split into primary and upper primary schools. Only the first part thus forms the primary level. Although primary education lasts eight years in twenty States and Union Territories and seven years in twelve (see International Bureau of Education (IBE) 2001) this is not a problem because of the flexibility of ISCED. In Indonesia this definition means that, for the colonial period, the European Primary School, Dutch-Chinese School, Dutch-Indonesian School, the Advanced Elementary Education, the Link School, the Standard School, the Continuation School, and the Village School can all be considered primary education. They are programme oriented and in general have a duration of between 3 and seven years. The advanced elementary education is also counted with primary education because it is also programme oriented and because it was considered an end to formal schooling and not a step to a 'lifelong learning', which is considered characteristic for secondary education. For the period after independence the *sekolah rakyat*, later renamed *sekolah dasar* (SD), is considered primary education with its entrance age of 6 or 7 years, and its six-year duration. It also has a clear program orientation with the exception that local languages are allowed during the first three years. In Japan, the *terakoya* (primary education for commoners) was replaced after the Meiji Restoration in 1868. In a following transition phase ending in 1882 a primary level was created which consisted of a 4-year Ordinary Elementary School after which children could continue in a 2-year Higher Elementary School. It was only in 1908 that a single 6-year Ordinary Elementary School was established which would continue afterwards.

Following the ISCED, the secondary level consists of two parts which largely share the same characteristics. First, there is lower secondary (or the end of compulsory) education. This generally has a duration of 3 years after primary education. Second, there is higher secondary education which either finishes the educational program by preparing for the labour market or prepares for higher education. This level starts generally at age 15 or 16 after finishing lower secondary education. These phases show an increase from still largely programme orientation at lower secondary, to more subject orientation at higher secondary education. Both general and pre-vocational/technical eduction focus on a broader range of subjects either to prepare the pupil for the labour market or for further education. Vocational/technical education trains for a specific occupation. These levels are clearly recognisable in India, Indonesia, and Japan, especially after World War II. In India the secondary level consists of the Upper Primary or Middle school and the Secondary school. This is either four or five years and follows directly on the primary level. In Indonesia after independence there was a standard lower and higher secondary education. However, prior to that there was a HBS (a former Dutch high school), a Lyceum, and general secondary schools all with a duration of between 3 and 5 years. The Japanese system, however, consisted of middle and vocational schools before the War and of lower and higher secondary schools afterwards, introduced during the occupation period. Yet, in all three countries the secondary level was often subject oriented. The stronger programme orientedness in higher secondary schools can, for example, be seen from the fact that, especially after the War, in India, just as in Indonesia, vocational education was largely given in Senior

Secondary Schools. However, in the colonial period there were also primary vocational courses. Here the enrolment was, however, not large and it therefore does not significantly alter the figures. This is contrary to Japan where most vocational education was given at the secondary level. The already relatively high enrolment ratios at the end of the nineteenth century caused primary education to be focussed on general skills while further specialisation had to await the secondary level. Until the Sino-Japanese War (1894-1895) vocational education had remained almost entirely private. However, combined with the developing Japanese technical industry, the war made clear that the demand for technically trained people was increasing. Therefore a Vocational Education Law was drafted and passed in 1894. Additional steps were taken in 1899 when fishery, forestry, and agricultural vocational schools were established at lower secondary level (Passin 1965: 97). At the start of the twentieth century also technical education at the upper secondary level expanded rapidly. This development continued during the first half of the twentieth century. As a consequence, already at the start of the twentieth century in Japan both a vocational and a general secondary education system had emerged which in India and Indonesia had to wait until after the Second World War.

The tertiary level in the ISCED is basically described as the remaining education. For simplicity, we include in this category also the post-secondary non-tertiary education because they share the same characteristics. Generally, the entrance requirement for tertiary education is completed secondary education. In addition, this level has a strong subject orientation leading to either an occupation or a research qualification. In the three countries of this study, higher education was scattered over different institutions of different ethnicity, religion and public/private denomination. In Japan this changed when many private institutions were recognised around 1919. However, as in India and Indonesia secondary education was relatively underdeveloped, this could only be a limited canal for following higher education. In Indonesia higher education was completely absent in the period before the 1920s while afterwards it was limited to technical, law, and medicine colleges with a duration of between 4 and 7 years. The number of universities in India was much larger, already enacted in the mid nineteenth century because the colonial government focused more on higher than primary education. However, both India and Indonesia lagged considerably behind Japan.

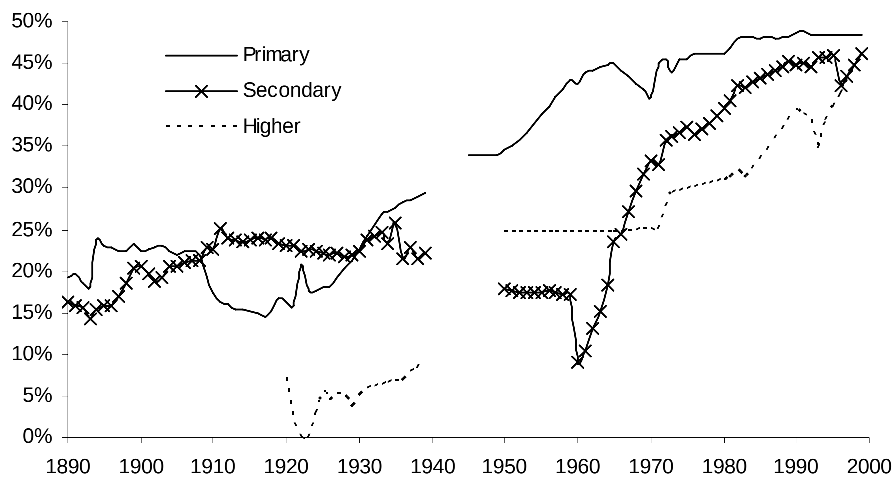
2.2 Estimates of levels of enrolment

Now we have made a distinction between three levels of education, it becomes possible to collect historical data on enrolment. The term 'enrolment' refers to the number of persons enrolled in (i.e. following) a certain education level in a certain year. Although enrolment rates are generally straightforward in that they are explicitly given in the statistical sources, three points have to be stressed. The first point concerns school attendance. If we look at the enrolment levels in the tables A.6.1-A.6.3 in appendix A.6, we notice that (given the size of the population) Japan has by far the highest enrolment at the start of the twentieth century. However, even in Japan actual school attendance was much lower. In India and Indonesia, the drop-out rates were also very large. In addition, these two countries had their own educational systems prior to the colonial period. However, these indigenous systems had deteriorated strongly in the eighteenth and nineteenth centuries. This was one of the main reasons why the colonial governments in both countries during the nineteenth century started to set up an alternative education system which would later be continued by the newly elected governments after independence. As a consequence, most of the data, except for some occasional statistics, were collected only on the new, colonial, education systems. This led to an underestimation of enrolment figures, because enrolments in the indigenous education system were largely excluded, although this problem was already relatively small at the start of the twentieth century.

The second problem with which we are confronted when trying to estimate enrolment figures is that in Indonesia there was a strong tendency to underenumeration in the population censuses at the start of the twentieth century. Contrary to the population data from the surveys and censuses (see for example Van der Eng 1996: 271), however, we opted not to correct the education data for underenumeration. As the educational reports in contrast to the population surveys were not based on estimates or corrections from the village head, the margin of error will be smaller. Furthermore, the data between 1914 and 1940 and after 1970 are relatively complete although only after 1970 for the first time the total number of schools and pupils was collected instead of being inferred from a sample. Before 1914, especially for the village schools, the differentiation of the data in sexes was not always given. This was partly due to the situation that the government experiment with these schools only started on a small scale around 1906. As a consequence, only limited statistics were reported for these schools in the following years. Moreover, the continuous changes in Indonesian primary education with, for example, the introduction of the Dutch-Indonesian School made data collection difficult. For the colonial period about 90% of the figures could be directly obtained from the sources. Where data were missing of, for example, a differentiation between boys and girls

Figure 3.1

Percentage girls per level of education in Indonesia, 1890-2000



Source: Appendix A.6, table A.6.1.

Note: The straight lines of the ratio of females in secondary and higher education after independence are caused by the assumption that the ratio remained constant in that period. We could have assumed that there was a linear in- or decrease in the ratios from before World War II, however, it is unlikely that the male-female composition just after the War changed considerably.

enrolled, the sex ratios of children enrolled at the begin and at the end of the period with missing data were taken. These ratios were interpolated and by multiplying this result with the total enrolment the number of girls enrolled was obtained. For the period after independence about 70% of the yearly data on enrolments were directly available. Of course, most data were missing in the 1940s during the period of WWII and the following struggle for Independence. The gaps in the data for these periods were either filled by using ratios with the available data or by linear interpolation. An especially difficult subject was higher education before 1977. The largest part of the total enrolment was available but the sex ratio was given only in a few years. For these missing data on boys and girls enrolled, again the interpolation of the available ratios was used. Consequently, the ratio of female students to total students remains about the same for the first years after the War, as we can see in figure 3.1. One could linearly interpolate the ratio from girls to total enrolments in higher education between 1940 and 1970. However, it is unlikely that this ratio changed strongly in the first years after the War and, consequently, we assumed that most of this increase in the ratio took place already before World War II. Furthermore, figure 3.1 shows that the enrolment in higher education started only in 1920. Before that time, those wanting to pursue higher education generally had to go to the Netherlands.

Compared to Indonesia, the Indian data are relatively complete both before and after independence, but we are confronted with significant changes in territory over the twentieth century. First, in 1937 Burma (present day Myanmar) was split of from the statistics of British India. After independence in 1947, British India was split in India and Pakistan.[56] To correct the enrolment figures for this split in territory, it was necessary to either add the Bangladeshi and Pakistani figures to the Indian totals after independence in order to obtain the totals for Undivided India or to filter the Indian totals from the figures before independence. We opted for the latter possibility. The reason was mainly that it would be difficult to obtain enough comparable data for these three countries. One problem was that the statistical methods and definitions differed substantially, making it very difficult to obtain comparable figures in order to create an aggregate figure. In addition, it would be almost impossible to integrate the educational systems of India, Pakistan, Bangladesh, and possibly Burma, into one system. In other words, these systems are so pluriform that it would be difficult to make any generalizing comments on them.[57] Furthermore, focussing on India would better reflect the actual situation without reverting to a 'theoretical construct of British India' instead of the present-day situation of three (or four) heterogenous countries. Finally, within British India, India was by far the largest part, so the error of removing the other countries from the data will probably not be very large.

The removal of Burma, Pakistan, and Bangladesh from the enrolment data is done in a very general way by calculating their ratio with total enrolments of British India around 1948 and assuming that this ratio remained constant in the period

[56] In 1971 Pakistan was split into Pakistan and Bangladesh.
[57] At least when treating it as one geographical aggregagate unit. Of course, if one wants to make a comparative analys, these three countries (India, Bangladesh, and Pakistan) could suffice.

between 1880 and 1948.[58] Although not always perfectly accurate, the outcome is probably quite reliable, mainly because India was so much larger than the other territories. Therefore it is necessary to come to a percentage of the different school

Table 3.2: Percentage of total number of students per level of education, sex, and country around 1948

	Pakistan	Bangladesh	India
Total Population*	39,448,000	45,646,000	359,000,000
Distribution Population*	8.88%	10.28%	80.84%
Primary Education			
Boy	4.24%	16.96%	78.80%
Girl	2.67%	6.14%	91.19%
Total	3.86%	14.34%	81.80%
Secondary Education			
Boy	14.67%	15.40%	69.94%
Girl	10.59%	9.53%	79.89%
Total	12.53%	12.97%	74.50%
Vocational Education			
Boy *	1.07%	0.76%	98.17%
Girl *	3.37%	0.63%	96.00%
Total *	1.37%	0.75%	97.89%
Higher Education			
Boy **	8.33%	5.12%	86.54%
Girl **	7.52%	3.80%	88.69%
Total **	8.23%	4.96%	86.82%

*Figures Pakistan and Bangladesh 1950, India 1948. Population figures 1950.

**Figures Pakistan, Bangladesh, and India from 1953.

types in India and Pakistan/Bangladesh. The 1948 division is given in table 3.2. These figures are used to correct enrolment for the colonial period back to 1880. We could have opted for a more refined way by estimating the enrolment levels for smaller areas and than deducting it from the total when they were outside the territory of contemporary India. However, this is unlikely to give significantly better results due to lack of enough detailed data.

2.3 Estimates of the Gross Enrolment Ratio

After having obtained the historical enrolment per education level it is now necessary to go one step further by estimating the Gross Enrolment Ratio (GER). The gross enrolment ratio is the number of persons enrolled at a certain education level, divided by the relevant age group. In other words, if 10 children are enrolled in primary education, which lasts from age 6 to age 12, and the total number of persons in the

[58] Until 1937 Burma was included in the general statistics for British India. Yet, as they were also given separately, these data could be deducted from the total level directly.

population between age 6 and age 12 is 20, then the gross enrolment ratio is 50%. In this way the gross enrolment ratio is given in tables A.6.1-A.6.3 (appendix A.6) as the enrolment as '% of the relevant age group'. It is important to note that the gross enrolment ratio calculates all persons enrolled in a certain level of education, not only the children which belong to that age class. As a consequence, the gross enrolment ratio may exceed 100%. If we would only include all children enrolled in a certain education level who belong to the relevant age class, we would get the net enrolment ratio. However, this data is generally not available for the period prior to 1960.

The reasons for the estimation of the gross enrolment ratio are clear when one considers the difficulty in comparing the enrolment data between countries or over time. If one compares for example India with the Netherlands Indies, it is obvious that the enrolment levels are far higher in India simply because India is a far larger country. In the same way, it makes a comparison of the enrolment data within one country over time possible because it corrects for the growth in population and the (associated) increase in enrolment. A final point to note is that the gross enrolment ratio also corrects for changes in the educational system. If, for example, primary education is extended from 4 to 6 years, than the enrolment level may increase dramatically. However, as the relevant age class is also broadened, this is not necessarily the case for the gross enrolment ratio. This is especially visible for Indonesia after the War where we reduced the age class for primary education from a weighted average of 5-12 and 5-10 years to 6-11 years.

Thus, after obtaining the enrolment numbers for Japan, India and Indonesia, it is desirable to also calculate the gross enrolment ratio for these countries. As the enrolment data were already calculated, we now need population figures. The data construction for India and Japan was relatively straightforward as the data were readily available. For India, we simply took the census data for 1891, 1901, 1921, 1931, 1941, 1951, 1961, 1971, 1981, 1991-2000 and the total population by Sivasubramonian (2000) and Bina Roy (1996). For each census year we calculated the relevant age groups per level of education. Using the ratios of the relevant age group to the total population of British India, we used the total population figures from Sivasubramonian (2000) and Roy (1996) for the Indian Union, to calculate the relevant age group for the Indian Union solely for each census year. Then the next step was to interpolate the ratios between the age groups and the total population. Using these interpolated data, we could use the total population figures for India to calculate the age groups in the years between the censuses. Then, by dividing the number enrolled by the relevant age group we arrived at the gross enrolment ratio. The same was done for Japan, where we used the five-yearly population data per age group from the Historical Statistics of Japan, in addition with the Statistical Yearbook of Japan. The total population was obtained from Pilat (2002).

However, the estimates for Indonesia were somewhat more complex because the enrolment figures before 1941 are also divided between ethnic lines. On the one hand this caused problems because of the different school duration in the indigenous and European schools. On the other hand, it also creates the possibility of calculating the gross enrolment ratio per ethnicity before independence. The latter we did in appendix A.5. The results are reported in table A.5.1 in appendix A.5. This table shows the large difference in enrolment among the different ethnic groups in Indonesia. Whereas in 1890 almost 1.5 times as many Europeans followed education as there were children in the relevant age class (a GER of 150)[59], only 2 out of 100 Chinese and 1.4 out of 100 Indonesian children followed primary education. Around 1940 these figures had to some extent converged, but a large gap remained.

To arrive at a gross enrolment ratio for the entire population of Indonesia, we have to add these gross enrolment figures for Chinese, Indonesians, and Europeans, weighted for their population shares, for the period prior to 1940 (see appendix A.5). For the years hereafter, we use the same method as for India and Japan. We used the population figures from the census data, where we corrected the 1961 census for the omission of Irian. As the duration of each level of education changed over time, we also used different population cohorts for eah level of education. For 1941-1969 we took the cohorts aged 6-11, 12-17, and 18-22, as did the *UNESCO Statistical Yearbook* for the period 1960-1970.[60] After 1970 the cohorts 7-12, 13-18, and 19-23 were used. The number of children in these cohorts were estimated from the census data and interpolated with the total population figures from Van der Eng (1996; 2002). Next, we divided the total enrolment per level of of education (see section 2.2 above) by the relevant age class to arrive at the gross enrolment ratio of that level.[61]

[59] This is possible when also older and younger children enter education.
[60] For the period 1950-1960 the UNESCO used 5-14 and 15-19, but these are implausible cohorts.
[61] We also distinguished between boys and girls. This had to be done also for the period prior to 1941 as we did not distinguish by sex. To do this, we estimated the age classes of boys and girls from the censuses (1890, 1895, 1900, 1905, 1920, 1927, 1930, 1961, 1971, 1980, and 1990-2000) and took the ratio with the total population figures. The ratios of the in-between years were interpolated and then multiplied with the total population.

Furthermore, we used some assumptions from the literature to arrive at the total enrolment rates during the War[62] and the division into male and female enrolments.[63]

3. ATTAINMENT AND AVERAGE YEARS OF EDUCATION

Although, as we have seen in chapter 2, some earlier analytical studies on the relation between human capital and economic growth used gross enrolment ratios or enrolment figures, present-day work prefers variables that are a better indication of the stock of human capital. Two related measures have become very popular. The first one is attainment, which has become especially popular since the work of Barro and Lee (1993; 2001). With attainment in a certain level of education we mean, following Barro and Lee, the percentage of the population of 15 years and older who have been enrolled[64] in that specific level of education and no more than that. So if, for example, primary attainment is 10%, this means that 10% of the population of 15 years and older has once attended primary education. Please note, however, that these are only those persons who did not pursue any further education. This means that, if primary attainment is 10%, secondary attainment is 15% and higher education is 5%, in total 30% of the population of 15 years and older has attended primary education as persons must first have completed primary education before attending secondary or higher education. The second, related, measure of the human capital stock is average years of education per capita. This variable is strongly linked to attainment because in fact it is calculated as attainment per level of education (including ‘no education’), multiplied by the years of education per level of education, and finally divided by 100.

[62] We now only miss the gross enrolment ratios for the period 1941-1944. This can be solved by calculating the missing enrolment data. They are estimated in the following way. First, total primary enrolment in 1943 was estimated by using the 1944 enrolment minus the total Europeans in primary education in 1940. The main idea is that it is unlikely that there was a strong increase in education of the indigenous population between 1943 and 1944. In addition, the Europeans were put in camps, so no school attendence is likely in that period. The 1942 enrolment figure for primary education was estimated by taking the 1944 figure - Europeans - (0.5*private education in 1940) as private education was strongly restricted in these years. The 1941 figure was a linear extrapolation of 1939 and 1940.

[63] The number of boys and girls in 1940 and 1941 were then calculated by the 1939 ratio as nothing really changed in those years. For 1942 the number of girls was calculated as the number of girls in 1943 - (% European girls*Total number of girls in 1940)-(0.5*girls in private education) as the number of girls in private education was as a % larger than in public education. For 1943 and 1944 the ratio of 1945 was used. These data were of course divided by the population in the relevant age. The gross enrolment ratio for boys in higher education was assumed constant for 1940 and rise to 0.01 for 1941. For 1942 there was an almost total drop of student numbers, which led to an enrolment ratio in 1943 of almost 0, and in 1944 a small rise.

[64] But not necessary completed.

There are several ways to calculate attainment. However, as we already noticed in the previous chapter, the methold of Barro and Lee outperforms the alternatives. For example Krueger and Lindahl (2001, 1117), in their overview article on the micro and macro growth literature, estimated that the reliability of the Barro &Lee data as 0.577 compared to 0.195 for the Kyriacou (1991) data. We will therefore start with a brief overview of the methodology of Barro and Lee (1993; 2001).

Barro & Lee estimated attainment at five-year intervals since 1950. They used census figures as benchmarks and, as most censuses are held once every 10 years, they used a formula to fill in every missing fifth year. This use of benchmarks is contrary to, for example, Nehru (1995) who relies solely on mortality and enrolment figures to calculate average years of education. Although the use of census data improves the quality of the attainment figures, it remains questionable how reliable the Barro & Lee estimates are.

Unlike their earlier estimates, in their more recent work Barro and Lee (2001) use net enrolment ratios, keep track of repeaters, and adjust them for later entries into the specified education levels. However it is quite likely that in this way they will underestimate the attainment as the percentage enrolled at a higher age may be large. This is especially true for developing countries such as India and Indonesia in the period after independence. Therefore we use the gross enrolment ratio, adjusted for the duration of official education. Although this includes repeaters, the importance hereof diminishes in secondary and higher education. Furthermore, other data are not available prior to 1950 in India and Indonesia. In addition early as well as late entry is also important. This means that there was no clear entry age, especially in indigenous education, in the colonial period. As a consequence, using the net enrolment ratio excludes both the children that enter before and after the specified age class. Ignoring this is likely to understate enrolment and, as a consequence, attainment. Furthermore, Barro and Lee use the available census data after 1950 as benchmarks. In many countries, especially in India and Indonesia, these censuses may have a strong bias, taking things as the political situation and literacy campaigns into account. In addition, it is noteworthy that in general, the Barro and Lee interpolation tends to underestimate the attainment figures for the years between censuses (Portela, Alessi, and Teulings 2004, 5). Therefore we used for all three countries as a starting point the census around 1960 and the 1965 data of Barro and Lee. Furthermore there is not much fluctuation in attainment in this period in all countries so it can be interpolated. In this way it is possible to obtain yearly figures.

From this starting point, our first step is to use the perpetual inventory method of Barro and Lee (1993; 2001) with the gross enrolment ratio as input and the years 1960-1965 as the most important benchmark years. The formula used to extrapolate the data back to circa 1890 is based on the formula used by Barro and Lee for the population 15 and over:

$$h_{1t} \equiv [1-(L15_t / L_t)] * h_{1t-5} + [(L15_t / L_t) * (PRI_{t-5} - SEC_t)] \qquad (3.1)$$

Here *h* is the attainment of *1* (primary education) in year *t*. *L15* is the population 15-19 and *L* the total population of 15 years and over. *PRI* is the gross enrollment ratio of primary and *SEC* of secondary education. In the same way secondary and higher attainment are calculated as:

$$h_{2t} \equiv [1-(L15_t / L_t)] * h_{2t-5} + (L15_t / L_t) * SEC_t - (L20_t / L_t) * HIGH_t \qquad (3.2)$$

$$h_{3t} \equiv [1-(L15_t / L_t)] * h_{3t-5} + [(L20_t / L_t) * HIGH_t] \qquad (3.3)$$

Here, *2* and *3* are secondary and higher education, *HIGH* is the gross enrolment ratio of higer education, and *L20* is the population aged 20-24.

Equations (3.1)-(3.3) indicate that for each level of education a duration of five years is assumed. However, this can be easily adapted to the different age cohorts in the different periods for the gross enrolment ratio. But even if we adapt the equations, for example by using longer time lags, mortality can remain the same. Mortality is calculated by Barro and Lee as the number of persons surviving from age 15 to age 19. As we assume that the death rate is inversely correlated with the length of education, and as the duration of education increases, there is a relative decline in mortality (because mortality remains to be estimated over a five year period). Thus there is no pressing need to alter the mortality assumptions from Barro and Lee. Finally, these figures were smoothed using a five-year moving average. As Barro and Lee estimated five yearly figures and because we adapted the five year period for changing school duration, the fluctuations became in our yearly data rather hectic. Therefore, we applied a five year moving average.

The second step in estimating attainment concerns the extrapolation backwards over 70 years (from 1960 back to 1890) using the method of Barro and Lee. This makes it possible that there is an increasing error over time even though the data were corrected for school duration and population growth. The reason for this divergence may be, as we already indicated in chapter 2, that the Barro and Lee method may underestimate actual attainment due to the fact that in their method mortality is independent of education. In phases with strong educational growth, the survival chance of younger (more educated) persons is underestimated as is, as a consequence, attainment (Portela, Alessie, and Teulings 2004, 5). However, Barro and Lee use their method in forward extrapolation. As we go backward in time, using this method may overestimate actual attainment.

We therefore, want to correct the attainment estimates for the bias in the mortality rates from Barro and Lee for all three countries. We used the adapted method of Portela *et al.* (2004) who assume that there is a bias when the data of Barro and Lee are extrapolated backwards, forwards, or when they are interpolated. However, we are only concerned with backward extrapolation. We can thus modify the formula of Portela to include only backward extrapolated data. We get:

$$Edu_{it} = \alpha + \beta_1 Before_{it} + \eta_i + \varepsilon_{it} \tag{3.4}$$

Here, *Edu* is attainment in country *i* at time *t* for primary, secondary, or higher education respectively, *Before* is the number of years from the 1960 observation of Barro and Lee to the first census observation, η is the between group (country) effect, and ε_{it} is the whte noise error term. Following Portela *et al.* (2004) we estimate a fixed effect model.

Now using a sample of 112 countries from the Barro and Lee dataset, we collected the attainment figures for primary, secondary, and higher attainment for 1960 and following years up and until the first census. The results of these (fixed effect) estimations are presented below.

prim= -0.199**Before* - 9.656**Dasia* - 0.205*(*Before*D1960)* - 0.0211*(*Before*D1965)*
(SE) (0.449) (1.15) (0.56) (0.376)

+ 0.09031*(*Before*D1970)* + 0.164*(*Before*D1975)* + 9.8 + ε_{it}
(0.19) (0.159) (1.27e-014)

No. obs. 229
$\mathbf{R^2}$ 0.93

sec= - 0.320**Before* - 12.39**Dasia* + 0.657*(*Before*D1960)* + 0.119*(*Before*D1965)*
(SE) (0.222) (16) (0.531) (0.097)

+ 1.7 + ε_{it}
(2.71e-014)

No. obs. 228
R^2 0.87

high= + 0.054**Before* - 3.599**Dasia* - 0.102*(*Before*D1965)* -0.113*(*Before*D1970)*
(SE) (0.056) (5.53) (0.0503) (0.047)

+ 0.4 + ε_{it}
(6.66e-015)

No. obs. 228
R^2 0.87

Here $Before * D_t$ is the variable *Before* multiplied with a time dummy. Now, if we followed the methodology of Portela *et al*., we would use the equation $PEdu_{it} = Edu_{it} - \beta_1 Before_{it}$, where β_1 is the beta coefficient from equation (3.4) and $PEdu_{it}$ is the corrected attainment. However, we have to be careful that the β_1 says that on average over a five year period the estimation of attainment ought to be an x-percentage lower, i.e. was biased upwards. For Portela *et al.* this does not matter because they only correct interpolation at a five-year interval, but we want to correct over the entire 40-year period.

Therefore, we used the following formula taking primary attainment as an example. Primary attainment has a decrease in percentage attainment (so an overestimation of attainment by the Barro and Lee method) of -0.199-0.2045 (on average)= -0.404% percentage points yearly decline over a five year period on average. However, we need the yearly percentage decline if we want to create a yearly correction factor. The reason is that the basis is the present period. So, simply using longer time lags would overestimate actual decline. We thus deduct -0.404%/38.8% (the average primary attainment around 1960 in 112 countries) = -0.01041. Now, we can estimate for every year how much has to be deducted by calculating $(1+\alpha)^t$, where *t* is the number of years until the basis, and a the yearly percentage. For a fourty year period, we thus have to subtract from primary attainment $(1-0.01041)^{40}=65.8\%$, 100%-65.80% = 34.2% of the estimated attainment using the Barro and Lee method 40 years before 1960. The correction

Table 3.3: Correction factors for the backward extrapolation with the Barro and Lee (2001) method

years	years backward	Primary education	Secondary education	Higher education
1959	1	0.990	0.975	0.982
1955	5	0.949	0.881	0.914
1950	10	0.901	0.776	0.835
1945	15	0.855	0.684	0.763
1940	20	0.811	0.602	0.697
1935	25	0.770	0.531	0.637
1930	30	0.731	0.468	0.582
1925	35	0.693	0.412	0.532
1920	40	0.658	0.363	0.486
1915	45	0.624	0.320	0.444
1910	50	0.593	0.282	0.406
1905	55	0.562	0.248	0.371
1900	60	0.534	0.219	0.339
1895	65	0.507	0.193	0.310
1890	70	0.481	0.170	0.283

Estimation method: see text.

factors for each fifth year are given in table 3.3. We calculate back from 1960, so the first year with a correction factor is 1959. The fifth extrapolated year (see column 2) is 1955, etc. Column 3-5 give the factor with which the attainment figure for each level of education as estimated with the Barro and Lee method has to be multiplied in order to correct for the bias in the estimation method.

The corrected results for primary, secondary, and higher attainment are presented in table A.7.1 in appendix 7. They seem to conform rather well to the expected values. For example, table 3.4 compares the literacy rates with total attainment (primary plus secondary plus higher attainment). Unfortunately, no literacy rates for Japan are available.[65] However, as we will argue in the next chapter, it is likely that it rises from 30-40% in 1890 to at most 100% in 1960, a figure which we also found in our estimates. For India, table 3.4 shows that the literacy and attainment figures follow the same pattern. However, both for India and Indonesia, attainment figures are somewhat higher than literacy figures. This might be because, as Mayhew (1926, 228) argued, "… school enrolment figures under the present system in India

[65] Figure 1.3 in chapter 1 reports the total attainment figures as an indication of literacy in Japan.

Table 3.4: A comparison between literacy and total attainment in India and Indonesia, 1891-1951

	India		Indonesia	
	Literacy	Attainment	Literacy	Attainment
1891	5.3%	4.4%		4.4%
1901	5.4%	5.8%		5.9%
1911	5.9%	7.9%		8.4%
1921	7.2%	10.4%	5.4%	11.8%
1931	9.5%	14.0%	9.0%	15.9%
1941	16.1%	18.3%	12.7%*	21.0%
1951	18.3%	24.8%		27.1%

* Calculated here. The 1930 illiteracy figure was used. From this, 1/40 multiplied with the gross enrolment ratio , PRI(t-40), was subtracted and 1/40 multiplied with he gross enrolment ratio, PRI(t-3), was added (the latter because we estimate illiteracy for persons aged 15 and over). This is done for each year after 1930 and so we arrive at 100-87.3%=12.7% literay in 1941. This method is also almost ideally suited to get the 28.9% 'no school attainment' in 1961 according to the Unesco Statistical yearbook 1974 (we arrived at 26.7% literacy).
Source: India: Statistical Yearbooks; Indonesia: Indisch Verslag 1931 and 1935. Unesco Statistical Yearbook 1974.

mean very little. The education given in very many of our primary schools ends, as an official reporter once remarked, with the cradle and allows a relapse of 39 per cent of its beneficiaries into illiteracy within five years." This means that it is likely that attainment figures are higher than literacy figures in the first half of the twentieth century. The same can be argued for Indonesia.

For the post World War II period we can compare our estimates with some alternatives. Yet, as these are mostly given as 'average years of education in the population', we will first convert our attainment figures to obtain average years of education in the population of 15 years and older. Indeed, the indicator 'average years of education' is closely related to attainment. We used the attainment figures to calculate the average years of education as $(h_{1t} * Years_{1t} + h_{2t} * Years_{2t} + h_{3t} * Years_{3t})/100$, where h is attainment (%) of *1* (primary), *2* (secondary), or *3* (higher) education. It is important to divide by 100 to include also persons with no education (primary + secondary + higher attainment does not necessarily sum to 100). The results of these exercises on attainment, and average years of education are presented in table A.7.1.

For all three countries, our estimates of 'average years of education' are above those of Barro & Lee (see figures 3.2-3.4). This is a pattern which can be found in many countries. For example, figure 3.4 shows that also in Japan the Barro and Lee figures are seriously lower than the three alternative measures. Second, we notice, together with Portela *et al.* (2004), that the data by Barro & Lee for the periods between the surveys seems to be somewhat underestimated. This is extremely well visible in the case of Indonesia. At least for 1965 and 1975, it is clear that the

Figure 3.2

Average years of education in Indonesia, 1950-2000

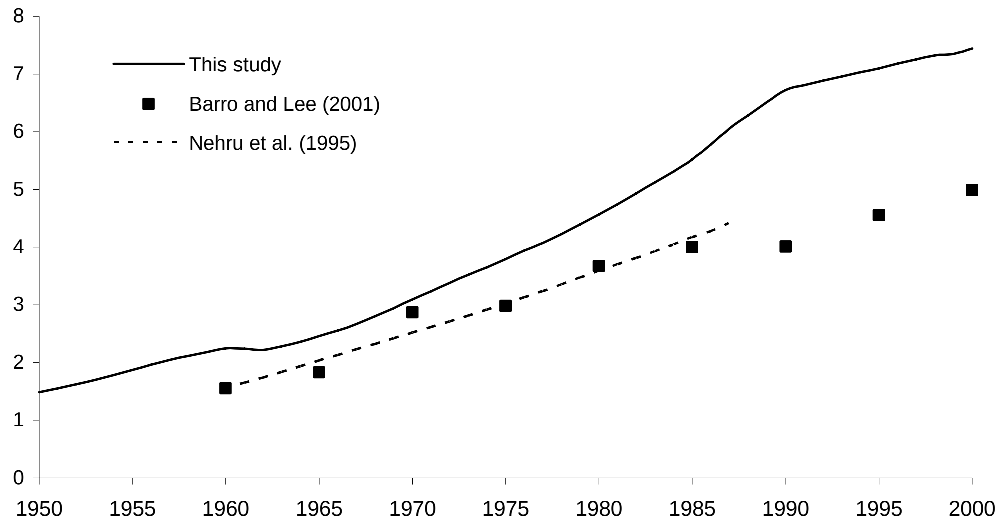


Figure 3.3

Average years of education in India, 1950-2000

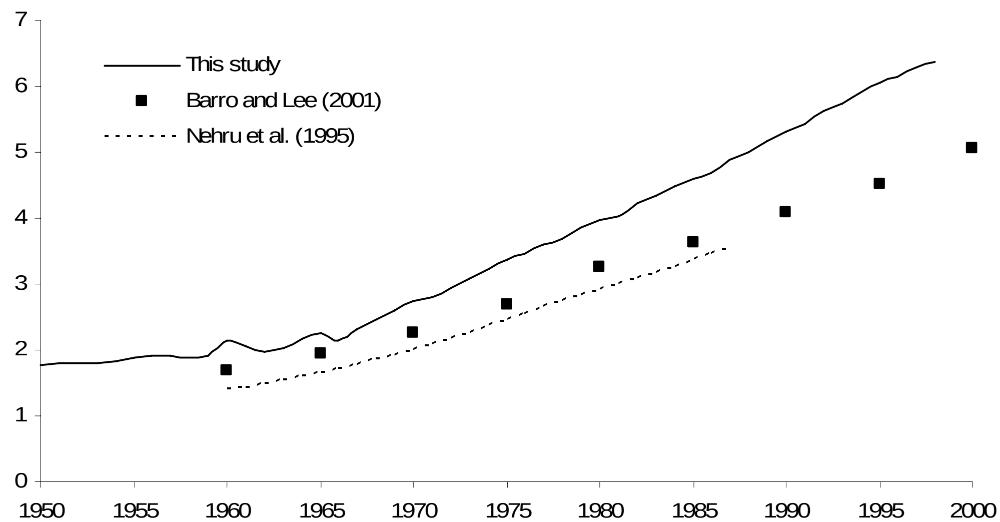
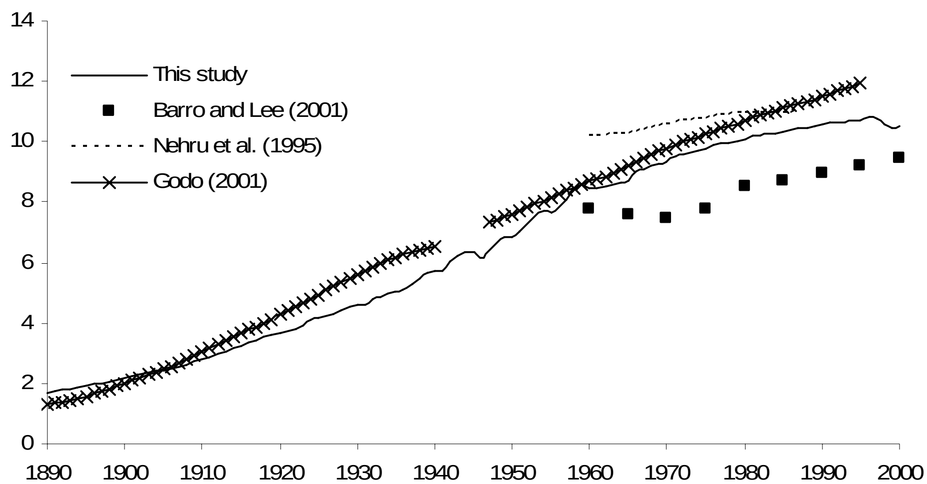


Figure 3.4

Average years of education in Japan, 1890-2000



Barro and Lee estimates are unexplainable low. Third, our estimates, although somewhat lower in the case of India and Indonesia and somewhat higher in the case of Japan, move in the same direction as the Nehru *et al.* (1995) estimates. Finally, for Japan, also some historical estimates are available from Godo (2001, table C1). The levels of these series corresponds quite well to ours. The main difference is that it shows somewhat higher growth rates in the late nineteenth and at the end of the twentieth century. Yet, we think this might be an overestimate. Especially at the end of the century, with already high literacy rates, one might expect that the growth of average years of education declines.

4. PRIVATE AND GOVERNMENT EXPENDITURE ON EDUCATION

We end this chapter with an overview of the collection of data on government and private expenditure on education. Here, government expenditure entails all government expenditure related to education, i.e. expenditure on students, school buildings, teacher salaries, and textbook materials. Private expenditure includes, as far as possible, all expenditure done by households on education, i.e. both school fees and expenditure on stationary (writing materials and textbooks). These data are on the one hand easier to collect than the enrolment data because government expenditure is mostly well documented. On the other hand, the difficulties may be far larger. One reason is that private expenditure is often badly documented, especially in India and Indonesia prior to independence. Therefore we opted not to distinguish private expenditure by level of education. This would create data which were far too unreliable.

Concerning government expenditure on education, a first problem is that not all financing was done at the national level. Often sums were also spent at regional levels. This was especially true in Japan at the start of the twentieth century. In addition, we are again confronted with the situation that the territory of India changed in the twentieth century making it necessary to correct the obtained data to arrive at the figures for the Indian Union. Finally, we have reported both the government and the private expenditure on education in tables A.8.1-A.8.3 (appendix A.8) in current prices. However, they could be deflated by using the consumer price indices of Indonesia, India, and Japan respectively as reported in appendix A.1. Although one could argue that it would be preferable to use the wholesale price index for government expenditure, we decided against this because a large part concerns for example teacher's salaries which have an obvious relation with the consumer prices.

By far the easiest collection of the data is again for Japan. The data are readily available in the *Historical Statistics of Japan* and the *Japan Statistical Yearbook* (various issues). The only important point to note concerns private expenditure. These data were also available in the *Historical Statistics of Japan* and in the *Estimates of Long-Term Economic Statistics of Japan since 1868* (Ohkawa, Shinohara, and Umemura 1967, Vol. 6, table 95). In general we took school fees and stationary. However, no data were available for 1941-1946. Therefore we assumed that private expenditure (in constant 1990 prices) remained constant from 1941 until 1943. This is not unlikely as most War-restrictions in education took place from that year on. We filled in the years 1944-1946 by linear interpolation.

Both the collection of government and private expenditure on education was far more complex in Indonesia. Fortunately, for government expenditure, in the colonial period the largest share of expenditure came from the Education Ministry as education was largely centralized (with exception, until the end of the 1920s, of the village schools). An important source concerning the educational finances in the Netherlands Indies were the reports of the Dutch-Indies Education Commission, especially Report No. 3 on government expenditures on education. This report presented data on government expenditure on education for the period 1911-1929 and in some cases even went back to 1900. The remaining years could be obtained from the Colonial Reports, Educational Reports, Budgets of the Volksraad, and, for the period prior to 1900, from the Budget of the Netherlands Indies.

Based on above observations and sources, we may conclude that prior to independence the government expenditure figures are, although somewhat more centralized than after independence, still very fragmented. It was only in 1930 when the Report no. 3 of the Dutch Indies Education Commission *De Overheidsuitgaven voor Onderwijsdoeleinden in Nederlandsch-Indïe* was published that these data were more or less systematically collected. The Report divided the finance data in data of the central government and that of the provinces. The central government was again divided by department, the most important one being the Education and Religion Department (Departement van Onderwijs en Eeredienst). Before 1911 there are no data available on the actual expenditure. Therefore the Commission only gave data on the Education budget. Because the expansion of education took place only after 1911 this should not cause much trouble. Therefore, from 1900 till 1911 only *begrotingscijfers* (budget figures) have been used. From 1911 the actual expenditure is available. Moreover, other departments than Education supervised some branches of vocational education. By far the largest was medical education. This has been added to the total current education figures.

For the period up until 1971 (and even 1998) the data are still not totally coherent. The data given for this period largely reflect the budget of the Education Ministry, which is the largest source of funding. In essence there are now two levels at which the education in Indonesia is financed by the government. The first level is the national level. Here three Ministries are involved: Education, Religion, and Home Affairs. The second level involves the provinces. There are three sources from which data can be obtained. The first one is the central government budget (recurrent, development, and, for public universities, self-generated funds). The second source is the Ministry of Home Affairs. This ministry pays teachers' salaries in public and 70% of teachers' salaries in the private primary schools. Here data are, however, not readily available although there are some years for which they are estimated. The third source is the Ministry of Religion. Here the data are only partly available. The main costs are the teachers' salaries in public and private religious schools. These data are, however, only available on a regional level from the offices of the Ministry of Religion. In sum, in 1995-1996 the Ministry of Education paid about 51%, the

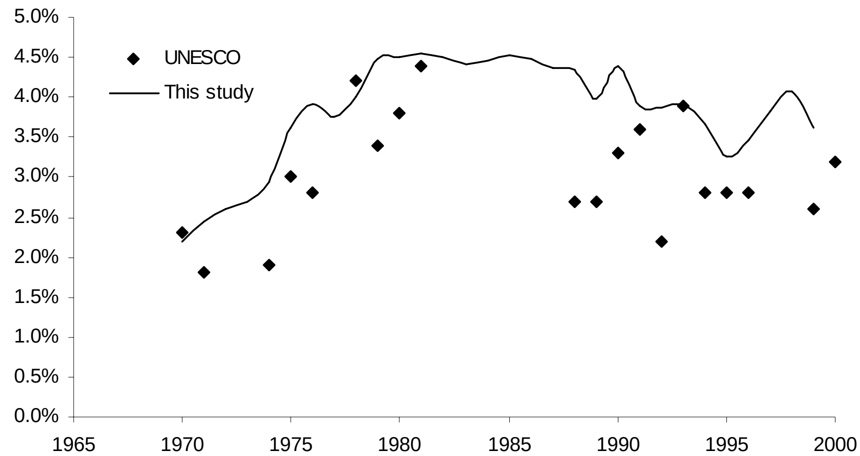
Ministry of Home Affairs about 38%, and the Ministry of Religion about 4% of total centralised government expenditure on education (Clark *et al.* 1998, 37-38). For the expenditure by lower government levels one has to turn to the Provincial accounts. Especially after independence the data on government expenditure in Indonesia are therefore not even partly available. Nevertheless two studies have been done into the education finances of Indonesia. Both studies were supported by (or took place within) a large project to obtain insight into the government finances. Therefore, they had access to data that, for other years, was not available. The first study, of Ruth Daroesman, appeared in two parts in the Bulletin of Indonesian Economic Studies in 1971/72 and in a separate draft report (Daroesman 1971; 1971; 1972). This study is largely based on a survey of the author herself as the government data were incomplete and unreliable. The second work on Indonesian education finance was performed by Clark *et al.* (1998). This study shows that between the study of Daroesman in the 1970s and the 1990s not much has changed in educational finances. The study of Clark *et al.* claims to be the first really comprehensive study of Indonesian educational finance in 1995/96. But even in this study, the almost 40,000 private *pesantrens* and kindergartens were not taken into account. Equally, many short-cut estimates had to be made just as Ruth Daroesman had done for 1970. One example constitutes the finances for teachers' salaries paid by the Ministry of Home Affairs.

Therefore it is not feasible to calculate for each year the actual expenditure on education for the post-colonial period. As mentioned, however, there are two works available in which the actual amount of government expenditure on education is calculated. Furthermore the data on the expenditure at the end of the colonial period were available. These were also divided into school level and to source of funding. With these benchmarks some available data on development and current budgets and on current GDP were used to obtain, with an interpolation of the ratios between total government expenditure in 1970 and 1995 and the data on government expenditure and total government expenditure, the data on government expenditure on education for the entire period. These data seem to be fairly accurate. If we compare them to the available expenditure figures obtained from the IMF Government Finance Statistical Yearbook (which only has a few data for the last years of the twentieth century) or with the UNESCO data, there are some differences but the pattern is the same (see figure 3.5).

Private expenditure is even more problematical in Indonesia than is government expenditure. The best data available are for the period after

Figure 3.5

Government expenditure on education as a percentage of GDP in Indonesia, 1967-2000



Note: The expenditure data from the UNESCO were as much as possible corrected for changes in definition.

Source: UNESCO Statistical Yearbook (various issues); Appendix A.8, table A.8.2.

independence. Two important sources are available. First, the input-output tables provide data on private expenditure on education for 1971, 1975, 1980, 1985, 1990, 1995, and 2000. These data are relatively reliable as they provide information on all streams of income, production and expenditure in the Indonesian society. As such, we will use these figures to provide benchmarks. Further, we have data on private expenditure on education from the Indonesian household surveys (SUSENAS) which are available since the 1960s. However Bina Roy (2003, 9) has remarked for India that expenditure surveys are generally much less reliable than commodity flow methods. This is partly because (often richer) households, underreport actual consumption. As the expenditure on education is often not underreported, education as a percentage of total consumption is overestimated. Consequently, we made the SUSENAS results comparable to the input-output tables and than estimated ratios for the given years between private consumption on education to total private consumption obtained from the Indonesian national accounts (see also appendix

A.4).[66] These ratios were interpolated. Multiplying these results with the total private consumption, gave the private expenditure on education between 1960 and 2000.

For the period prior to 1960 we followed the same method as outlined in appendix A.4. We used household expenditure data from several surveys in the period

Table 3.5: Private expenditure on education per household category based on the household surveys, 1924-1959 (mln current guilders)

(non-)-agriculture	household category	1924	1932	1937	1939	1941	1942	1953	1959
Agriculture	Agricultural employee household				0.4	1.1			45.6
	Operator, land owner 0,0-0,5 ha agriculture household	8.4					0.4		58.5
	Operator, land owner 0,5-1 ha agriculture household		0.9				1.7		120.4
	Operator, land owner >1 ha agriculture household	10.5					10.6		
non-agricultural	Non agricultural lower level rural household	1.7	1.4		0.4				
	Non labour force rural household								
	Non agricultural higher level rural household				0.8				
	Non agricultural lower level urban household			0.4				26.0	107.8
	Non labour force urban household			2.3				15.4	110.4
	Non agricultural higher level urban household								30.6
Total*		**18.5**	**17.5**	**13.3**	**16.6**	**14.2**	**27.6**	**81.8**	**1,087.3**

* Estimation method (see text)
Source: Household surveys (see table A.4.1 in Appendix A.4); total educational expenditure, see Appendix A.8.

1880-1960. An overview of these surveys is given in table A.4.1 in appendix A.4. From these surveys we obtained the educational expenditure of several household categories for several years (see table 3.5) (for a description of the household classes see Appendix A.4.). Please be aware that the figures in table 3.5 include a considerable margin of error.

Because for the period prior to 1960 only data on a few household classes and years were present, we used these data to calculate the ratios with the educational expenditure of other classes. This gave total educational expenditure for some years. The missing years were imputed where government expenditure on education, skilled and unskilled wages, and and educational enrolments were used as independent variables. However, imputation leaves the original data points of the dependent variable intact. For private expenditure these may show strong fluctuation as not all

[66] The total private consumption expenditure statistics were obtained from Badan Pusat Statistik, *Statistik Indonesia (Statistical Yearbook of Indonesia)*, Jakarta: BPS 1976-2003. Further they were obtained from Pusat Penelitian dan Perkembangan Statistik, Biro Pusat Statistik, *Pendapatan Nasional Indonesia 1960-1968 (National Income of Indonesia 1960-1968)*, Djakarta: Pusat Penelitian dan Perkembangan Statistik, Biro Pusat Statistik 1970. Finally, the input-output tables were used.

differences between household surveys could be removed. Therefore, just as in appendix A.4, we regressed the imputed values of educational expenditure on the other variables such as government expenditure on education, skilled and unskilled wages, and educational enrolment. We used the resulting coefficients to predict the private education expenditure variable. Yet, because of lack of suitable household surveys, we miss data on private educational expenditure for the period prior to 1928. Therefore we used the ratio in 1928 from private educational expenditure with total private expenditure to estimate the expenditure on education between 1880 and 1927.[67]

For India the data are easily obtainable from the statistical yearbooks. The correction for the separation of Pakistan and Bangladesh can be done in the same way as we did for the enrolment figures. The expenditure on education in India in 1950 was 89.06% of total expenditure of India, East and West Pakistan and Bangladesh (undivided India). This figure was used for all expenditure back to 1890, of course after substracting the figures for Burma. For the period after independence, it is important to note that, just as in Indonesia, the central government, state governments, local authorities and a variety of private sources financed education. In addition, the budget for the state and provincial governments is divided in the development and the maintenance budget (development and current budget in Indonesia) (see Bordia 1995, 436). Private expenditure on education was arrived at by calculating the expenditure on education by individuals and private funds. This same method was used by Bina Roy (2003) when she estimated total private expenditure and private expenditure on education in India between 1900 and 1950. We extended these series to include 1880-2000.[68]

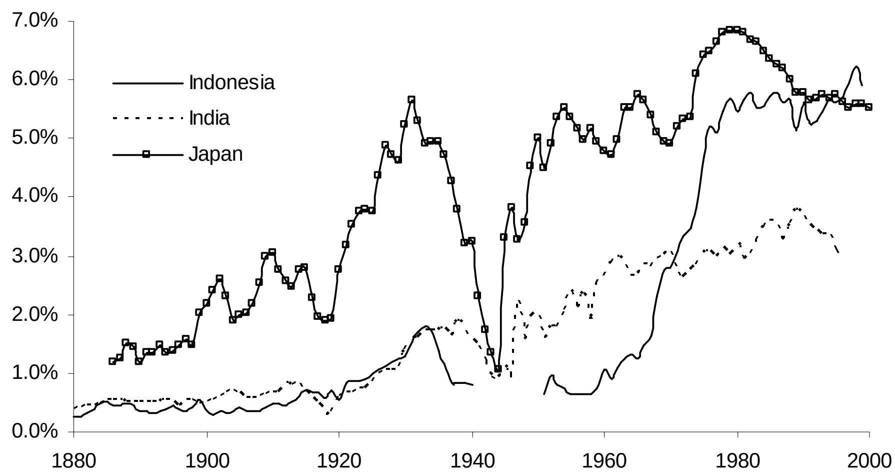
The results of both the government and private expenditure on education for Indonesia, India, and Japan are presented in tables A.8.1-A.8.3 in appendix A.8. The total educational expenditure, that is private plus government expenditure, as a percentage of the GDP is reported in figure 3.6. One point to note is that already in 1890, the share of educational expenditure in Japan was far higher than that in India and Indonesia. We may also notice that in the 1970s a strong rise of the share of

[67] This means that the percentage private education expenditure in total private expenditure is assumed constant between 1880 and 1927.
[68] However, these do only partly include expenditure on stationary. Therefore, we think they might be somewhat underestimated. However, the difference is likely to be marginal.

educational expenditure took place in Indonesia. That this is largely caused by an increase in government expenditure can be seen from a comparison with figure 3.5. Combined with an equally strong rise in GDP due to the oil boom in those years, this means that the growth of educational expenditure was really astonishing. India, however, experienced a gradual rise of the share of education in GDP from the 1920s onwards. This is probably caused largely by on the one hand the political focus on

Figure 3.6

Government plus private expenditure on education as a percentage of GDP in India, Indonesia, and Japan, 1880-2000 (in current prices)



industrialisation and less so on education and on the other hand the lack of political will to invest more in education. Indeed, the 1950s and 1960s in India seem to be largely dominated by plans for educational reform that never materialised. A more extensive description of the educational developments in India, Indonesia, and Japan is presented in chapter 4.

5. CONCLUSION

The present chapter was intended to give a brief overview of the basic variables that are the starting point of any study on human capital. Although data for the construction of these variables such as attainment, average years of education, and (as an indicator of human capital formation) enrolment are in principle available, there are several obstacles when one wants wants to collect them and make them comparable. We saw that there were three main problems. One is lack of data, especially in Indonesia during the Second World War and the following period of decolonization. This requires the use of alternative assumptions and estimation methods to get an idea of the movement of the educationan variables during that period. The second difficulty was the split of British India in India and Pakistan (the latter was subsequently split in Pakistan and Bangladesh). Although it would have been possible to collect data for small administrative regions and use it to correct the national figures for the border changes, we decided to calculate the ratio between on the one hand India and on the other Pakistan and Bangladesh and to perpetuate this ratio backwards. Finally, we were confronted with an overestimation of educational attainment when using the Barro and Lee-method to bring the attainment estimates back in time. Using a slightly adapted method of Portela *et al.* (2004) we constructed a set of correction factors to correct for the overestimation of attainment at each level of education.

The results from our estimates indicate that Japan was clearly more developed in the field of education at the start of the twentieth century than were India and Indonesia. Japan had a far greater share of educational expenditure in GDP and had far higher levels of attainment and enrolment at all levels of education (see next chapter for a description). But also between India and Indonesia there were differences. We briefly touched upon some of these such as the steady increase in educational expenditure as a percentage of GDP in India during the period 1940-1960 while in Indonesia there was a decline followed by a boom in educational expenditure. Yet, a more extensive description of the educational development of these three countries is given in the next chapter where we will try to connect this development to their institutional structure.

4. Converging Patterns? Educational Policies and Development in an Educational Age

1. INTRODUCTION

In chapter 2 we pointed out that there is a large literature that estimates the effect of education on economic growth. However, it also became clear that this relation may vary considerably between countries. Essentially, two models have emerged that discuss these differences. First, there is the 'human capital model' (Fuller, Gorman, and Edwards 1986). This theory, mainly propagated by Western scholars, argues that school investments increase labour productivity both at an individual and national level. However, this theory works mainly at the individual level. An individual decides to follow education based on the anticipated returns while the schools will offer the necessary skills as signalled by the wage rates. Second, mainly propagated by non-Western scholars, there is the 'institutional model' which argues that the increase in literacy and skills is mainly driven by political and ideological factors.

Both models suffer from considerable weaknesses. The human capital model is based on a market mechanism and, consequently, it is difficult to explain deviations from the optimal schooling levels that are not caused by misinterpretation of expectations. An example of an attempt to such an exercise is Fields (1974) who argues that wages in developing countries adjust slowly, creating an imbalance in their labour markets and hence, overeducation. The problem with the institutional model is that the individual relation between schooling and labour output is limited and that the economic effect on school expansion should be studied at a national level.

Yet, as our study is also based at the macro level, we think this latter weakness is less important in this case. Indeed, the latter model has become increasingly popular both with sociologists (Fuller, Gorman, and Edwards 1986) and some economists (Bauer 1997).[69] One could argue that the human capital model equals one end of the institutional model, i.e. the case with optimal, country-specific institutions. This suggests that, as most Western scholars focus on the human capital model while most non-Western scholars focus on the institutional model, it is likely that non-Western

[69] They all found either that the human capital model must be rejected or that the institutional structure may explain the development of the education system and, through that system, influences economic growth.

countries suffer from sub-optimal institutions compared to developed countries and, hence, from a lower effect of education on growth.

Based on the quantitative data discussed in the previous chapter, we go deeper into the existence of institutional differences of human capital forming institutions in India, Indonesia and Japan. In doing so, we try to develop some hypotheses about the effects this may have on the relation between human capital and growth. In the next section we start with a brief overview of the literature on the historical development of human capital forming institutions. Section 3 to 5 look whether the pattern found is also applicable to Indonesia, India, and Japan. In section 6 arrive at a brief conclusion where we compare the three countries and try to distil some hypotheses on the relation between human capital and economic growth which we can test in further chapters.

2. GENERAL PATTERNS OF EDUCATIONAL DEVELOPMENT IN THE LITERATURE

2.1 Introduction

Most studies on the development of education systems and their differences between countries are from educational sociology. This strand is captured under the common term 'world model of education' literature. As the name suggests, in this literature it is generally argued that education systems in most countries follow a common development. Indeed, this is part of the reason why the International Standard Classification of Education (ISCED) was developed which we touched upon briefly in the previous chapter. Even with the existence of all sort of country-specific characteristics, the ISCED nevertheless managed to develop some common characteristics of the education systems from all countries.

Although this literature makes a distinction in the underlying reasons for educational development between different countries, the actual development of the education systems shows a common pattern. Generalizing, it is argued that in most, nowadays developed, countries, the education system arose from internal, country-specific, economic, religious, and political developments (Boli 1989). As these countries are mostly Western European or Western Offshoots such as the United States, there are also large similarities in their internal characteristics. Yet, the development of the education systems in what we call now, 'developing countries' was not based on local societal developments. In fact, it seems to have been copied from Western Europe with the idea of stimulating economic development by means of increasing the skills in the population in the same way as in the Western countries (Ramirez and Boli, 1987).

2.2 The rise of mass education

In the ‘world model of education’ literature it is argued that around 1800 in Europe and some western offshoots a system of mass education (defined as primary schools open in principle to all classes of society)[70] arose caused by economic and political developments (Ramirez and Boli 1987; Boli 1989; Nuhoglu Soysal and Strang 1989).[71] For example, instead of the aristocratic and priestly classes, increasingly the entire population became involved in the political process. This increased the need for the state to ‘educate reliable citizens’. In other words, in order to prevent political change and unrest, common people should be taught the correct moral and political values. These developments in the political field were enforced by economic development. For example the increased use of written contracts, books, and trade correspondence made literacy more important (Houston 1983).

The increase in mass primary education caused by these developments was spectacular. For example, in 1840, the gross enrolment ratio (the number of children enrolled in education divided by the number of children in the relevant age class) in primary education in France was 50.9%. This was spectacular compared to the figures for India and Indonesia that a few decades later were still around 1%. Yet, at the end of the nineteenth century also a take off to mass education took place in much of what is now known as the ‘developing world’ (Ramirez and Boli, 1987; Benavot and Riddle 1988).[72] However, there were two important differences in the development of

[70] As a consequence, this does not mean that children actually have to attend schools. So long as parents have a feasible option to send their children to school, we define it as a system of mass education. If we would have simply looked at the numbers enrolled, we would end up with a tautological analysis: ‘mass education started because a high percentage of children was enrolled in primary education’.

[71] The religious argument is also frequently put forward in the literature. Examples are the Calvinist worker attitude or, for Japan the ‘reformation’ in Japan. In the 16th century many developments had taken place that changed the nature of the Japanese government such as the evolution of an administrative corps, the refinement of administrative technology, and the utilization of talented individuals from different social backgrounds. Although this ‘Reformation’ was followed by what Schooler (1990) sees as a successful Counterreformation when the Tokugawa family rose to power, the Reformation-like situation could not be turned around completely. The religious argument is, however, extremely problematic. To give just one example, it is not clear at all whether higher literacy is caused by the arrival of Protestantism or that Protestantism arrived in regions with a high literacy. We will therefore further abstain from this line of reasoning.

[72] It is argued, however, that for the great mass of developing countries, entry into mass education only started after World War II (Meyer, Ramirez, and Nuhoglu Soysal 1992, 137). However, the simple observation that a large part of the growth in enrolments did take place only after 1950 does not

mass primary education in the developing countries compared with its development in the West.

First, the underlying developments causing the rise of mass education in the developing countries were different from those in the Western countries. Instead of growing from religious, economic, or political changes, here the start of mass education was based on the idea that economic and social progress could only be achieved by copying the Western educational model (Ramirez and Boli, 1987). Several other arguments have also been put forward, including the building of a class of reliable citizens, colonialism causing a simple copying of the education system of the colonizer country, and the need to train capable administrators. However, for all arguments the underlying factor is the idea of that economic and social progress can be stimulated by copying the Western education system. In the 'world model of education' literature, this is often referred to as the 'myth of progress' (Benavot 1983, 65; Ramirz and Boli 1987, 10; Kamens, Meyer, and Benavot 1996, 136).[73]

The second difference of the rise of the 'world model of education' in the developing countries was its result: a slower increase in mass education and, up till now, lower levels of educational attainment. This is clearly shown by the data of Benavot and Riddle (1988, 202) which show that until 1940 the primary enrolment ratios in Asia where the lowest of all regions except for Africa and the Middle East.[74]

2.3 The rise of secondary and higher education

In first instance, the rise in primary enrolments was hardly accompanied by an increase in enrolments at the secondary level. However, in the Western countries in the mid-nineteenth century an increasing demand for further educational opportunities arose. Economic and social developments made it possible that well to do persons,

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exclude possible commitments of the States involved to mass education or, at least, to the 'modern', Western, education system.

[73] Admittedly, (Ramirez and Boli 1987, 10) distinguished 5 legitimizing myths, i.e the myth of the individual, myth of the nation as an aggregate of individuals, myth of progress, myth of socialization and life-cycle continuity, and the myth of the state as the guardian of the nation. However each myth is based on the idea that education will deliver progress in the form of economic and social upliftment and in the form of a strong state.

[74] It may be that, because of its weaker links with economic and political development, the growth of enrolments in these regions was less strong. For example, some indigenous education in Indonesia had a very religious nature which caused this form of education to be badly connected to the demand from the economy. Therefore, many Dutch and Indonesian educators held it in low esteem as it did not provide much possibilities to enrol in a job after graduation. Although, at the 1936 conference in Padang-panjang, attended by many Muslim educators, it was decided to structure these schools and to upgrade the secular subjects in the curriculum (Hing 1995: 13), still the problems with educated unemployed continued.

even if not related to the nobility, could send their children to secondary schools. This increasing secondary education was strongly programme oriented, contrary to the already existing general and classical institutions.[75] As the average educational attainment rose and the demand for education increased, in the 1920s and 1930s a shift emerged to more general secondary education. This is what Trow (1961) called the 'second educational transformation'.[76]

The rise in secondary education in developing countries only took place after the 1910s and accelerated only after World War II. As the 'world model of education' literature argues that developing countries try to follow the educational development path of the Western countries, and as they lagged in educational development, developing countries started to copy mass secondary education from the western countries since the first decades of the twentieth century and especially after World

Table 4.1: Full-Time Students in Vocational Programs as a percentage of persons enrolled in total general secondary education by select regions of the world, 1950-1990 (number of countries in parentheses)

Region of the World	1950	1960	1970	1980	1990
Africa*	19.0	16.2	13.8	8.5	3.6
	(21)	(30)	(44)	(39)	(30)
Asia**	10.1	10.1	11.2	4.1	3.6
	(12)	(17)	(24)	(27)	(25)
Middle East/North Africa	15.8	12.1	11.5	8.9	6.7
	(11)	(15)	(17)	(16)	(12)
Latin America/Caribbean	29.9	23.0	16.0	11.6	7.1
	(19)	(23)	(30)	(34)	(24)
Europe	37.9	34.6	21.1	9.2	17.9
	(19)	(23)	(30)	(31)	(36)
Totals, all regions	24.2	20.0	15.1	8.6	8.6
	(82)	(108)	(145)	(147)	(127)

*Excluding North Africa
**Excluding Middle East
Source: 1950 and 1960: Benavot 1983, 68; 1970-1990: UNESCO statistical yearbook (various issues).

[75] It might even be argued that the programme oriented secondary education created a way for further education and, at the same time, closing the way to higher education for the non-elite. For a comparison between Asia and Europe see Wilkinson (1963, 20-21)
[76] Trow (1961, 148) dates it between 1900 and 1940. However, this is for the United States, which, as pointed out, as a developed country anticipated developments that would commence in the developing world some decades later.

War II. Consequently, their focus is much less on vocational or practical programmes and more on general subjects.[77] This can be seen in table 4.1. It is especially in Europe (37.9%) that a large share of persons enrolled in secondary education follow a vocational or practical education stream. This figure is much lower for the other regions. Most notably in Asia in 1950 there are only 10.1 students in vocational or practical programmes compared to 100 in general secondary education. Furthermore, we may notice that the share in vocational programmes declines in all world regions.

This results in two important findings. First, there is tendency to general secondary education which in turn might lead to an expansion of higher education. This is also confirmed by the findings of Kamens, Meyer, and Benavot (1996, 137) who find that the share of comprehensive and general secondary education in the higher secondary education program increased strongly in the richer countries between 1960 and 1980 while this share rose more moderately in the poorer countries. Yet, this latter finding can also be caused by the situation that the initial share of vocational education in these countries was already lower at the start of this period.

Second, it shows that this pattern from vocational to general secondary education in all regions is the same, indicating that there is indeed to some extent a world development in education.[78] Indeed, if the developments would be largely country specific, we would expect a radically different development after independence. However, this does not seem to be the case.[79] Some studies, using regression analyses, showed that independence had no strong effect on educational policy (Benavot 1983, 72; Meyer, Ramirez, and Nuhoglu Soysal 1992, 140). Equally, it is argued that country-specific effects on educational development are small (Meyer *et al.* 1977, 251).

Undoubtedly, the increase in general secondary education also increased enrolments in higher education as there is a larger pool of people who can pursue higher education. This increase may be driven by social or economic motives. Social

[77] Alternatively, Bennett (1967, 106) argued that it are mainly cultural determinants (whatever they may be!) that cause this effect in Asia. Green (1953a; 1953b) is more specific when he suggests that the low share of vocational education in Asia might be explained by caste, authoritarian patterns of communication, and the higher status attached to white-collar jobs.

[78] Another example is the increasingly equal definition of childhood in constitutions (Boli-Bennett and Meyer 1978, 805). However, not many studies focus on the patterns of educational development over the whole historical period. One exception is provided by Matthijssen (1972). He divides educational development in several phases, each with its own power structure and educational characteristics.

[79] For an alternative view see Herting and Bauldry (2001), Hirschman (1979), and Ramirez and Meyer (2002, 13).

motives can be pluriform, but entail mainly that younger persons find higher education easier attainable. In addition, they think they can reap the benefits of higher education more easily. Both factors can be caused by increasing education levels in the population which make higher education both easier accessible and more accepted for lower class persons (Hayden and Carpenter 1990). For example, from the overview study on the returns to education of Psacharopoulos and Patrinos (2004), we can see that the returns to higher education are relatively lower in Western than in developing countries. As the enrolment in higher education is also much higher in Western countries, this suggests that there is a limited access both to higher education and, after a degree has been obtained, to the labour market in developing economies. A second reason for the increase in higher education may be economic. Due to changing economic structure, there is a rise in the returns to higher education (Jackson and Weathersby 1975; Nicholls 1984). Both classes of arguments are in conformation with the idea that national economic and social developments drive educational development.

3. THE EDUCATIONAL STRUCTURE IN INDONESIA

3.1 The rise of a colonial education system

At the start of the nineteenth century a weak indigenous education system coexisted with a weak western education system. As far as there were western schools, they were meant for (Indo-) European children. These schools were generally led by missionary organisations, sometimes with the financial support from the East-Indies government. The indigenous system of education, which had no connection with the colonial government, consisted largely of Koran school (*pesantren*) for Muslims where they learned to read and write with the help of Koran texts.

Neither the small indigenous system nor the European schools, provided enough trained persons for government functions and industry. In the early 19th century especially the former factor proved important as '[t]he need for schools for the indigenous population became more important when the village leaders became obliged to participate in the government administration for which they needed certain skills.'[80] Therefore, the government started slowly to become more active in the field of education made visible in several changes in the law such as the East Indies

[80] Colonial Report (Koloniaal Verslag) (1849). Translation from Dutch by the author.

Government Act of 1818, which obliged the government to provide schools for Europeans, and to supervise some of the existing indigenous schools. In addition the East Indies government also had to allow Indonesians entering European schools.

However, it was only at the end of the nineteenth century that the education system in Indonesia was considerably expanded to also include Indonesians. In the Netherlands, this was a period of rapid expanding educational enrolments and the Dutch parliament wanted to extent this also to the colonies. These efforts resulted in the Royal Decree (Koninklijk Besluit) of September 1893 which regulated the whole Indonesian school system. The system was changed in such a way that two categories arose. There came five-year First Class schools (Scholen der eerste klasse) for children of high-class or wealthy Indonesian parents and three-year Second Class schools (Scholen der tweede klasse) for children of the Indonesian population in general. Besides this two-tier structure of Indonesian education, the European schools remained in place. As a consequence, the dual structure of the existence of a European and an Indonesian school system side by side, which had in effect existed from the start of the nineteenth century, remained in place.

3.2 Increasing enrolments

3.2.1 Primary education

Although in the mid-nineteenth century the idea already had taken hold that for economic and administrative improvement more Indonesians needed to be educated, in the late nineteenth century the idea arose that the colonizer countries were also responsible for the economic and moral upliftment of the colonial peoples. This development resulted in Indonesia in the Ethical Policy. An important aspect of the policy constituted of improved access to education.

In theory, already from the mid nineteenth century, schools had been open to the indigenous population. However, in spite of the increase in the number of second-class schools and the number of students, these lower class schools never had become popular. Between 1904 and 1914 the number of indigenous second-class schools rose from 603 to 1,167 whereas the number of students rose from 86,342 to 174,415. Although this was a doubling of the number of students, compared to the total population this increase was small if one considers that it increased the gross enrolment ratio in primary education from 1.1 to 2.1%.[81]

For this reason the Governor-general, Van Heutsz, became interested in the village schools, set up in the 1890s by the resident of Kedu (Java), P.M.L. de Bruyn Prince. In the next few years the experiment was extended to include the complete island of Java and in 1909 also a test in Atjeh was allowed whereas in 1914 on the island Sumba also some village schools were set up (Lelyveld 1992, 83). The population had to bear the largest share of the expenses, the profession of teacher did not have much standing, and the quality of these schools was low. Nevertheless, between 1909 and 1914, the number of these desa schools rose from 723 to 3,521 and the number of pupils from 43,713 to 239,415.[82] So the growth in this new class of education was more than double that in the second-class schools.

This increase can also be seen in figure 4.1. This figure shows two important developments. First, the number of children in primary schools rose strongly as from

Figure 4.1

Log enrolment in primary education in Indonesia by ethnic group, 1890-1940

Source: Colonial Report (various issues)

around 1907. This was largely due to an increase in the enrolments of Chinese and Indonesians.

[81] Please note that these figures exclude all other sorts of education such as village schools.

[82] Second-class schools were later renamed standard schools which in the 1920s got a fifth and sometimes even a sixth grade for agrarian education (to give the students the possibility to set up their own enterprise). With the start of the school year 1932-1933 the already started process of converting standard schools into Village- and continuation schools was strongly promoted. In that year the number of standard schools decreased with 233. Slowly nearly all Standard schools disappeared.

However, it were not only the numbers enrolled in the desa-schools that increased. Equally the number of Indonesians in European (or related) primary education increased. Where in 1900 only 2,603 children of Indonesian origin entered European and related schools (against 369 Chinese and 17,030 Europeans), in 1920 this figure had increased to 52,682. These figures include enrolments in the former First Class Schools, which got Dutch in the curriculum and were renamed HIS (Hollandse Inlandse School: Dutch-Indonesian Schools).[83] This shows that there was a clear demand for European and related education.

The situation was now that the second class Indonesian schools made place for mass education in the desa schools while the first class schools were turned into Dutch-Indonesian schools. This changed the dichotomy in indigenous education. Whereas at the end of the nineteenth century the difference was largely between Indonesians of higher and lower social classes, the dichotomy was now between Indonesians following mass education and Indonesians following European oriented education. Of course, both dichotomous situations largely consisted of the same social groups.

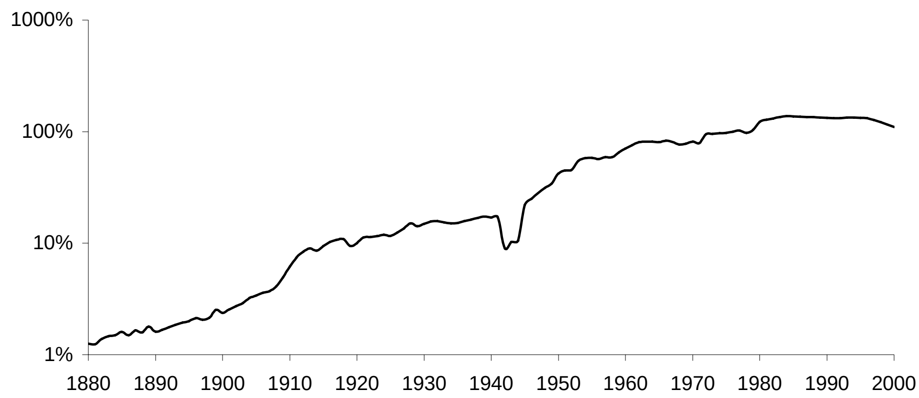
There was thus a decrease in the ethnic differences in educational enrolments in the first four decades of the twentieth century. This process got an impetus during World War II when the Japanese abolished European primary education and created a uniform six-year primary school (Goto 1992, 12). This process was continued after independence when no difference was made between ethnicities. Most important in this respect was the introduction of Bahasa Indonesia as a uniform language in the schools. However, room was left for local languages.

This created a massive rise in enrolments. Figure 4.2 shows that after a rise between 1907 and 1941 and a decrease in enrolments during the War, primary education exploded as from the late 1940s. After a stagnation in the mid-1960s when

[83] Yet, this increase was partly due to the decision to introduce the possibility to learn the Dutch language in first-class schools (Lelyveld, 1992: 78). Dutch was introduced as from the third year and the number of school years was extended with one to a total of six as from 1907-1908. After an advice of Hazeu in 1911 it was decided to add a seventh year and to teach Dutch already from the first year. This did not relieve all doubts in the government concerning the quality of education in the first class schools. Therefore, in 1914, this school was converted into the Dutch-Indonesian School (H.I.S., Hollands-Inlandse School). After the village schools, it were the Dutch-Indonesian schools, which showed the fastest rate of growth in the 1920s.

Figure 4.2

Log gross enrolment ratio in primary education in Indonesia, 1880-2000



Source: Appendix A.6., table A.6.1.

Suharto came to power, the gross enrolment ratio started to increase again in the 1970s, fuelled by the increasing government expenditure on education from the boom in oil prices. In the mid 1980s the gross enrolment ratio reached its peak of around 137%. Such a peak in the gross enrolment ratio above 100% takes place in many countries when they try to arrive at universal primary education. It means that also older (and possibly younger) persons follow primary education. Afterwards, the gross enrolment ratio again declines as every designated child follows primary education so the need for older persons to follow this level of education disappears.

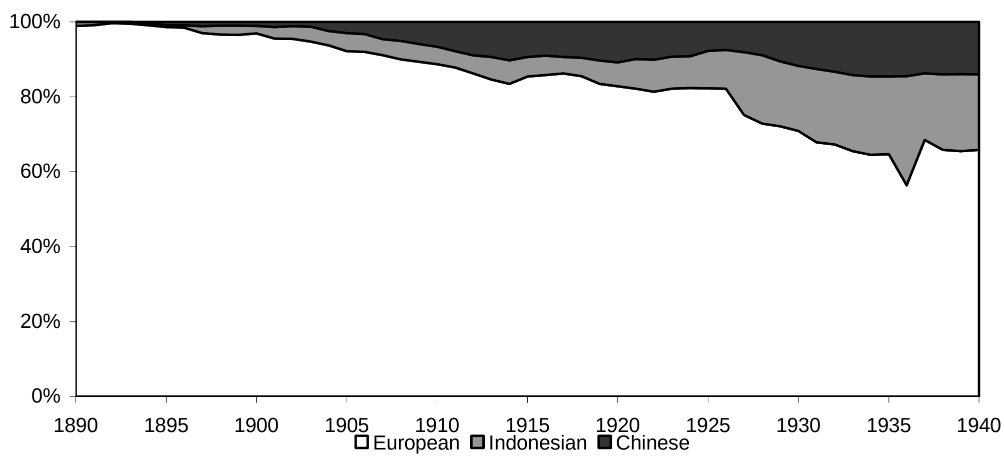
3.2.2 The rise of secondary and higher education

Even though access to primary education for the Indonesian population increased in the first decades of the twentieth century, it still remained difficult to enter secondary education. First, of course, a low enrolment in primary education means that the number of persons eligible to follow secondary education is also small. Second, the possibility of Indonesians entering secondary education was also reduced because the latter was largely given in Dutch.

In the 1910s and 1920s the opportunities for entering secondary education for Indonesians increased. Link schools were introduced, which were aimed at bridging the gap between Indonesian primary education (and of course the HIS) with the (largely European) secondary education. However, the continuation in secondary education remained problematical for the Indonesian population until after decolonization.[84] In figure 4.3, we see a relative rise in the number of Indonesian and Chinese children enrolled in secondary education after 1905, but especially after 1925. However, their numbers remained relatively low compared to European

Figure 4.3

Share of ethnic group enrolled in general secondary education in Indonesia, 1890-1940



Source: Colonial Reports (various issues)

enrolments. As a consequence, in this respect the dual structure of the education system remained intact until World War II.

The options for the Indonesian population in secondary education were thus very limited. Still, as figure 4.2 shows, there was a considerable increase in primary enrolments which at least suggests that there was also an increasing demand for further education. This gave, compared to the international patterns described in section 2, rise to a remarkable situation. The Europeans did follow the pattern set out in section 2 of first increasing primary education and than increasing secondary education. However, because secondary education was difficult to access for the indigenous population, the demand for further education that arose was expressed as an increase in vocational primary education. This was a divergence from the global educational development path as generally vocational education was given at the secondary level.

Indeed, table 4.2 shows that the increase in enrolments in vocational education for Indonesians between 1880 and 1940 was much larger than in general (secondary)

[84] Even after decolonization problems remained with culture, income, language instruction, etc.

education. For Chinese, both sorts of education developed in about the same manner. Finally, European enrolments in general secondary education were slightly higher than in vocational education.

Again, just as in primary education, World War II had a strongly egalitarian effect on secondary education by closing the Dutch schools. However, in effect most

Table 4.2: Enrolment per race in general secondary and vocational education in Indonesia, 1880-1940

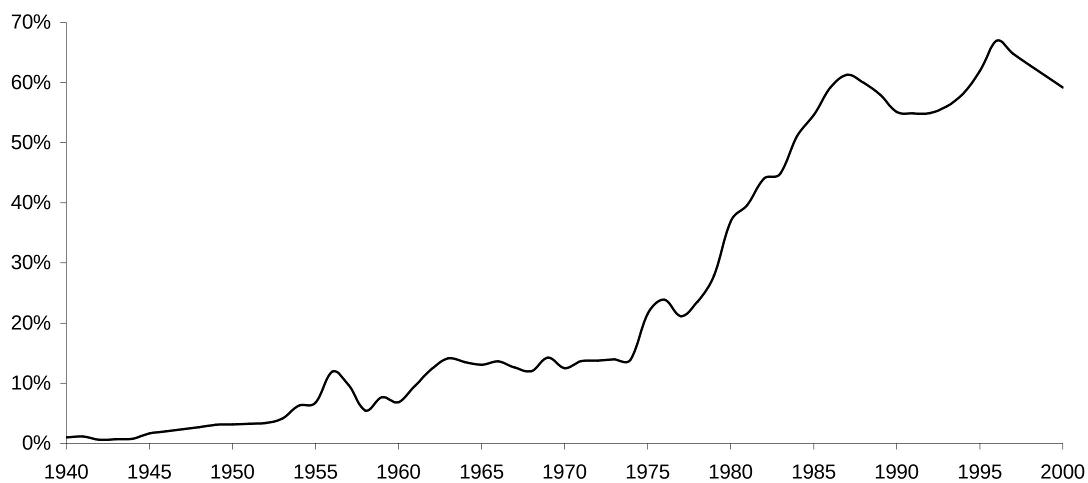
	General Secondary education			Vocational education*		
	Indonesian	Chinese	European	Indonesian	Chinese	European
1880	0	1	492	563	5	103
1890	5	0	461	485	4	89
1900	14	7	666	617	25	113
1910	61	88	1.175	2.921	119	537
1920	184	313	2.398	7.669	313	1.410
1930	862	588	3.536	20.355	915	3.466
1940	1.572	1.093	5.130	32.522	1.969	3.952

* Includes vocational primary education.
Source: Colonial Report (various issues)

changes took place only after independence. A uniform three year lower secondary and a three year higher secondary school was established. Combined with increased egalitarian access, this led to a strong increase in enrolments. Figure 4.4 shows that

Figure 4.4

Gross enrolment ratio in secondary education in Indonesia, 1840-2000



Source: Appendix A.6., table A.6.1.

the gross enrolment ratio in secondary education increased from the late 1940s, when the education system was reformed after the War and the ensuing Dutch 'Police Actions'. In addition, we may note that the gross enrolment in secondary education started to rise especially strong in the mid-1970s. Of course this may partly be caused by the increase in government funding caused by an increase in the government budget by the oil boom in those years. However, it is also clear that the faster increase in secondary education coincides with a gross enrolment ratio in primary education that was close to 100%. Consequently, after reaching universal primary enrolments, attention now shifted to secondary education.

But although the enrolment numbers strongly increased, the characteristics of secondary education changed much less in the first decades after the War. Before the War, general secondary education had been largely European while Indonesians mostly entered vocational (primary) education because there were few alternatives. Even though the accessibility of secondary education after the War increased, there still were tendencies to try to increase the share of persons enrolled in vocational compared to general secondary education. This had three main reasons. First, during the War, academic-type schools were replaced by vocational ones in order to produce enough trained persons that could be used in the War-related industries. In addition, although private institutions were prohibited from setting up new secondary schools, the existing ones were extended with handicrafts in the curriculum, which was deemed necessary for the war effort (U.S. Department of Commerce 1963). After the War this policy of furthering vocational education was continued. In 1957 the Education Department was split into the Department of General Education (Jawatan Pendidikan Umum) and the Department of Vocational Education (Jawatan Pendidikan Kejuruan), which signaled once more an emphasis on vocational education as well as a rapid rise in the number of schools and pupils (Hing 1995, 70).

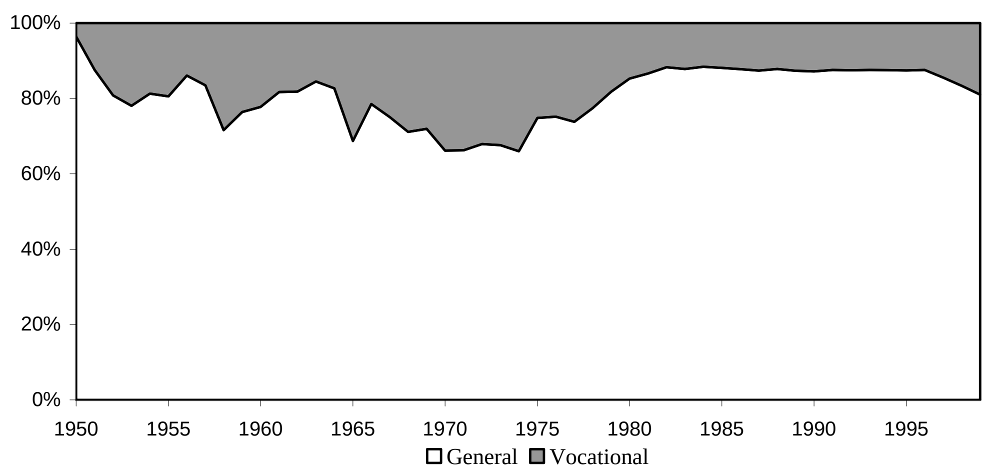
The second reason for a continuous emphasis on vocational secondary education was that from 1956 to 1965, the period of Guided Democracy, Indonesia's education system lacked effective planning, knew inflation of the currency, and witnessed a strong expansion. As a consequence, a drop in educational standards was inevitable (Beeby 1979, 6). This was partly caused by the idea to form a completely new education system based on the needs of Indonesia rather than on a western, capitalist, base. However, just as in most other colonies that struggled with this problem, there was no ready-to-use model. In addition, the available teachers, being schooled under the Dutch regime, were influenced by their training. This situation was worsened by a chronic lack of finance, which would only partly be resolved when the oil crises in the 1970s caused a boom in government spending in Indonesia. In other words, prior to the oil crises there was not much financial and political room to change the education system fundamentally.

This brings us to the third reason for a continued emphasis on vocational education. The lack of finances drove developing countries to borrow with international organizations. However, organizations such as the World Bank issued loans and technical advice on the condition of increasing investments in vocational education.

These policies lasted until the early 1970s. However, they aroused little enthusiasm in the population. Although vocational education increased from only 6,000 in 1950 to over 250,000 in 1970, the share in total secondary education

Figure 4.5

Share of persons enrolled in vocational and general secondary education in Indonesia, 1950-1999



Source: BPS, Statistical yearbook (various issues).

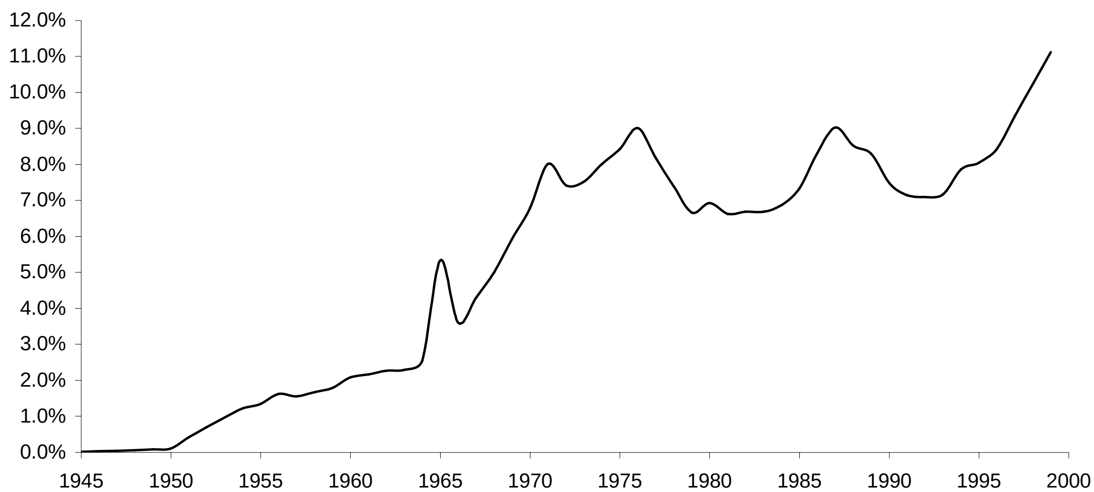
remained low. This can be seen in figure 4.5. Here we see that the share of vocational in total secondary enrolments increased until the 1970s.

Three reasons may be given for the decline in the share of vocational education after 1970. First, secondary education from the 1970s onwards began to grow even faster. This made access easier and, consequently, people could follow their first choice: general secondary education. Second, in the 1970s the policies aiming at increasing vocational education were abandoned. Not only were much of the colonial teachers slowly replaced, but also the government increased its educational expenditures which made them more independent of the international organizations. In addition, were in the pre-1970s international institutions such as the World Bank had mainly focussed on technical and vocational education (Heyneman 2003), after the 1970s they started focussing more on general education.

The relative increase in general secondary enrolments in the 1970s and 1980s also caused an increase in enrolments in higher education. The gross enrolment ratio for higher education increased from 0.01% in 1930 to 0.11% in 1950 and 11.12% in 1999 (see table 4.6). Higher education was only introduced in Indonesia in the 1920s

Figure 4.6

Gross enrolment ratio in higher education in Indonesia, 1945-2000



Source: Appendix A.6., table A.6.1.

and until 1950 there existed only a small number of colleges. It was only after 1950, when secondary education also started to increase, that higher education expanded. However, this expansion was not so massive and it is likely that in the coming decades the gross enrolment ratio will expand to around 30%.

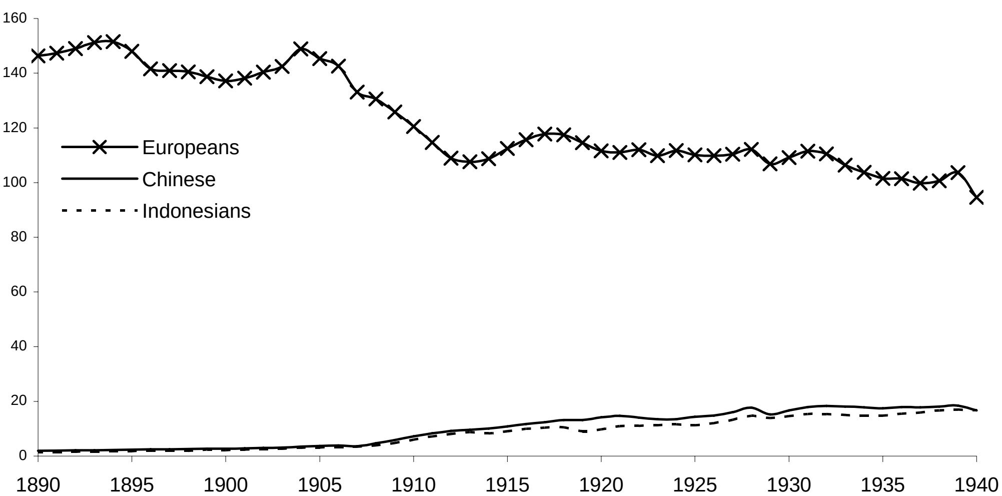
3.3 Social changes in the enrolment composition

The increase in primary education from the late nineteenth century followed by a slow increase in secondary education between the 1910s and 1940 and a faster increase after 1960, finally followed by an increase in higher education in the second half of the century also has important consequences for the composition of enrolments. Over time, especially a change in ethnicity and sex took place within each level of education.

We start with a brief look at ethnicity although we have made some remarks on this already in the previous sub-section. Looking at the gross enrolment ratios per ethnicity we see that for Indonesians and Chinese these are considerably smaller than

Figure 4.7

Gross enrolment ratio in primary education in Indonesia, 1890-1940



Source: Appendix A.5, table A.5.1.

those for Europeans. However, there is an increase as from around 1907. Equally, we saw in figure 4.3 that as from the start of the twentieth century the share of Indonesians and Chinese in total secondary education grew. Yet, we have to be aware that the total number of Indonesians and Chinese is also much larger than that of the Europeans. Consequently, the gross enrolment ratio of Chinese and Europeans was with 0.8% and 0.2% in 1920 much lower than that of Europeans with 29%.

The question of equality among ethnicities thus remained to be solved at the start of World War II. Indeed, this was one of the most important, and least discussed, issues during World War II and after Independence. In this period the focus on ethnicity was abolished. In principle, everyone got the same opportunity to enrol in education. The introduction of Bahasa Indonesia besides the local language contributed a great deal to this development.

The same developments that took place in the ethnic composition of enrolments also took place in the differentiation by sex. In figure 3.1 (chapter 3) we gave the percentage girls enrolled per level of education. The most remarkable finding is a strong increase in the percentage girls enrolled in secondary education from 1880 to around 1910 whereafter it remains constant until around 1960 when it increased again to around 50% in 2000. These increases in female enrolments (1890-1910 and after 1960) can to some extent be attributed to the increase in over-all education. This is a development that was also visible in primary education. For example, in primary education, we notice an increase in the share of girls enrolled from around 15% in 1915 to around 30% in 1940. The rise in the share of girls in primary education after 1915 is largely due to the increase of the number of girls in Indonesian primary education. Both European public primary education and Indonesian private primary education already had a fairly high percentage of girls enrolled, up to around 50% at the start of the twentieth century. However, the percentage girls enrolled in Indonesian public primary education rose from 8% in 1880 to 11% in 1920, 20% in 1930 and 27% in 1939, an increase that for 90% can be attributed to the desa schools. In the same way, secondary education around 1880 was very small, and largely public. However, around 1880/1890, the numbers enrolled in secondary education started to increase. This increase can to a large extent be attributed to the set up of private secondary schools, which were largely intended for girls.

Equally, the increase in the share of females enrolled in secondary education after 1960 corresponds largely with a period of fast growth of secondary enrolments. Indeed, the unequal division between both sexes, as almost everywhere else in the world, decreased when the level of education increased. For example, in 1970 the number of girls enrolled in primary education to the total enrolments in primary education was 41%. This was a considerable increase compared to the 29% in 1939.

3.4 Who pays? Public and private expenditure on education

The development of the education system over time is likely to also have consequences for educational expenditure on education. For example, the rise in mass education with the introduction of the low quality desa school is likely to have led to lower per student expenditure on education although over-all expenditure increased.

Equally, in the rise in secondary and higher education is likely to have led to higher over-all expenditure as higher levels of education are often more expensive. This can

Figure 4.8

Share of educational expenditure by level of education in Indonesia, 1880-1999

Source: Appendix A.8, table A.8.2.

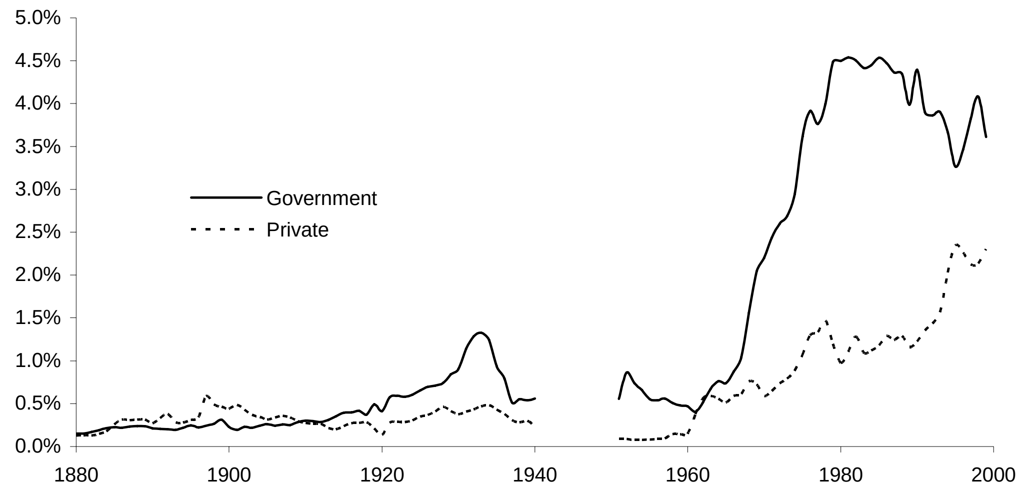
be seen in figure 4.8. This figure shows that prior to World War II primary educational expenditure as a percentage of total educational expenditure fell slightly even though its share in total enrolments remained about the same. The rise in higher education and, especially after the massive rise in secondary enrolments in the 1960s, expenditure on secondary education did, however, decrease the share of expenditure on primary education.

Where the increase in mass education caused by the introduction of the desa school did not necessarily signal an increase in total educational expenditure as they replaced the more elitist (and thus more expensive) first and second class schools, the increase in secondary and higher enrolments did. Indeed, we can see in figure 4.9 that educational expenditure starts to increase as from around 1910 together with increasing enrolments in primary and secondary education. However, only from the mid-1960s expenditure on education starts to increase strongly.

These findings are interesting for two reasons. First, education expenditure as part of GDP (both public and private) started its fast growth already in the 1960s. This is contrary to the view that the oil boom was the main cause behind the increase in public educational expenditure (Jones 1994). Second, the increase in expenditure on education prior to 1960 was mainly caused by government expenditure. It was only after 1960 that private expenditure also started to contribute to a larger extent to the

Figure 4.9

Government and private expenditure on education as percentage of GDP in Indonesia, 1880-1999



Source: Appendix A.8, table A.8.2.

increase in overall expenditure. As private expenditure is a better reflection of the population's attitude towards education, this suggests that the view towards education changed. This may be caused by the situation that the economic benefits increased because lower class persons had access to higher skilled jobs, a situation that was less likely to occur under colonial rule where most jobs requiring high skills were filled by Europeans. Also, the 1960s signalled the rise of general secondary education, which better conformed to the demand of the population at large.

4. THE EDUCATIONAL STRUCTURE IN INDIA

4.1 The rise of a colonial education system

As was the case in Indonesia, in India the indigenous education system had a long history. It was already during Mughal reign that education was furthered by some of the Sultans. This was, however, not done in any systematic way. During Akbar's reign (1556-1605) this policy was continued while, at the same time, Akbar wanted to align education more with social needs (Qanungo 1962, 448). Besides the rise of Muslim education (especially the 'muktabs' for elementary and the 'madrassa' for higher education), the old Hindu schools continued to exist which consisted of the 'pathsalas' for elementary education and the 'tols' for higher education. These schools were quite numerous, which led to a relatively high literacy rate.

In the mid-nineteenth century, when the effect of the western education system was still negligible, the indigenous system accounted for a relatively large share of educational enrolments. For example, in Bombay around 1840 about 17% of the school-aged boys were enrolled in indigenous schools. This compares favourably with the figure of 8% for all India in 1891, which corresponds with a literacy of about 10% for men.[85] If we use the same relation between literacy and enrolment of 1891 and apply it to the 1840 figure, we get a male literacy in Bombay in 1840 of about 21%. Other sources also confirm this interpretation. For example, some research has been carried out by officials of the East India Company at the start of the nineteenth century. In a minute of 10 March 1826 Thomas Munro observed that in Madras, with a total population of 12,850,941, there were 12,498 schools and 188,650 pupils. Equally, in Bengal and Bihar, the missionary William Adam found that in the mid 1830s there were 100,000 schools on a population of about 40,000,000 (Gosh 2000, 8). Although we have to be careful as both Munro and Adam also included places of domestic instruction, we may conclude that a literacy rate of 10-20% for men may be acceptable.

Yet, this education had already been in decline since the late eighteenth century. First, the collapse of Mughal rule meant that many schools were no longer sponsored. Second, the arrival of the Europeans, who demanded an education more conform with the requirements of government and their economic objectives, further hastened the decline of the indigenous education system. Nevertheless, as was the case in Indonesia, in India this decline was (partly) compensated by the setting-up of a western-style education system.

4.2 Increasing enrolments

4.2.1 Primary education

Three reasons lay behind the increased influence of the colonial government in education. First, there was the economic need for trained personnel in industry.

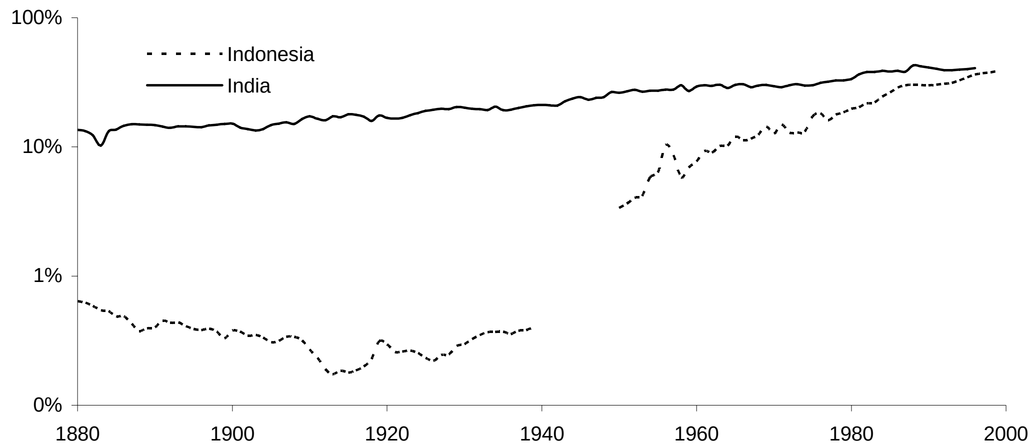
[85] This figure of 10%, however, is likely to be an underestimation as probably many indigenous languages were not included. This further increases the difference between enrolments and literacy, which might be explained by the existence of 'home education'.

Second, this demand for trained persons was also visible in the government administration itself where, with a relatively small number of British, the number of Indians enrolling in the service was also small. Third, the low numbers of Europeans in India required the colonial government to seek support from the indigenous population. One way of doing this was to establish links with a class of educated Indians. The decision that education should mainly be given in English caused these schools to be attended largely by people from the higher castes. As a consequence, this led to the creation of a class of literati from the higher castes, thus reviving caste differences (Di Bona 1983; Kumar 1991). It would however be wrong to assume that this was solely caused by the British educational policy in India as already before the British hegemony the indigenous education system was a system based on class differences (Bara 1998, 131).

As the colonial education policy was mainly based on higher educated Indians both for government and private occupations, there was a clear focus towards enrolments in secondary and higher education. For example, the share of total secondary and higher enrolments in total enrolments in India in 1880 was 13.5% against 0.6% in Indonesia. However, at the end of the nineteenth century the practical consideration of creating indigenous administrators and skilled craftsmen for industry diminished in favour of the idea that education was important for their moral and economic upliftment. Indeed, it was clearly phrased in the educational despatch of 1854 that "[t]his knowledge will teach the natives of India the marvellous results of the employment of labour and capital, rouse them to emulate us in the development of the vast resources of their country, guide them in their efforts, and gradually, but certainly, confer upon them all the advantages which accompany the healthy increase of wealth and commerce" (Gosh 2000, 77). This can therefore be seen as some sort of 'ethical policy' as started in Indonesia around 1900. Nevertheless, the focus remained more on secondary and higher education than on an increase in primary enrolments. Figure 4.10 shows that prior to World War II the share of primary enrolments in Indonesia was much larger (and increasing) than that of secondary and higher enrolments. It was only after the War, when the ideal of universal primary enrolments was approached, that secondary and higher enrolments started to rise. In India, however, the share of primary enrolments was relatively low compared to Indonesia. The share of secondary and higher enrolments in total enrolments knew a steady, though slow, growth towards the end of the twentieth century. This is indicative for the situation that universal primary education was only achieved in India at the end of the century which in turn suggests that the following decades will probably witness a

Figure 4.10

Logarithm of the share of secondary and higher enrolments in total enrolments in India and Indonesia, 1880-2000



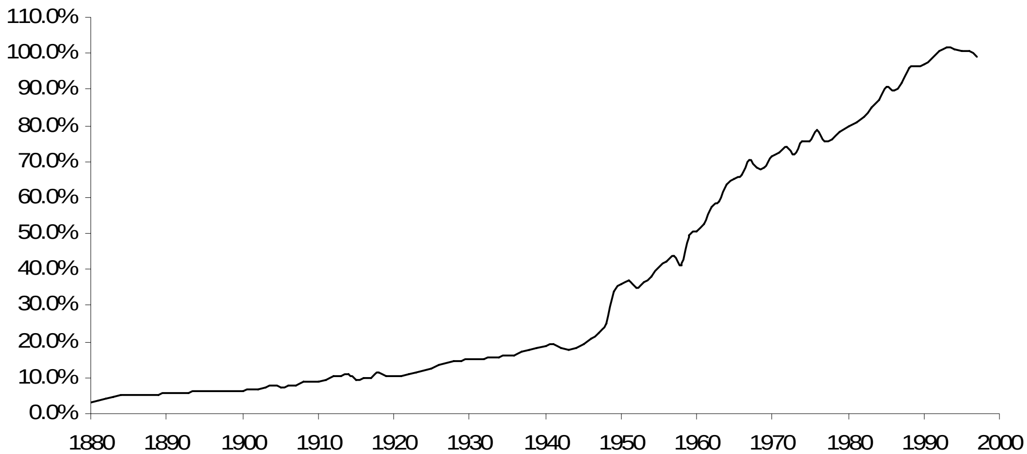
Source: Appendix A.6, tables A.6.1 and A.6.2.

stronger increase in the share of secondary enrolments as was the case in Indonesia since the 1960s-1970s.

This does not mean, however, that no attempts were being made to further extend primary education. For example, just as with the experiments of De Bruyn Prince in Kedu, in India field experiments with mass education were held. Examples were Thomas Munro in Madras, Henry Hardinge in Bengal and James Thomason in the North-Western Provinces (Sen 2002, 117). It was, however, with the 1854 despatch that the British government came up with a scheme for mass education for all India. Although the educational quality was low, educational enrolments did increase from 270,000 in 1860 to 2,366,902 in 1890. Indeed, figure 4.11 shows that there was a steady increase in the enrolment in primary education between 1880 and 1940, followed by a far faster growth after World War II. The post-War developments are of course mainly due to the drive of the government to arrive at universal primary education. As a consequence, in 1950, in article 45 of the Indian Constitution, it was laid down that within 10 years from the commencement of the Constitution, free and compulsory education for all children up to 14 years of age would have to be reached (Borooah and Iyer 2002, 3). Yet, from figure 4.11 it is clear that this had to wait for another 50 years. Only in 1992 a gross enrolment ratio of 100% was reached while the share of the population with primary education was even in the year 2000

Figure 4.11

Gross enrolment ratio in primary education in India, 1880-2000



Source: Appendix A.6, table A.6.2.

only 83%.[86] Given the fact that enrolment is summed over at least 40 or 50 years to obtain literacy, universal literacy will only be achieved around 2040.

4.2.2 The rise of secondary and higher education

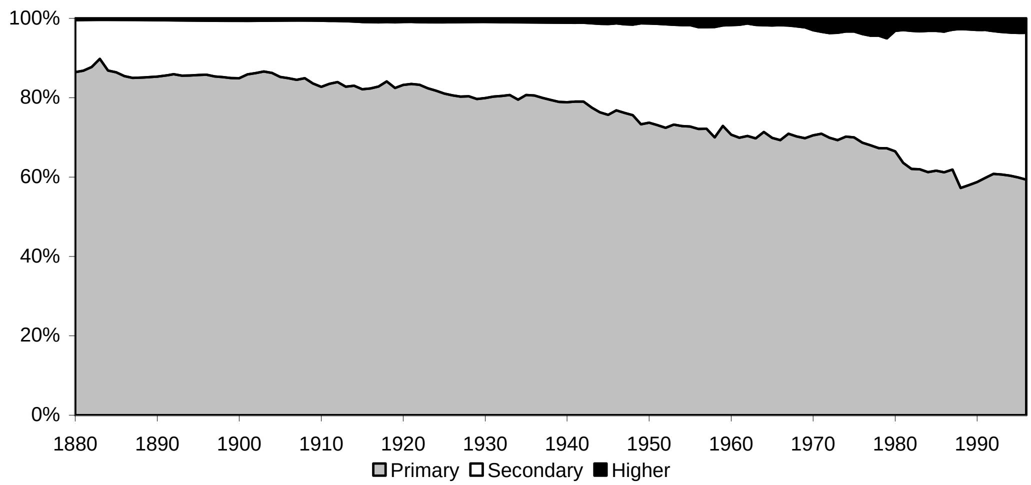
As we have seen in figure 4.10, secondary and higher enrolments were much higher in India at the start of the century than in Indonesia. If one looks at enrolments in secondary education divided by the enrolment in primary education, which gives a rough indication of how many children continued in secondary education after having successfully concluded the primary level, one finds that in 1880 this figure was 15%. This figure was large compared to the 0.6% in Indonesia. From the numbers enrolled in secondary education about 5 % further enrolled in higher education. This figure increased after World War II to around 10%. Although not as impressive as the enrolment in secondary education, this figure was still large enough to lead Sundaram (1946, 517) to argue that ‘high school education came to be unduly dominated by the requirements of the universities, and representatives of the universities on the boards of high school education have dictated what the high schools should turn out.’

[86] Literacy in 2000 was somewhat above 60% (see figure 1.3 in chapter 1).

Indeed in those years India still far exceeded most developing countries in the share of secondary and higher education in total education. In fact, their share in 1950

Figure 4.12

Enrolment shares in India, 1880-1995



Source: Appendix A.6, table A.6.2.

was only marginally larger than it had been in 1880 (see figure 4.12). Nevertheless, in absolute numbers, secondary and higher education did increase. Where in 1890 the gross enrolment ratio for secondary education had been 0.84%, in 1950 it was 16.6%.

Given the situation that both figure 4.10 and 4.12 indicate that the shares of on the one hand primary enrolments and, on the other, secondary and higher enrolments remained relatively stable, this raises the question why this occurred. There may be three basic answers. First, the high starting point at the end of the nineteenth century. The already relatively high level of educational enrolments leaves not much room for a quick increase in the share of secondary education. Equally, as secondary education was already relatively extensive, it would be difficult to extend primary education without offering the new classes the opportunity for further education.

A second reason for the relatively slow growth of the share of secondary and higher enrolments may be the industrialisation policy after independence. In general the idea was that education (especially secondary and higher) was necessary for the development of an industrial sector. Crucial in this respect was the appointment in 1948 of a University Commission with Dr. S. Radhakrishnan as chairman. This commission promoted vocational education at higher levels of education. This in turn was deemed necessary as the newly independent state wanted to concentrate on the promotion of heavy industry. The reconstruction of university education was considered essential to meet the demand for technical labour (Gosh 2000, 178). This idea also furthered cooperation with individual entrepreneurs. For example, in the universities of Bombay and Calcutta, cooperation of local industrialists and the colleges took place in technical courses which increased job opportunities (Caldwell Wright 1952, 206). This government policy also explicitly stated the importance of secondary education for the development of university education. In other words, the idea was strong that secondary and higher education was the way to economic progress. Consequently, the growth in primary enrolments, which due to the relatively low level of enrolments after the War had still important strides to make, was compensated with an at least equal growth in secondary and higher enrolments.

This brings us to the third reason for the constant development of the shares of the different education levels: the de-linking of primary education from secondary and higher education. As indicated before, there was a relatively high share of persons enrolled in secondary education. The role of primary education was thus to a large extend to produce graduates that could enrol in secondary and higher education, i.e. primary education was linked with secondary education. This meant that the rise in enrolments in primary and secondary education were strongly interrelated. Although there was a process of de-linking primary and secondary education since the 1930s[87], this process was slow and had only a marginal effect.

[87] Three factors played an important role in the de-linking of primary from secondary education. First, the rise of mass primary education. Although we have seen that the shares of primary and secondary enrolments only changed slightly over time, figure 4.10 shows that there was indeed a strong growth in primary enrolments. This caused the absolute number of children that did not pursue secondary education to increase strongly. Second, the administrative changes which took place in the 1920s and ‘30s. These resulted in placing education in the hands of the State Governments which were largely controlled by members of the Indian nationalist party, Congress. This can be seen as a change to an education system that was administered by the Indians themselves (Mujeeb 193, 209). At the beginning of 1937 Congress had won the elections, made possible by the Act of 1935, and formed governments in seven provinces. Following the ideas of Gandhi, this led to an increased interest in both universal compulsory education for children between the age of 6 and 13 in the vernacular language and in increased practical education. Both factors may be the cause of de-linking of primary and further education. Indeed, the vocationalisation of education is a third reason for the de-linking of primary and secondary education. Vocationalisation had been present at the start of the century as well, which can be seen in the continuous discussions by Congress (the Indian nationalist party) about uneducated Indians. Indeed, the correlation between the growth of secondary and vocational enrolments before World War II is -0.6 and highly significant while the correlation between the growth of primary and secondary enrolments was 0.14. Although the latter was only significant at 25%, the point remains that the growth of primary enrolments is either not or positively connected with the growth of secondary education while the effect of the growth of vocational education is negative. As after the War

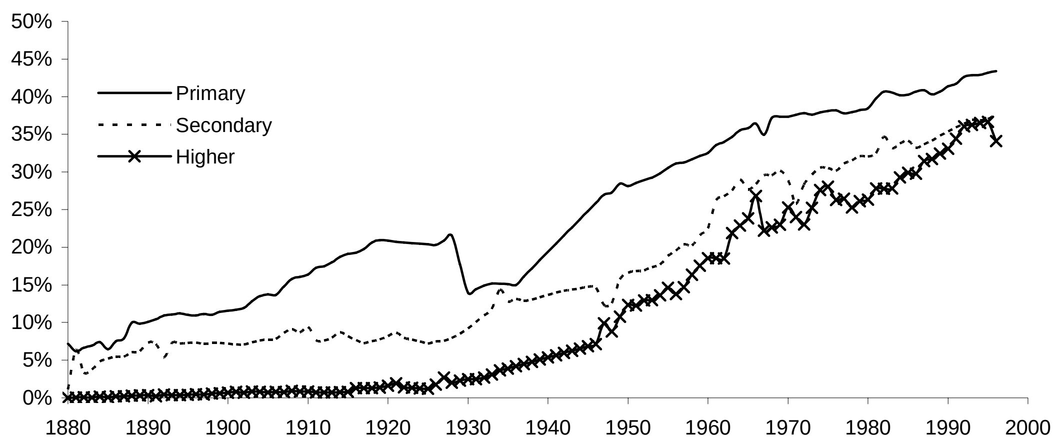
4.3 Social changes in the enrolment composition

The same difference between Europeans and the indigenous population that was found in Indonesia was also present in India. Clearly Europeans were in a privileged position. For example, in the 1911 census, Hindu males had a literacy rate of 10.1% of which 0.9% was in English. However, looking at Christians (mostly Europeans and Indo-Europeans) these figures were, with 29.3% and 12.6%, much higher.

The main difference with Indonesia is in the distribution of the sexes in education. Whereas in Indonesia the increasing primary enrolments at the start of the twentieth century led to a decrease in inequality in education, in India the relatively

Figure 4.13

The share of girls by level of enrolment in India, 1880-1995



Source: Appendix A.6, table A.6.2.

limited increase in primary education before the 1920s led to a continuation of inequality. Indeed, as long as the rise in primary education remained to some extent coupled with the rise in secondary education, the weaker groups remained in a disadvantaged position, even in primary education. One way to look at this is simply reviewing enrolments. Figure 4.13 shows that the share of girls enrolled remained below 20% before the Second World War. This is low compared to Indonesia where these levels reached 25-30%. In the 1930s we even see a decline in the share of females enrolled. However, this is mainly caused by an increase in male enrolments

vocational education was mainly given at secondary level, the correlation became of course positive (0.08) although not significant.

while the number of females enrolled remained about constant. The situation that it were mostly the stronger groups that profited from the increase in mass primary education in this period once again shows that primary education still was not de-linked completely with social status (and thus with higher education).

In sum, although India exceeded Indonesia in gross enrolment rates, the share of females in total enrolments was considerably lower. We argued that this was caused by the situation that there was an emphasis on secondary and higher education. However, a second reason for this difference might be religion. As India consists largely of Hindus with a large Muslim minority while Indonesia is largely a Muslim country, a relatively more beneficial role in education for females in Indonesia may also be caused by a less beneficial effect of the Hindu faith on female enrolments. Table 4.3 provides data on literacy rates provided by the census of India for the whole

Table 4.3: Literacy in Undivided India by sex and religion, 1891-1911.

		1891	1901	1911
Hindu	Male	9.5%	9.4%	10.1%
	Female	0.4%	0.5%	0.8%
Muslim	Male	6.7%	6.1%	6.9%
	Female	0.3%	0.3%	0.4%
Christian	Male	34.2%	29.1%	29.3%
	Female	13.5%	12.5%	13.5%

Source: Statistical Abstract Relating to British India (various issues).

of British India by sex and religion. Christians had by far the highest literacy rates, both for males and females. As this group also includes Europeans and Indo-Europeans, which had often better access to educational opportunities, this is not surprising. Indeed, we find the same in Indonesia. However, Indonesia is a Muslim country whereas India is largely Hindu (with a large Muslim minority). So, simply said, if religion is at stake, we would expect that the Muslim figures in India are close to Indonesian figures while the relative female enrolments among Hindus are lower than female enrolments in Indonesia. Both are not the case. Female enrolments were about the same for Muslims and Hindus. In addition, the attainment figures for the indigenous population in Indonesia in 1911 were around 1% for females in primary education and 3.7% for males. This shows that literacy was somewhat better under the Indian Muslims for males, but not for females.

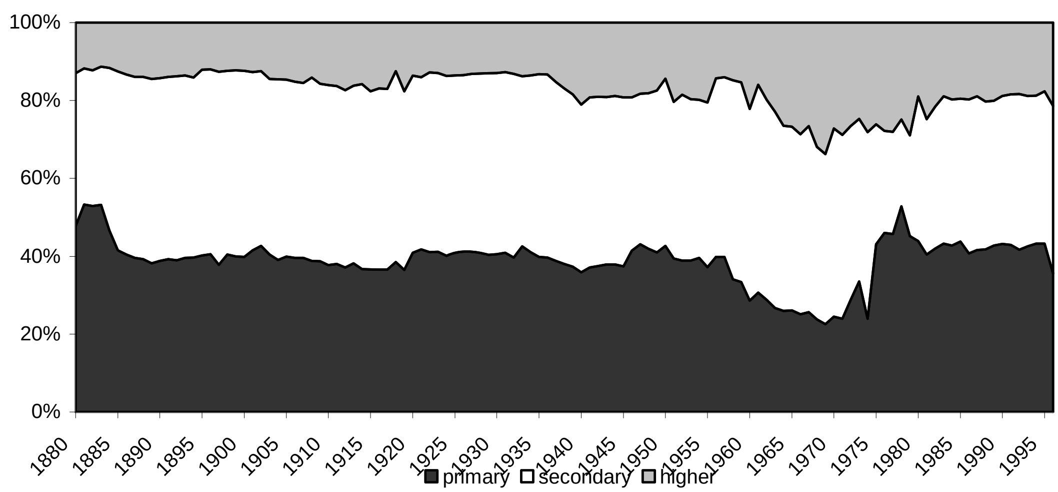
Nevertheless, eventually the share of females in education increased slowly over time. The rise of mass education from the early twentieth century also witnessed increased female participation. In the 1920s, this went hand in hand with increased female participation in secondary and higher education (see figure 4.13). However, around 1940, the gross enrolment ratio of girls in primary education still was low with only 7.6% compared to 11.2% in Indonesia while the share of females in primary education was even higher. With the rise of mass secondary education, in India the share of girls in secondary education increased strongly over time to 37.7% in 1996. However, this figure was still lower than that of Indonesia in 1939.

4.4 Who pays? Public and private expenditure on education

In the same way in which the enrolment composition differed from that in Indonesia due to the higher level of educational enrolments at the start of the century, so did educational finance. Two points can be distinguished. First, as secondary and higher education were more expensive and more extensive in India, the share of these levels

Figure 4.14

Percentage shares of public expenditure by level of education in India, 1880-1996



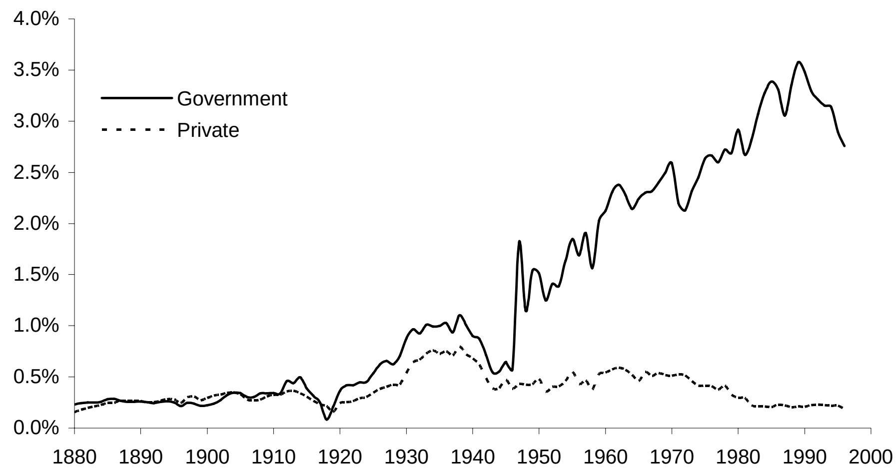
Source: Appendix A.8, table A.8.3.

of education in total expenditure was also much higher than in Indonesia. In Indonesia in 1920 the share of secondary and higher public expenditure in total public expenditure was 21.8% while in India it amounted to 59.1%. But this ratio remained high and about constant over the entire twentieth century (see figure 4.14). This is not surprising as we already pointed out that the enrolment shares also remained about constant.

A second consequence of the educational structure on educational finance in India was the relation between public and private expenditure on education. We already argued that prior to the War primary education had a link with secondary and higher education. This was de-linked since the 1930s, but because of the already relatively high shares of secondary and higher enrolments, not much changed in the educational composition. Yet, the existence of a link before the 1930s means that it were mostly the wealthier persons that entered schools. This also meant that they were better capable of 1) reaping the benefits from a school certificate as higher class persons had a better chance of getting a job and 2) paying the school fees. Consequently, it is likely that the private expenditure on education moves up with

Figure 4.15

Government and private expenditure on education as a percentage of GDP in India, 1880-1996



Source: Appendix A.8, table A.8.3.

public expenditure which is indeed what we see in figure 4.15.

Interestingly, however, after an initial decline in the share of both public and private educational expenditure in GDP in the late 1930s due to the economic decline and the following War, after 1950 the movement of public and private expenditure moves apart. Indeed, we even see a rise in public expenditure combined with a decline in private expenditure. This may be caused by the de-linking of primary from further education which caused an increase in the enrolment of poorer children who were often state financed. Indeed, after the war there was a stronger increase in both enrolments in primary education and in state expenditure on education. As primary education was largely state financed as well, this led to a large increase in public expenditure that was not accompanied by an equal increase in private expenditure.

5. EDUCATION IN JAPAN: ANALYSING THE GROWTH OF A MODERN EDUCATION SYSTEM

5.1 The rise of the Japanese education system: the development of mass education

Around 1870, primary attainment in Japan was around 20% but this is probably an underestimation (Dore 1965, 318-319) which makes it likely that literacy was higher. Dore (1965) makes as an informed guess for enrolments in *terakoya* (elementary education for commoners) that about 40% of all Japanese boys and 10% of all girls were getting some form of formal education outside their homes at the start of the nineteenth century (see also Passin 1965, 54). Looking at the level of education of conscripts in 1873, Crawcour (1970, 34) also arrives at fairly high enrolment figures.

We therefore may arrive at the conclusion that Japan already in the mid nineteenth century had an education level that was higher than in India and Indonesia. But where in India and Indonesia the existing indigenous education system was slowly replaced by a colonial one, in Japan the old education system was modernized after the Meiji Restoration of 1868 when the feudal state was replaced by a centralised nation-state. One of the main causes of the Meiji Restoration was the threat of the western colonial powers; the aim thus became to industrialise and create a strong state. To that end, it was also necessary to create an educated workforce and to include western science and technology in the educational curriculum.

Many authors have argued that the period of the Meiji Restoration, when the Tokugawa family lost power, constituted a significant break in the educational system of Japan.[88] However, other authors have argued that this is less the case (Godo and Hayami 2002). We tend to side with the latter for four reasons. First, education had already been aimed at practical subjects from the late eighteenth century when more commoners were allowed to follow formal education. Therefore, Japan had a well developed educational base already before the Meiji restoration. Without this base, it

[88] See for example Kaigo (1952). This author argues that the Japanese system adapted strongly to the American one during the Meiji Restoration.

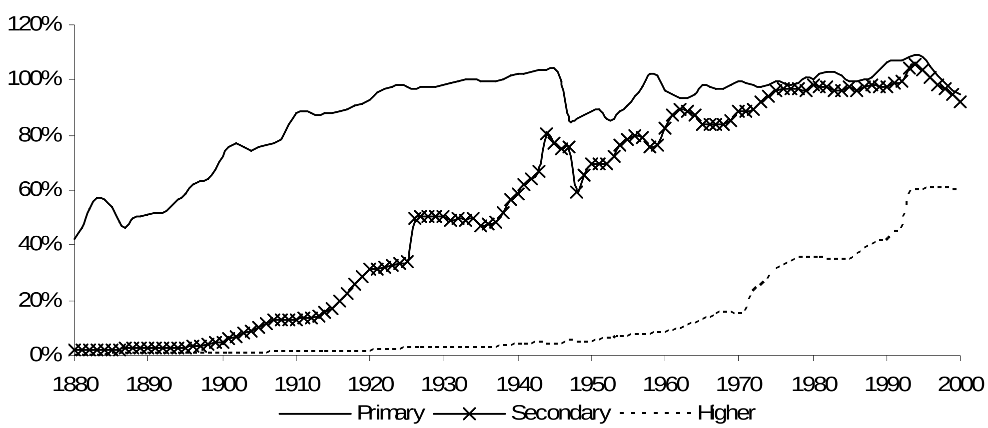
would be hard to imagine the enormous increase in education afterwards. That is, there was already a culture in which parents sent their children to school. This can also be seen from our gross enrolment figures which were in 1880 42% in primary education which rose to 72% in 1900. Although this was a strong rise, it is also clear that, already at the time of the Meiji restoration, the educational base was much larger than in India and Indonesia. Second, the inclusion of western subjects was already allowed into the curriculum at the end of the eighteenth century, be it hesitantly (Passin 1965, 52). While during the nineteenth century in virtually all domains Western Studies entered the curriculum, it would only be fully put into work after the Meiji Restoration in 1868. Third, western subjects were not only introduced because of changing attitudes, but also because it was deemed necessary to create a powerful nation able to defend itself. Fourth, Japan was never was a colony, so it was not confronted with the change from an indigenous education system to a system where indigenous and colonial education existed side by side, and, finally, to a national education system as was the case in India and Indonesia. The Meiji reformers were simply another Japanese government and therefore it is unlikely that the structure of education could have radically changed.

5.2 The rise of secondary education

Around 1880 Japan had already reached the level of primary education that India and Indonesia would only reach after World War II. In that year Japan had a gross

Figure 4.16

Gross enrolment ratio per level of education in Japan, 1880-2000



Source: Appendix A.6., table A.6.3.

enrolment ratio in primary education of 42% against 3.2% and 1.3% in India and Indonesia respectively. Consequently, we see in figure 4.16 that, although there was an increase in the gross enrolment ratio to around 100% in 1940, the major changes before the War were in secondary enrolments. Indeed, after the War, with the exception of a brief period in the 1940s during the American occupation when the education system was modified, gross enrolments in primary education remained at around 100%.

Gross enrolments in secondary education started to increase in the 1890s. Initially, there was some focus on vocational secondary education. Enrolment in vocational education (excluding normal schools) was only 2,459, or 2.2% of total enrolment at secondary level in 1890 which increased to 16,981, or 7.8% of total enrolment at secondary level, in 1900. Although still small in absolute numbers, this did provide a marked rise in secondary education. Two main reasons for this increase may be identified. First, the high level of primary education created a demand in the population for further education. Second, there came an increasing awareness that vocational education, which due to the high levels of primary enrolments mostly was given at the secondary level, was important for the economic development of the nation. As Passin (1965, 62) argues: ‘in the explicit view of the Meiji reformers, education opened the way to the full utilization of the intellectual resources of the country: Men of talent, even if of commoner origin, were more valuable to the new state than unqualified samurai. “Self-cultivation” and “merit” became the watchwords of the day.’ This development was further strengthened by the Sino-Japanese War (1894-1895). Until that war vocational education had remained almost entirely private. However, combined with the developing Japanese technical industry, the war increased the demand for technically trained people. Therefore a Vocational Education Law was drafted and passed in 1894. Additional steps were taken in 1899 when fishery, forestry, and agricultural vocational schools were established at the lower secondary level (Passin 1965, 97). This increase in vocational enrolments was continued with, for example, the National School Ordinance Enforcement Regulations, following on the National School Ordinance in 1941,which stipulated among others that secondary education should deepen the knowledge and technical skills common and essential for the livelihood of the people. However, just as can be seen on a global scale in table 4.1, in the 1940s-1950s the share of vocational in secondary education started to decline.

5.3 The post-War period

Under American influence, the Japanese education was reformed after the American model. A first step was the banning of the nationalist parts from the curriculum (Nishimoto 1952, 24). The second step was the adoption of a 6-3-3-4 plan. That is, 6 years primary education, 3 years junior high school, 3 years senior high school, and 4 years of university. These changes made the access to secondary education much more egalitarian.

However, the rise in enrolments in secondary education also had a negative effect. Before the War, it was especially the movement from primary education to (high rank) secondary schools that proved problematical. If one entered such a high rank secondary school, a following university diploma was almost guaranteed. The problem thus was in entering secondary schools. Indeed, the relatively small numbers enrolled in secondary education also prevented a strong rise in higher education. The role of the universities was thus 'to produce educated manpower to meet political and economic needs, not to create broad opportunities for social development' (Hayes 1997, 298). However, after World War II an increasing number of persons was now able to advance to secondary education. The enrolment in secondary education increased from 70% to 90%. It now became of the utmost importance to gain access to high rank universities. This is what still causes an enormous pressure on secondary school students today (Sato 1991, 96). Their results at secondary level must make them eligible for a place at a high rank university. If obtained, that is almost a guarantee for a diploma and ensuing career. Nevertheless, we still see in figure 4.16 that the gross enrolment ratio in higher education increases strongly as from 1950-1970. It is interesting to remark that in the 1950s, at the start of the growth in higher education, around 10.4% of all students enrolled in higher education were female. However, this figure increased in the period of educational growth until it reached 57% in 2000. Again this is an indication that a strong expansion of educational opportunities is the best way to increase female enrolments.

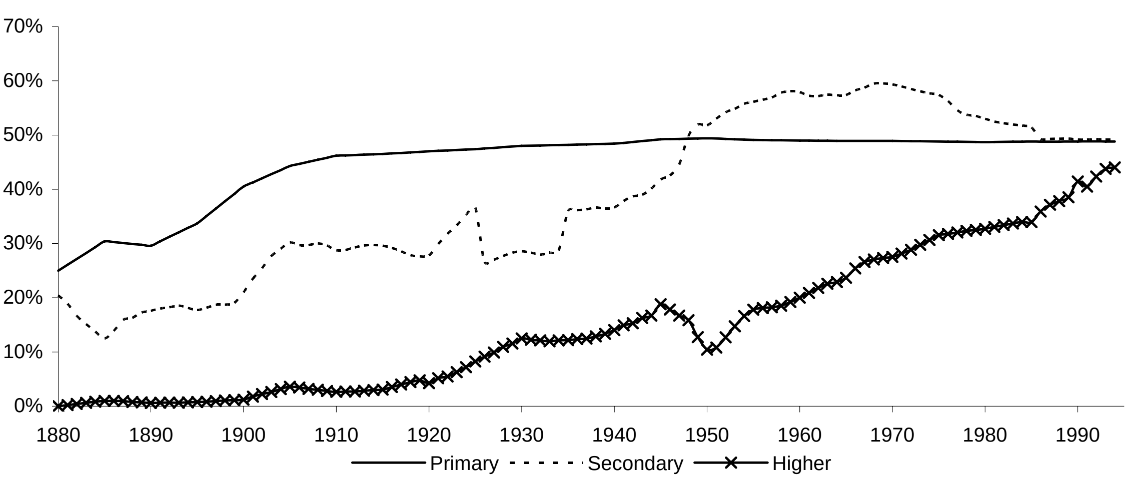
5.4 Social consequences of educational development

Drawing our conclusions from the rise of mass primary education in India and Indonesia, we would expect that during a rise in mass education, the difference in both class and sex declined. As enrolment and attainment in Japan were much higher than in India and Indonesia, we would expect the class differences to be lower and the share of girls enrolled in primary education to be higher at the start of the twentieth century. Indeed, this seems to have had a strong effect on class differences in enrolment. To name just one example, the profession of teacher was dominated by the samurai before 1868. In the following years this slowly changed. In the Kumamoto Prefecture Normal school in 1878-1887 80% of the persons enrolled were samurai and 16% commoner. This had virtually reversed in 1928-1932 when these numbers were 10% and 90% respectively (Sato 1991, 77). Clearly somewhere between 1860 and 1920 class differences had in this respect declined.

This decline in unequal educational participation in education also took place in female enrolments (see figure 4.17). In 1880 already 25% of all persons enrolled in

Figure 4.17

Percentage females enrolled per level of education in Japan, 1880-2000



Source: Appendix A.6, Table A.6.3.

primary education were females. This compares favourable with the 7% for India and 16% for Indonesia respectively. In 1920 the Japanese figures had even risen to close to 50%. Yet, in secondary education this would only be the case around 1950. Godo and Hayami (2002) explain the low increase in female participation in secondary and higher education before 1940 with the remark that 'while boys and girls received the same education at primary school, middle schools were segregated according to gender. The only tertiary education in the public school system open to females were girls high-school graduate courses, girls higher normal schools, and very limited courses of vocational colleges.' The largest increases in the share of girls in secondary education thus had to await the rise in mass secondary education.

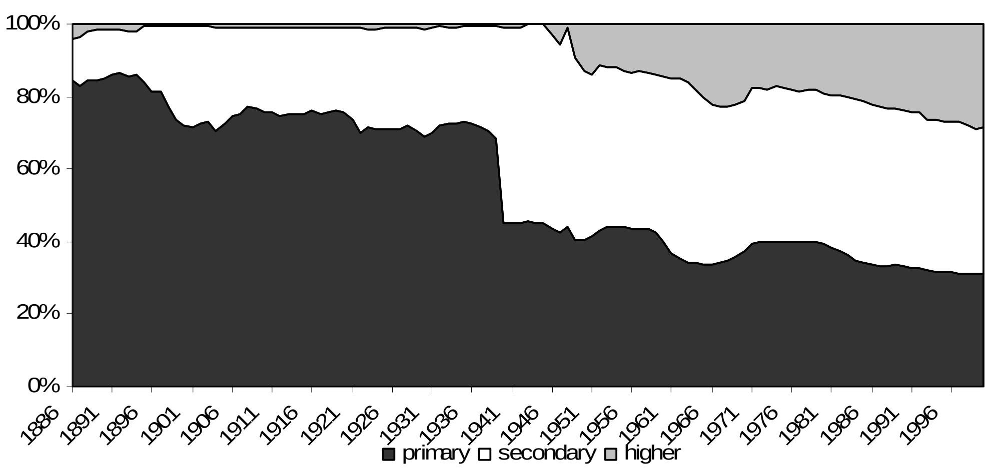
It is interesting to see that between 1950 and 1985 the share of women in secondary education even exceeded 50%. This is a pattern that happens at all levels of education (for example primary education in Indonesia (see figure 4.2)) when universal enrolments are reached and also some younger or older persons wanted to be schooled. The reason why this was especially pronounced in Japan was the inclusion of several 'miscellaneous schools' which were in the 1950s to 1980s dominated by female enrolments.

5.5 Who pays? Public and private expenditure on education

For Japan the developments of educational finance are less dramatic than for India and Indonesia (in the case of India it is exactly the lack of change in the composition of expenditure that is surprising). The main reason is that the data only start after the largest increase in mass education had taken place. Nevertheless we can make two interesting observations. First, contrary to India, we do see that the shares of

Figure 4.18

Share of public expenditure per level of education in Japan, 1886-2000



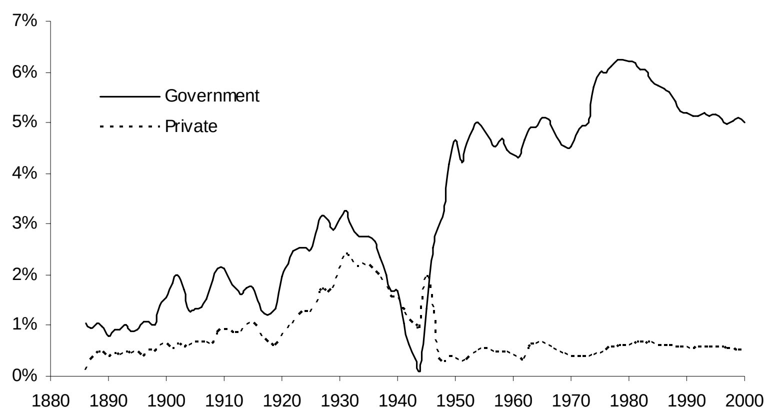
Source: A.8, table A.8.1.

secondary and higher education increase over time (figure 4.18). Especially after World War II the share of public expenditure on secondary education increases. Around 1950 we also see that the percentage expenditure on higher education starts increasing.

The second observation is that in the period prior to 1950 there is a complementarity of government and private expenditure on education (see figure 4.19). This is the same in India and Indonesia prior to World War II. However,

Figure 4.19

Government and private expenditure on education as a share of GDP in Japan, 1880-2000



Source: A.8, table A.8.1.

whereas after the War in Indonesia this complementarity remains and in India there is a substitution, figure 4.19 suggests that in Japan there is either no relation or a limited complementarity.

6. CONCLUSION

6.1 A comparison between India, Indonesia, and Japan

Both in section 2 on the literature and in sections 3 and 5 on Indonesia and Japan we noticed a development from primary to secondary, and finally to higher education. The exception to this pattern is India where total enrolments do increase in such a way but the relative share of each level of education only changes slightly. Table 4.4 gives a schematic overview of the development of education in these countries and some of

Table 4.4: An overview of the process of educational development in India, Indonesia, and Japan

Educational phase	Region	Approximate period	Underlying developments
Rise of mass education	Western countries*	1790-1940	*Economic growth, causing a demand for literate persons for example to read and write contracts. *Political developments that drew more and more citizens into the political process which necessitated the state to educate 'reliable citizens'.
	Non-Western countries*	1880-1980	*'Myth of progress'
	Japan	1800-1840	*Preserving independence *Economic developments
	Indonesia	1890-1990	*Training capable administrators *The idea of ethical policy. (economic and moral progress) *Removal of ethnic differences after the War. *Introduction of Bahasa Indonesia as the general language at schools.
	India	1870-1990	*The training of personnel for the government and industry. *The construction of an indigenous class that would support the British. To this end they had to supply first primary education before the Indians could move on to secondary and higher education. *The idea of ethical policy. This can be subdivided into economic and moral progress for the indigenous population by following the institutions of the colonizer country.
Rise of secondary education	Western countries*	1850-1970	*The rise in primary enrolments caused a larger base that could demand secondary education. *The economic structure of society changed in such a way that more secondary trained persons were necessary. *The social structure changed so that it became more accepted for the lower classes to follow secondary education.
	Non-Western countries*	1920-	*'Myth of progress'
	Japan	1890-1980	*The rise of primary education created a larger base from which persons could pursue secondary education. *Threat of Western countries led to higher levels of education. *Economic development necessitated the increase of secondary education. *The Sino-Japanese War made clear that increase of (vocational) secondary education was necessary to produce enough goods.
	Indonesia	1910-	*The rise of primary education created a larger base from which persons could pursue secondary education. *During the War vocationally trained persons were necessary in war-related industries. *After the War, international organisations demanded an increase in vocational related secondary education in order to obtain development loans. This changed in the 1980s to general education. *Easier access to secondary education (first with the introduction of the link schools in the 1920s and later with a reduction in private costs and better job opportunities.
	India	1870-	*To train a class of literati to support the British, an extension of secondary education was necessary. *The rise of primary education created a larger base from which persons could pursue secondary education.
Rise of higher education	Western countries*	1940-	*The rise in secondary enrolments caused a larger base that could demand secondary education. *The economic structure of society changed in such a way that more higher trained persons were necessary. *The social structure changed so that higher education became easier accessible and it became possible to reap the benefits from this education (less social discrimination on the labour market).
	Non-Western countries*	1960-	*'Myth of progress'
	Japan	1930-	*The rise in secondary enrolments caused a larger base that could demand secondary education. *Easier access to higher education.
	Indonesia	1950-	*The rise in secondary enrolments caused a larger base that could demand secondary education.
	India	1870-	*The rise in secondary enrolments caused a larger base that could demand secondary education.

		*The relatively high enrolment levels already at the start of the century meant that it was more common for persons in secondary education to progress to higher education. *The industrialisation policy after World War II favoured vocational higher secondary and higher education. *The de-linking f primary from secondary and higher education was only marginal and took place only since the 1930s. Consequently, an increase in primary education was linked with an increase in secondary and higher education.

*Literature (see section 2 of this chapter)

the underlying reasons for these patterns.

We can distinguish three important points. First, the shifts in educational enrolments in Japan are closer to those in the Western countries than those in the developing countries: a rise in mass education in the nineteenth century which was completed before World War II, followed by a rise in secondary education from the end of the nineteenth century on until the end of the twentieth century and, finally, a rise in higher education starting just before the War. This corresponds with the underlying reasons of these developments. Whereas in Japan it were mostly the threat of Western countries, economic development, and a change in the social structure that drove educational reforms, in India and Indonesia these reasons were mostly exogenous to the indigenous population.

Second, Indonesia follows almost exactly the pattern described in the literature. Although it lags to Japan and the Western countries, there is a clear tendency to move from increasing primary to increasing secondary and, finally, increasing higher enrolments. Yet, the reasons for this development were more exogenous to its society. Colonial development, the need to train capable administrators, the role of international organisations, and the idea that Western style education was necessary to join in economic growth caused a copying of the western-type education.

Third, whereas Japan and Indonesia developed from lower to higher education, India developed top down. In India the aim of the colonial government was, besides the training of capable administrators, also to create a class of literati that could support British rule of India. This necessitated a relatively high level of secondary and higher enrolments. Interestingly, this remained so over the entire twentieth century. Primary, secondary, and higher education, both in enrolments and expenditure on education grew about in the same relation. This, we attributed to the high starting point at the start of the century which made it newly enrolled primary students more obvious to continue to secondary and higher education. In addition, this was influenced by the industrialisation policy after the war which favoured secondary and higher enrolments, even though there was also a strong incentive to create mass primary education. Finally, the de-linking of primary from secondary and higher education was a slow process which meant that an increase in primary education went hand in hand with increases in secondary and higher education.

6.2 The relationship between education and growth

It is likely that the different emphasis on different educational levels in different time periods also had an effect on its relation with economic growth. This can be derived both from the literature and our analysis above.

First there is the difference between public and private expenditure on education. In all three countries in the first half of the twentieth century, private expenditure on education moved together with public expenditure. As private expenditure can to some extent be seen as a measure of the economic importance of education for the individual, this indicates that the growth of education in the first half

Table 4.5: per student expenditure on education in current prices (yen), converted at exchange rate and PPP (Japan is set at 100)

Phase	Japan	India		Indonesia	
	n.a.	Exchange rate	PPP	Exchange rate	PPP
		Public per student expenditure on education			
1913	100.0	56.7	**114.4**	**135.1**	**241.2**
1922	100.0	29.4	82.4	84.3	**149.5**
1930	100.0	37.9	68.5	82.2	**192.3**
1938	100.0	52.8	89.8	65.9	**106.6**
1952	100.0	25.4	31.3	31.4	28.5
1958	100.0	21.3	31.9	8.6	12.2
1969	100.0	4.3	8.4	3.3	10.5
1990	100.0	1.0	5.6	1.7	13.2
		Private per student expenditure on education			
1913	100.0	75.0	**153.3**	**151.7**	**270.0**
1922	100.0	36.3	**101.3**	80.6	**142.5**
1930	100.0	25.4	45.6	37.9	88.6
1938	100.0	32.2	55.1	28.1	45.2
1952	100.0	61.0	75.2	26.9	24.3
1958	100.0	33.6	50.4	15.0	21.4
1969	100.0	5.0	9.6	6.5	20.8
1990	100.0	2.6	1.5	2.2	16.3

Note: The bold figures indicate per student expenditure in India and Indonesia that is higher than that in Japan.
Source: Exchange rate and PPP see appendix A.3.

of the century met the demand from the economy. However, after the War this changed for India and to a lesser extent Japan. In Japan there was almost no relation between public and private expenditure on education. This had mostly to do with the lowering of school fees. Simply said, it was not necessary anymore for an individual to invest a large share of his income in education. However, in India, an increase in government expenditure went hand in hand with a lowering of private expenditure. This also had the interesting consequence that there apparently was a maximum investment in education. People did not think it economically interesting to invest anymore themselves. In Indonesia, this was not the case. Both public and private education kept growing together after the War. However, we have to keep in mind that the increase was much higher in Japan than in Indonesia. Indeed, table 4.5 shows that after the 1920s/1930s per student expenditure on education were higher in Japan than in India and Indonesia and the difference remained growing.[89]

This suggests that the relation between education and the economy changed over time. Looking at the effect of education on growth by dividing the countries in the sample in 4 groups with a supposed different educational development, Azariadis and Drazen (1990) suggest that this is indeed the case. Yet, the fact that after the War also the enrolment composition changed suggests that the level of education also had an effect on the relation between education and growth. Indeed, generally, economists found that primary and secondary education exert a positive influence on growth while higher education exerts a negative or insignificant effect (Barro 1991; McMahon 1998). The negative effect of higher education is often attributed to the decline in the quality of higher education due to the strong increase in enrolments that took place at this level, especially in developed countries in the last three or four decades.[90]

[89] The higher levels of public and private expenditure in India and Indonesia at the start of the twentieth century are largely caused by the nature of their education systems. Whereas in Japan there was much cheap primary education, in Indonesia there were more elitist second and first class schools. Desa schools were only on a massive scale introduced in the 1910s when we see that the difference with Japan reduces. In India, there was a relative high level of more expensive secondary and higher education. In addition, in the first decades of the twentieth century, education in Japan experienced low finance.

[90] An alternative option is of course the existence of a different lag structure of higher education in regressions. It is possible that secondary education has an initially negative effect which becomes positive in the long run for example due to faster adoption of foreign technologies.

6.3 Some hypotheses on the relationship between educational development and economic growth

The main conclusion is that the development of educational institutions had an impact on both the patterns of formal education development (see section 6.1 of this chapter) and on the relation between the amount of education and economic growth (section 6.2 of this chapter). The question is now how we can test this. What effect does this development of educational institutions have on the relationship between human capital and economic growth?

One could come to the conclusion that, if the relation between education and growth changes over time, if the relation between each level of education and economic growth is different, and if there is a changing enrolment composition, **the changes in the enrolment composition are to a large extent the cause of the changing relationship between human capital and economic growth**. Hence, the phases with a changing focus on primary, secondary, or higher enrolments we found in this chapter must mirror the changes in the human capital coefficient.

This would only be true if we followed the human capital model, i.e. if the education produced at each level exactly matches the demand for that level of education in the economy. This would also be true if there were institutional obstacles which remain constant over time. In that case, **the relationship between education and growth would be lower but still changing with the enrolment ratio** (see for example Bowman and Andersen 1963, 253). An especially good example of this case is India where we argued that the initial focus on higher education kept its influence over the entire twentieth century. Even though it is unlikely that the occupational structure remained the same over time, still the educational structure only changed slightly.

In sum, to test the presence of educational institutions we have to check (1) whether the change in importance of the different levels of education coincides with changes in the human capital coefficient and (2) whether the human capital coefficients in India and Indonesia are lower than those in Japan. In addition, because India and Indonesia started later with increasing mass education, and because the less optimal institutions cause a slower growth in enrolments, we might also test whether the patterns found in point (1) take place earlier in Japan than they do in India and Indonesia.

6.4 Limitations

Our study focuses on a time series, not on a cross-section. This allowed us in this chapter to analyse the role of educational institutions. However, although giving a better opportunity to historically analyse the development and consequences of education-related institutions, it makes it more difficult to analyse the role of standard institutional measures such as property rights. These measures are often stable in the sense that one observation in the past (for example 1900) is used to explain economic growth at the end of the twentieth century. Hence, this sort of analysis requires a cross-section set-up which we cannot perform due to the small sample (only three countries). However, the educational institutions sketched in the previous sections have implications for the size of the human capital coefficient, and the breakpoints in the relationship between human capital and economic growth. Therefore, a confirmation of these hypotheses (which we will address in chapter 7) is also a confirmation of the importance of educational institutions in India, Indonesia, and Japan.

However, before turning to this analysis, we first have to elaborate on the stock of human capital. So far we largely used formal education which, as indicated in chapter 2, is only a limited proxy of human capital if one wants to estimate growth models. Therefore we start in the next chapter by estimating an alternative human capital stock. As an estimate of the human capital coefficient also depends on the growth theory used, we use our newly estimated human capital stock to distinguish between the different growth theories in chapter 6. The effect of human capital forming institutions on economic growth (in the form of the hypotheses presented here) will be discussed in chapter 7.

5 New estimates of the formation and stock of human capital

1. INTRODUCTION

After defining human capital (chapter 2), collecting data (chapter 3), and looking at the development of the education systems (chapter 4), we will combine this quantitative and qualitative evidence into a set of estimates of the stock of human capital for the period 1890 to 2000 that conforms to the definition we use. Such a set of estimates is important as we need to construct a stock that reflects, as far as possible, all aspects of human capital. That is, not only must it reflect the quantity of human capital, but also the change in its quality.

To that end, we start in section 2 with a brief outline of the data and some of the problems we encountered. In section 3, we turn to the estimation procedure of the stock of human capital in the 1980s and 1990s based on household surveys. We then move on to the construction of time series of the stock of human capital in section 4. This includes both the estimation of the appreciation/depreciation of the stock and the construction of a Perpetual Inventory Method (PIM) to bring the human capital series back to 1890. To this end we use the human capital estimates for age cohorts from the household surveys together with private and public expenditure on education and foregone wages. Following this construction of the human capital stock, in section 5 we turn to the analysis of this series. After estimating the subjective margins of error and taking a closer look at the components, we claim that this stock has a considerable degree of plausibility in view of the definition of human capital used. Therefore, it is more suitable in growth regressions than most of the current human capital proxies. We end in section 6 with a brief conclusion.

2. DATA AND MEASUREMENT ISSUES

There are three methods to estimate human capital.[91] First, there are proxies of human capital. These became especially popular with the Penn World Tables (Summers and Heston 1988; 1991) as it became possible to perform cross-country analyses which required a large human capital database. The most famous example of such proxies is the dataset by Barro and Lee (1993; 2001) consisting of five-yearly estimates of 'average years of education' in the population aged 15 (or 25) and over. However,

[91] For excellent overviews of the available human capital estimates see Le, Gibson, and Oxley (2003) and Wößmann (2003).

besides the low signal (they only to a limited extent reflect 'true' human capital), the main problem is that these data only capture the quantity of human capital.

There exist two alternative estimation methods. The first one is the prospective method, which looks at future earnings to calculate human capital. The second one is the retrospective method, which focuses on the investments in human capital. The advantage of these two methods is that they express human capital in monetary terms and keep into account the heterogeneity of labour. However, the definition of human capital may be problematic. For example, should it include the costs of rearing a child? In addition, these methods often require much data which are mostly only available for recent years, so only for a few years estimates can be made.

Some methods have been developed in order to combine the strengths and to avoid the weaknesses of the pro-and retrospective methods (Tao and Stinson 1997; Dagum and Slottje 2000). Yet, these methods are also data-intensive. Therefore, up till today, only a handful of studies use these techniques.

Since the combined approach offers the highest accuracy, our objective is to construct a human capital stock with a much more limited demand for data. In addition, we aim to adapt our estimates in such a way that they can easily be used to empirically test the new growth theories. We will use a slightly modified definition of the OECD (2001, 18), defining human capital as "the knowledge, skills, and competencies embodied in individuals that facilitate the creation of personal, social and economic well-being."[92] This definition excludes factors which relate to either physical aspects, like the costs of raising a child, or that relate to non-physical factors, which are nevertheless inherent to a physical person, such as innate ability. In other words, human capital consists of all forms of knowledge acquired with the exclusion of both innate abilities and the costs of reproducing labour.

The factors affecting the acquiring of knowledge, which together make up human capital, are generally unobservable. This is also the reason why most studies that tried to calculate the monetary value of human capital either used the input (costs) or the output (future earnings), or a combination of them. Although applying it in a different way, we use a latent variable approach[93] similar to Dagum and Slottje (2000).

[92] Please note that we excluded 'human attributes' from this definition as innate characteristics do not have an investment component.

[93] A latent, or unobservable, variable approach makes use of the relation between the unobservable variable and other available variables. It is likely that human capital is strongly related to social variables, e.g. age, sex, social status.

We estimate the probability of an individual having a 'relatively high educational level' and construct an index reflecting 'educational capital', that is, the total per capita stock of human capital minus 'experience' and 'on the job training' (see table 5.1). Next, we use the total spending on the education of low-educated young individuals in order to

Table 5.1: The division of the estimated stock of human capital on the basis of surveys by data, method of estimation.

Share of human capital	Data	Method
Educational Capital	a) Public expenditure on education (local and national)	Cost-based
	b) Private direct expenditure (school fees, books)	Cost-based
	c) Indirect expenditure (foregone wages)	cost-based
	d) Non-government, non-private effect**	Residual
Experience*	Experience part of earnings	Income-based

*Experience does also include 'on-the-job training' as it can also cause a rise in wage by age-class.
** While estimating the 'educational capital' index, we condition these index values on variables such as age, sex, and occupation. However, it is likely that, especially for older persons, the 'educational capital' (and as a consequence the index values) is higher than one might expect purely based on public and private expenditure and on foregone wages. Therefore, subtracting the latter from 'educational capital' gives the 'non-government, non-private' part of educational capital as can be inferred from this table. As a consequence, the 'non-government, non-private' effect consists of the share of educational capital that cannot be attributed to public or private expenditure on education or to foregone wages. This effect therefore mainly consists of factors such as home education.

estimate a benchmark level of 'educational capital' for the entire population aged 16-65. This is based on Tao and Stinson (1997), just like the use of an earnings equation to estimate experience and on the job training.

In short, our method has a cost- and an income-based component. The estimates of the human capital stock we obtain from the household surveys in the next section reflect the effect of public and private expenditure on education, the foregone wages (the cost-based component), 'experience', and 'on the job training' (the income based components). While the latter components can only directly be estimated using household surveys, the former can also be estimated using alternative sources, such as:

a) Skilled and unskilled yearly wages.
b) Per student public expenditure on education per level of education.
c) Per student private expenditure on education.

These latter sources will be used in section 4 to bring the estimated human capital stock further back in time.

We will not go into detail regarding the alternative sources under point a-c because these have been extensively discussed in chapter 3 and appendix A.1 and A.8.

The only point we want to make here is that for Japan for the period 1954-2002 we use the more detailed wage data by education level and by sex which are available from the *Japan Statistical Yearbook* and the *Historical Statistics of Japan*. For the period before 1954 a simple distinction in skilled and unskilled wages was used as is given in appendix A.1.

The household surveys require more attention. In order to estimate the human capital stock we need surveys with individual level data for Japan, India, and Indonesia (see table 5.2). For Indonesia we used the Sakernas (Indonesian Labour Force Survey) and for India the National Sample Survey. The latter surveys report for about every fifth

Table 5.2: Overview of the surveys used for the estimation of the human capital stock for India, Indonesia, and Japan in the 1990s

Country	Name	Sort survey	Issuer	Remarks
India	National Sample Survey	National sample	India, National Sample Survey Organisation	The subject Employment & unemployment covered in the surveys used in this text are issued once every five years.
Indonesia	Sakernas (Indonesia Labour Force Survey)	Labour market	Indonesia, Badan Pusat Statistik	Started in 1976, but the data for the early years are unreliable. Therefore we used the surveys from the early 1990s.
Japan	International Social Survey Programme	Social survey aimed at the entire population	ISSP, Japan	Covers yearly changing social aspects. Has a common core with data on age, earnings, education.

year data on the labour force. For Japan we used the International Social Survey Programme (ISSP).

At this point two problems arise. First, for some individuals in a survey no information on education was given. This occurs in each survey a few times. Yet, it is possible that omitting these observations would create a bias, since these individuals were likely to have a lower number of years of education on average. Therefore, we imputed the missing education variables using a regression on other variables such as age, occupation, sex, marital status. An example of this exercise is presented in table 5.3 for Japan although the same also applies to India and Indonesia. It is clear that the number of imputations in the variable ‘years of education’ is only marginal, never exceeding 1% of the sample. Equally, on average the imputed ‘years of education’ are lower than the average of the sample. Although the share of missing observations in each sample is small, their effect can be considerable when one looks at the results per age. As we need the results per age to calculate possible appreciation or depreciation of human capital, we need to correct for these missing observations.

The second point of concern in using household surveys is that of weighting. Although, for example, the surveys for Japan have no weights since they are constructed such that they are representative of the Japanese society, some

Table 5.3: Number of imputations of missing education variables and the average years of education of the entire sample and of the imputed individuals in the household surveys in Japan 1993-2002

	Sample*		Imputations		
Survey	Size of the sample	average years education in the sample	Number of imputations in each sample	% in sample	average years of education of the imputed values
1993	1.138	12.1	4	0.35%	9
1994	1.130	12.0	2	0.18%	9
1995	1.064	12.4	2	0.19%	12
1996	1.045	12.3	6	0.57%	12.2
1998	1.131	12.6	3	0.27%	12
2000	937	12.7	5	0.53%	12
2002	899	12.8	1	0.11%	10

*Including the imputed values

modifications need to be implemented. Even in surveys where such weights are present, it may be necessary to calculate a set of alternative weights in order to let the age structure of the sample perfectly reflect the actual age structure in the society. This is important for two reasons. First, we need the human capital per age later on to construct historical estimates of the human capital stock using a PIM. Second, if age-classes are not perfectly reflecting the national situation, the estimate of the stock of human capital for the survey used might be too high or too low. For example, assume that the estimated human capital for persons aged 16 is much higher than that of persons aged 65 while the number of persons aged 65 in the sample is overrepresented. As we will see in the next section, we use a regression analysis to estimate educational capital, which is a share of human capital. If the number of persons aged 65 is overrepresented, the estimates of average per capita educational capital will be underestimated.

Therefore we constructed a simple weight to counter these problems. We simply divided the percentage of age j in the total population aged 16-65 in the national census by the percentage of age j in the total population aged 16-65 in the sample. In other words:

$$Weight_j = \frac{\%inCensus_j}{\%inSample_j} \quad (5.1)$$

Here, *j* is the respective age of the individual. The weight is thus the same for all individuals, *i*, at the same age.

3. A NEW METHOD OF ESTIMATING THE HUMAN CAPITAL STOCK: USING HOUSEHOLD SURVEYS

Using above mentioned definition and data, in this section we start with outlining the method used to estimate the stock of human capital for the years for which we have household surveys. The historical estimates, based on a perpetual inventory method, are presented in section 4.

As we have seen in table 5.1, we can define the human capital stock as follows:

Human capital stock ≡ total investments + non-government, non-private effect + experience (5.2)

These three components of the stock of human capital we estimate in the following three steps. In step 1 we start with total investments (which consists of the sum of all public and private expenditure on formal education plus foregone wages) and with the non-government, non-private effect. The result, which we call educational capital, is an index with a value indicating each individual's relative human capital. In the second step we convert this index in a monetary value by calculating the total public and private expenditure plus foregone wages for a young individual who is likely to have no, or only a low, non-government, non-private effect. Using this benchmark we can use the index to estimate the educational capital for all individuals. In the third step we estimate a Mincer-equation with the value of educational capital per individual to estimate experience. These three steps are outlined in more detail below:

Step 1: We need to estimate a latent variable ec_i (educational capital per individual).

Following Kendrick (1976), educational capital (which we define as the sum of total investments plus the non-government, non-private effect, see equation 5.2) is basically nothing more than the sum of all expenditure on education in the population in year *t*. However, summing all expenditure over time is extremely data-intensive. For example, a person aged 65 in 1990 probably started his education around 1932. To estimate all educational expenditure in 1990, we therefore need time series on public and private expenditure on education and on foregone wages going back to 1932. In addition, investments in education can depreciate (or appreciate) which we cannot directly observe. Finally, it is likely that especially older persons also acquired skills through non-formal education such as home education. Thus, directly taking 'years of education' from the household survey and use those to calculate all investments would likely underestimate total educational capital as it ignores the non-government, non-private effect. Therefore, we must correct the number of 'years of education' per person in the sample in such a way that it also reflects the non-government, non-private effect, i.e. factors such as 'home education'. This we can do by regressing a dummy variable indicating whether a person has more (1) or less (0) years of formal education than the 'median of 'years of education in an occupational category'[94] on variables indicating 'home education' such as age and sex (older people and women are more likely to have been subject to home education). In this way we say how much the 'real' years of education per person (corrected for the absence of home education) is likely to be.

The first step is thus to estimate a latent (or unobservable) variable by using a probit model. Now assume that the probability of having a relatively high educational level compared to the occupational group (that is: having an education level higher than the median of a certain occupational group)[95] depends on the unobserved educational capital (ec_i), (see table 5.1). This latent variable is determined by explanatory variables in such a way that the larger the value of ec_i, the greater the probability of having a relatively high educational level. This ec_i is expressed as:

$$\begin{aligned} ec_i &= \beta_1 + \beta_2 Sex_i + \beta_3 Province_i + \beta_4 Age_i + \beta_5 RealForgoneWage_i + \beta_6 RealGovExp_i \\ &+ \beta_7 RealPrivExp_i + \beta_8 Sex_i * Age_i + \varepsilon_i \qquad \varepsilon \sim N\left(0,\sigma^2\right) \end{aligned} \tag{5.3}$$

[94] The main advantage of taking a dummy variable is 1) it removes outliers and 2) it allows for a stronger correction of unobserved factors of educational capital such as 'home education'.

[95] It is preferable to estimate the median per occupational group because it avoids placing occupations with totally different education levels in one group. For example, persons working in agriculture generally have less years of education than in some other occupational classes. Therefore, using more occupational classes is more precise. It seems, however, that the results do not significantly change even if we estimate the median educational level for the entire sample. This is one reason why we prefer the median. In a normal distribution, the mean, median, and mode are equivalent. When the distribution deviates from normality the median is preferable.

, where *i* indicates an individual, *Sex* is a dummy indicating whether a person is a male (1) or female (0), *Province* is a dummy indicating province or region[96], and *Age* is the age in years. Further we have *RealForegoneWage*, which is the wage foregone during the years one followed education.[97] We calculated only the foregone wage from the end of compulsory education.[98] If no compulsory education was enforced by law, we start at age 10.[99] Because children tend to get a lower wage than adults, we opted to attach the following weight to the adult wages:

Age	10	11	12	13	14	15	16	17	18	19	20
%wage	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%

So there is no overestimation of human capital in time periods when children start to work earlier. Also, this approach can uniformly be applied to both developed and developing countries. As a consequence, we avoid the problem of having to use different values and so enforce differences between developed and developing countries. Further variables in equation (5.2) are *Real Government expenditure* per student per level of education, and *Real private Expenditure*, which is the average household expenditure on education in year *t*.[100] Finally we have inserted a cross term of *sex* and *age*. We inserted this cross term in order to capture the effect of 'education at home', which cannot be seen directly from government expenditure or private expenditure. For example, it is likely that girls were more susceptible to home education than boys because they, for example, wove or took care of younger children. In addition this happened more often in the early decades of the twentieth century than later.

[96] For Japan these are the call areas: Hokkaido, Kanto, Chubu, Kinki, Chugoku, and Kyushu.
[97] It might be possible that *foregone wages* is correlated with physical capital, *K*. However, since we use *foregone wages* as an **indicator** for a relative high level of education, instead of estimating a structural model, this does not poses a problem. In addition, as mentioned before, foregone wages is often correlated with other monetary variables on human capital. Hence, it is often left out of the regression.
[98] This is difficult in itself because, for example in India, some states may have different ages for compulsory education. However, for Japan, we took 10 years for the period before 1908. Between 1908 and 1946 it was 12 years, and 15 years for all persons following education thereafter. For India we took compulsory education until age 14 since the 1950s and for Indonesia before 1994 until 12 years and until 15 years thereafter.
[99] As we attach 0% to children aged 10, we *de facto* start at age 11.
[100] All monetary independent variables, i.e. government expenditure, private expenditure, and foregone wages, have a large chance of causing strong collinearity. Therefore, it might sometimes be better to leave them out of the equation. This we also did in most cases.

Therefore, inserting the cross term might capture this effect.[101] In the same way, the inclusion of 'age' as an independent variable might pick up the effect that elderly persons are more likely to have had a greater share of home education compared to formal education.[102]

In the previous paragraph we described equation (5.3). But, like we mentioned, ec_i is unobservable. Therefore we estimate a probit regression.[103] Assume that Y=1 means that an individual has a relatively high educational level and Y=0 that he has not. Now assume that there is a critical level of the unobservable variable, ec_i^*, when this is the case. So, if $ec_i > ec_i^*$ a person will have a relatively high educational level (higher than the median). This critical level is also unobservable, but if we assume that it is normally distributed with the same mean and variance we can estimate both the critical level and the index of the entire variable ec_i. Now, given the assumption of normality, the probability that ec_i^* is less than or equal to ec_i can be computed from a standardized normal CDF as:

$$P_i = P(Y=1 \mid X) = P(ec_i^* \le ec_i) = P(Z_i \le \beta_1 + \gamma' X_i) = F(\beta_1 + \gamma' X_i) \tag{5.4}$$

Here $P(Y=1 \mid X)$ is the probability that a person has a number of years of education higher than the median given the values of X (the vector of the explanatory variables).

[101] We have to be aware that it might be necessary to insert quadratic functions of the monetary variables to capture any possible non-linearities. Ignoring this possibility might bias the estimation result as it is by no means certain that persons with 20% chance of having a relatively high educational level also have 2 times more educational capital as those persons with 10% chance of such a relatively high educational level. Inserting these quadratic variables may counter this problem. For each of these monetary variables, we decide whether to include the quadratic variable if the optimum is within the range of the survey. For example, if we take government expenditure, we might get:

$$aLog\left(RealGovExp\right)_i + b\left(Log\left(RealGovExp\right)_i\right)^2$$

For the optimum, we obtain:

$$Log\,RealGovExp_i^* = -\frac{a}{2b}$$

Now if $Log\,RealGovExp_{\min} < Log\,RealGovExp_i^* < Log\,RealGovExp_{\max}$, we decide to include the non-linearity in the regression. In other words, as the estimated optimum falls within the range of the variable in the dataset, we include the non-linearity in the regression. Otherwise, we will exclude it. However, in actual calculation most often one will find that there is no need to include quadratic terms, partly because they are strongly correlated with the other variables.

[102] Part of the reason why this effect is picked up is because we use the human capital of persons around 16 years as a basis to calculate the human capital for all other persons (see step 2 in the text). Consequently, the upward effect of variables such as home education for, mostly older, persons is retained.

[103] This part is largely based on Gujarati (2003, 608-610).

Here Z_i is the standard normal variable, i.e. $Z \sim N(0,\sigma^2)$. F is the standard normal CDF. Since P presents the probability of having a relatively high educational level, it is measured by the standard normal curve from $-\infty$ to ec_i. Now we can obtain information on the stock of educational capital, ec_i. We take the inverse of equation (5.4) to obtain:

$$ec_i = F^{-1}(ec_i) = F^{-1}(P_i) = \beta_1 + \gamma' X_i \tag{5.5}$$

In other words, after having estimated *P*, the chance of having a relatively high educational level from equation (5.3) (or, more formally written, equation (5.4)), we can take its inverse to estimate an index of educational capital.[104] This index thus represents the number of years of schooling per individual corrected for factors such as home education.

Step 2: Estimating the monetary value of the educational capital.

We now have an index of educational capital, i.e. of the sum of total investments and the non-government, non-private effect (see equation (5.2)). If we want to turn this into a monetary value, we run into some distortions:
1) the depreciation of money (even though we used real 1990 monetary units, problems with unaccounted inflation may seriously hamper the estimates),
2) depreciation/appreciation of human capital,
3) the 'non-government, non-private' effect which is unobserved even using the income- or cost-based approaches.
These three problems may cause biases in the value of the estimated educational capital.

To convert the educational capital index into a monetary value for each individual, we have to estimate the educational capital stock for some sort of baseline entrant similar to Tao and Stinson (1997). Using the index we can extend the value of the educational capital stock of the baseline entrant to the other individuals in the sample.

[104] What we are actually doing is to condition the Y on the X-values. This means that we first construct a variable indicating a relatively high level of education based on years of education. Then we calculate the probability of having a relatively high number of years of education. The final step is to condition the y-variable to the x-variables to construct the educational capital index. This index thus strongly resembles the original input (years of education) but is not completely the same. There are two main advantages in first transforming 'years of education' into a dummy variable. First, it removes outliers. Second, using a probit allows us to estimate home education as well (see table 5.1 and the text). If we would simply take 'years of education' we would miss home education. However, using a probit, we might condition it on variables such as age*sex in order to capture the effect of home education.

Yet, because the estimation of the educational capital stock faces the three problems mentioned above, we have to choose a baseline entrant to minimize these three problems.[105] As mentioned before, our human capital stock includes people between the ages 16 to 65 (in the labour force). Therefore, we opt for a person aged 16 with solely primary education, for whom we calculate his foregone wage, and his private and government expenditure incurred in 1990 prices. Summing these yields the educational capital of the baseline entrant in 1990 prices. Now, we can estimate the value of educational capital of other individuals in the sample using the educational capital index from step 1. If we calculate the value of average educational capital per age in the sample and we multiply it with the number of persons at that age in the total population we arrive at the value of the total stock of educational capital.

Step 3: Estimating the income-based part of human capital: 'experience' and 'on-the-job training'.

In the previous two steps, we estimated the educational capital stock, which was the total investment (public, private, and foregone wages) in human capital, added with the 'non-private, non-government' effect. Yet, as we can see in equation 5.2, human capital also has an income-based part, i.e. 'experience' and 'on-the-job training'. To estimate this part, we start by estimating an earnings equation, which we can do in a cross-section for each household survey separately:

$$LnE_i = \alpha + \beta_1 ec_i + \beta_2 t_i + \beta_3 t_i^2 + \varepsilon_i \qquad (5.6)$$

E_i and ec_i denote per capita wage and the value of the educational capital stock (from step 2) respectively, t_i and t_i^2 are variables included to capture the effect of experience and 'on the job training', and ε is the error term, assumed to be independent and identically distributed. The variable t is calculated as age minus 'school duration' minus 6 years. For those with lower secondary education or primary education levels, t is estimated as age minus 15 years. This is necessary to avoid overestimating the experience of persons with only lower education as children generally gain less experience than adults (Dougherty and Jimenez 1991). As a consequence, $\beta_2 t_i - \beta_3 t_i^2$ is the interest on experience and on-the-job training from individual i with age (m_i). To

105 We can of course also calculate the costs of education for different persons and compare the results.

arrive at an estimate of experience, we simply take the mean interest per age *j*, $\overline{m}_j$. Then, for each age *j*, we sum the mean interest of the previous ages, so the experience at age *j* is $Exper_j = \sum_{16}^{j} \overline{m}_j$.

In other words, we calculate the interest on 'experience' for each age (from age 16 to age 65). As it is unlikely that persons aged 16 have a different innate ability than persons aged 65, this avoids an ability bias. Next, we sum the interest for each age to obtain the estimates of value of the relevant experience. For example, if we want to calculate the experience at age 20, we sum the interest on experience from age 16 to 20. The same we do for all other ages from 16 to 65.

However, this method can only be performed for persons with wage>0. It is, however, unlikely that persons outside of the labour force (with wage=0) have no experience at all. In order to correct for this sample selection bias we apply a method based on Heckman (1979).

First, we assume that the estimated experience from regression (5.6) also holds for persons with *wage=0*. Hence, the experience estimated by equation (5.6) for persons aged 30 is not only used for those persons aged 30 with *wage>0* but also for those persons aged 30 with *wage=0*. This creates a strong overestimation of experience as it is unlikely that the persons outside the labour force have the same level of experience as those in the labour force.

Second, we run a probit regression where we estimate the chance that someone is in the labour force, i.e. *wage>0*, Hence, we run a regression of whether someone is in the labour force (*Y=1*, i.e. *wage>0*) or outside the labour force (*Y=0*, i.e. *wage=0*) on a vector of explanatory variables such as age, sex, educational capital, and marital status. This results in an estimate for each person of the chance he or she is in the labour force.

Third, we multiply this chance for each person with the calculated experience of a person of that age. This means that persons with a high probability of being in the labour force, even if they are at present outside the labour force, have, given their educational capital and age, relatively much experience. The basic idea is that those persons with a higher chance of being in the labour force also have more chance of having had a job earlier and, hence, of having more experience.

4. BRINGING THE HUMAN CAPITAL ESTIMATES BACK IN TIME: A PEREPETUAL INVENTORY METHOD

Above three steps resulted in estimates of the monetary value of the human capital stock in some years in the 1980s and 1990s. The results are given in table 5.4. There are three important aspects to note. First, the per capita human capital stock was fractionally higher in Indonesia compared to India. This difference was around 3.5%. Of course, the total human capital stock was much higher in India because of its far larger population. Second, the per capita human capital stock in Japan is much higher than in India and Indonesia. The per capita stock in India is around 3.3% and in Indonesia 3.4% of that of Japan. This is remarkable because, if we had taken 'average years of education', the per capita stocks of India and Indonesia compared with Japan would have been 53.8% and 65.3% respectively. If assume, somewhat unrealistically, that 'average years of education' only consists of the quantity, and the stock of the newly estimated human capital consists of both the quality and quantity of human capital, then the quality of human capital would amount to 1-0.033-(1-0.538) = 50.5% of the difference of the per capita stock of human capital between India and Japan and 1-0.034-(1-0.65)= 61.6% of the difference between Indonesia and Japan. It thus seems that the quality of human capital is lower in Indonesia than it is in India. Indeed, comparing India to Indonesia, we find that the quality of human capital

Table 5.4: Total and per capita stock of human capital and total stock of gross fixed non-residential physical capital in Indonesia, India, and Japan in 1990 international USD, converted at purchasing power parity (PPP)

	Indonesia			**India**			**Japan**		
	Physical capital	Human Capital		Physical capital	Human Capital		Physical capital	Human Capital	
	Total	Total	Per capita	Total	Total	Per capita	Total	Total	Per capita
	Billion USD	Billion USD	USD	Billion USD	Billion USD	USD	Billion USD	Billion USD	USD
1993	649.0	348.7	1,851	2,530.1	1,589.6	1,787	4,458.1	6,721	53,907
1994							4,610.3	6,782	54,248
1995							4,768.6	7,256	57,888
1996	870.8	397.7	2,008				4,943.9	7,868	62,622
1997							5,112.7		
1998								8,407	66,590
1999	1,053.6			3,768.0	2,001.7	2,028			
2000								8,642	68,206
2001									
2002		534.8	2,378					9,408	74,036

Source: Human capital: this chapter; physical capital: appendix A.2.

would explain 1-0.944-(1-0.853) = -9.1% of the difference. In other words, the gap in per capita human capital would be 9.1% larger if India had the same quality of human capital as Indonesia.[106] Third, the amount of the estimated human capital is lower than the physical capital stock in India and Indonesia. The exception is Japan, where the estimated human capital stock is significantly larger than the stock of physical capital. This corresponds with the finding of Judson (2002, 217) that the human capital stocks in rich countries are significantly larger relative to both physical capital and GDP than in poorer countries.

These estimates of the stock of human capital also contain information of the human capital per age for persons aged 16 to 65 years old. We assumed that persons of these ages were eligible for the active labour force and their human capital was thus included in the stock of human capital. If we know the appreciation/depreciation of human capital by age, we can use this information to estimate how much human capital is added to the stock between circa 1950 and 2000. This information allows us to bring the human capital stock from the 1980s and 1990s back to 1890 which we need to cover the entire twentieth century.

There are two ways in which we can utilise this information to bring the human capital stock back to 1890. Both methods are strongly related to a Perpetual Inventory Method (PIM). A PIM requires two data series. First, we need the annual flow of human capital that is added to the stock. This is the gross fixed human capital stock. Second, we need the yearly appreciation (a percentage increase in value) or depreciation (a percentage decrease in value) of the human capital. Now, there are two ways in which can generate a series of human capital. First, we sum all flows that are added to the stock over 50 years (for persons aged 16 to 65), minus their depreciation (or plus their appreciation). The definition of human capital than becomes:

Human capital stock in year t ≡ sum of all additions to the stock of human capital in year t-1 to t-50 minus the depreciation (or plus the appreciation) (5.7)

[106] Assuming 'average years of education' is the quantity of human capital and 'Total HC' is the quality and quantity of human capital. We want to know what difference between the stocks of human capital can be explained by the quality. To arrive at this, we first estimate 1-%'average years of education'. In other words, 1-the percentage of 'average years of education' compared to the country with which you want to compare it (0.538 if you want to compare India to Japan). Now you have solely the quantity. Now simply subtract this from 1-%'Total HC', which is the total difference minus quantity and quality.

The disadvantage of this method is that it sums human capital accumulation over 50 years which means that the first estimate of the human capital stock is only available 50 years after the first estimate of human capital accumulation. Yet, the main advantage is that we can directly apply the appreciation/depreciation figures by age without reverting to constructing an average for the complete stock.[107] Therefore, we prefer this method. To extend this series back to the year in which we have the first observation of human capital accumulation we use the following equation:

Human capital stock in year t-1 ≡ (human capital stock in year t minus the human capital accumulation in year t-1)/(1-depreciation in year t-1) (5.8)

The main disadvantage of this method is that we have to assume a depreciation (or appreciation) of the total stock.

In the next five steps (step 4-8) we will thus use equation (5.7) and (5.8) to bring the human capital stock based on the household surveys back to 1890. Step 4 to 7 focus solely on equation (5.7). In step 4 we estimate the appreciation/depreciation by age and in step 5 and 6 we estimate the human capital accumulation in the second and first half of the twentieth century respectively. As we now have all the necessary variables, we turn in step 7 to the estimation of the human capital stock based on equation (5.7). In step 8 we bring the human capital stock back in time for the last 50 years using equation (5.8). These five steps are outlined in more detail below:

<u>Step 4: Estimating the appreciation/depreciation of human capital.</u>

To estimate equation (5.7), we need the appreciation/depreciation of the stock of human capital by age class. Therefore, we estimate the percentage change by age class from the human capital estimates based on the household surveys in step 1-3 above. For example, we estimate how much the per capita human capital for persons aged 40 in year *t* increases or decreases compared to the per capita human capital of persons aged 41 in year *t+1*.[108]

[107] In addition, it can be considered a cross-check for our human capital estimates based on household surveys in step 1-3. If the sum of the human capital accumulation over 50 years minus their depreciation (or plus appreciation) equals the human capital estimates based on the household surveys, this suggests that the appreciation/depreciation figures do not significantly change over time.

[108] This is no appreciation/depreciation because a) in the first years a person enters the human capital stock, he or she might still form human capital at secondary or higher schools, b) as a correction for mortality is excluded, this might increase the per capita human capital because mortality is higher among

The results are presented in table 5.5. In Japan and India we notice an increase in appreciation by age, followed by a decrease. This suggests that educational capital is relatively constant over time and that the pattern is dominated by experience, where appreciation declines at later ages. In Indonesia, however, the pattern of appreciation fluctuates over time. We might explain this development by the situation that Japan was already more advanced in education than was India and Indonesia at the start of the century. As secondary and higher education are more likely to retain their value (no

Table 5.5: Yearly appreciation of the per capita stock of human capital by age class in Japan, India, and Indonesia based on surveys in the 1990s

age class	Japan	Indonesia	India
16-20	3.7%	7.0%	5.1%
21-25	4.9%	4.9%	6.1%
26-30	5.8%	3.5%	9.4%
31-35	5.3%	1.9%	10.2%
36-40	4.9%	1.5%	7.7%
41-45	4.8%	3.4%	6.1%
46-50	4.6%	4.9%	3.7%
51-55	4.4%	4.9%	2.1%
56-60	3.7%	2.7%	-1.4%
61-65	2.8%	7.7%	-5.5%

Note: A negative value indicates a depreciation.

chance of relapsing in illiteracy, better chances of retraining skills when one's job becomes economically obsolete), the appreciation/depreciation pattern of experience (first increasing and later decreasing) is likely to dominate. That this pattern also dominates in India might be attributed to the focus on secondary and higher education at the start of the century.

Step 5: Estimating the gross fixed human capital formation in the second half of the twentieth century

To calculate the stock of human capital, equation (5.7) indicates that we also need the human capital that is added to the stock by people who enter the stock of human capital (i.e. who are 16 years old). We use the appreciation/depreciation figures from step 4 to estimate the gross fixed human capital formation (GFHCF, gross increase of the human capital stock in year *t*) back to around 1945 for persons aged 16. We will call this the

persons with lower levels of human capital, and c) such parts of the human capital stock as 'experience' and 'on the job training' are formed later in life causing an increase of the appreciation (or decrease the depreciation) of the per capita human capital stock if it is not corrected for.

$GFHCF_{16}$ to distinguish it from the total GFHCF ($GFHCF_{tot}$) which consists of all investments (also of persons older than 16) added to the stock in year *t*.

The starting points are the per age class estimates of human capital based on the household surveys (step 1-3). Say, we take the survey for 1993. A person aged 17 in the 1993 survey was 16 in 1992. Therefore, we took the per capita human capital from a person aged 17 in the 1993 survey and corrected it for the percentage change in per capita human capital from age 16 to age 17 obtained in step 1. In this way we arrived at the per capita human capital of a person aged 16 in 1992.We did the same for a person aged 18 in the 1993 survey (aged 16 in 1991), etc. In this way we brought the per capita human capital of a person aged 16 back to 1945.[109]

Since we had surveys available for several years, we carried out this exercise for all these years. This yielded multiple, rather homogenous, estimates of the per capita human capital stock for a person aged 16. We then took the average and multiplied it with the total population aged 16. In this way we arrived at the $GFHCF_{16}$.

<u>Step 6: Estimating the gross fixed human capital formation in the first half of the twentieth century</u>

In step 5 we brought the $GFHCF_{16}$ back in time to 1945. Yet, given that equation (5.7) indicates that we have to sum this variable over 50 years, this means that we can only estimate the first human capital stock in 1995. However, our final objective is to bring it back in time to 1895. To this end, we need to estimate the $GFHCF_{16}$ for the period 1895-1945 as well. As pointed out in equation (5.2), the human capital stock (and thus also the GFHCF) consists of an observed component (government and private expenditure on education plus foregone wages), an unobserved component (the 'non-government, non-private' effect), and experience. However, it is not necessary to calculate experience as we are solely estimating the human capital accumulation for a person aged 16 (who just enters the human capital stock) and thus has no experience yet. We will thus only have to estimate the accumulation of what we called in step 1-3 'educational capital' for a person aged 16.

First we estimate the observable component of the $GFHCF_{16}$. This can be calculated (assuming 6 years of primary education from age 6 to age 11, 3 years of

[109] The implicit assumption is thus that the percentage change in per capita human capital from age x to age x+1 remains the same between 1945 and 2002.

lower secondary education from age 12 to 14, and three years of higher secondary education, age 15-17)[110] as:

$$GovInvest_{t,16} = \sum_{i=6}^{11}\left(\tfrac{1}{6} * PrimEnrolled_{t-i} * GovExpPrim_{t-i}\right) + \sum_{i=2}^{4}\left(\tfrac{1}{3} * LowSecEnrolled_{t-i} * GovExpLowSec_{t-i}\right)$$

$$+ \tfrac{1}{3} * UpSecEnrolled_{t-1} * GovExpHighSec_{t-1}$$

$$PrivInvest_{t,16} = \sum_{i=6}^{11}\left(\tfrac{1}{6} * PrimEnrolled_{t-i} * PrivExp_{t-i}\right) + \sum_{i=2}^{4}\left(\tfrac{1}{3} * LowSecEnrolled_{t-i} * PrivExp_{t-i}\right)$$

$$+ \tfrac{1}{3} * UpSecEnrolled_{t-1} * PrivExp_{t-1}$$

Here, $GovInvest_{t,16}$ and $PrivInvest_{t,16}$ are the cumulated government and private investment in persons aged 16 in year *t* respectively. Further *Prim*, *LowSec* and *UpSec* enrolled give the number of students enrolled at that level of education in year *t*. The fraction before those variables indicates the number of years of education at each level. The sum signs indicate how many years have to be summed before age 16 is reached. For example, 6 years of primary education, 3 years of lower secondary, and 1 year of upper secondary education as the final two years of the latter education level are intended for persons above age 16. We did not include foregone wages in some cases because compulsory education may last up to age 16 and we only started to include foregone wages after the end of compulsory education. However, we did include foregone wages for earlier decades when compulsory education did not last until age 16. If we sum the above-mentioned investments, we arrive at the $GFHCF_{16}$ without the 'non-government, non-private' effect.

Second, we need to estimate the unobservable part, the 'non-government, non-private' effect. As we have the total $GFHCF_{16}$ for the period 1945-2002, we simply have to subtract the $GFHCF_{16}$ without the 'non-government, non-private' effect from these figures to obtain the 'non-government, non-private' effect. As we had both the $GFHCF_{16}$ without the 'non-government, non-private' effect for 1895-2002 and the 'non-government, non-private' effect for the period 1945-2002, we used the following single equation regressions to backcast the latter:

Japan:

$$\text{'non-government, non-private effect'}_t = 0.043*trend - 0.711*Other_t + 0.003*Other_t^2 + \varepsilon_t$$

(SE)	(0.044)	(0.084)	(0.0004)

[110] These ages may differ by country or time period.

India:

$$\text{'non-government, non-private effect'}_t = -0.018*trend - 0.056*Other_t - 0.001*Other_t^2 + \varepsilon_t$$

(SE) (0.009) (0.024) (0.0001)

Indonesia:

$$\text{'non-government, non-private effect'}_t = 0.023*trend - 0.349*Other_t - 0.001*Other_t^2 + \varepsilon_t$$

(SE) (0.003) (0.033) (0.0006)

Here $Other_t$ is the $GFHCF_{16}$ without the 'non-government, non-private effect in year *t*. We included $Other_t^2$ because it is likely that there are non-linearities. For example, it is likely that the 'non-government, non-private' effect is much larger relative to the formal education expenditures at the start of the century because it includes such measures as 'home education' and 'on the job training'. Indeed, we find this squared variable to be significant. Adding our backcasts to the estimates of the $GFHCF_{16}$ without the 'non-government, non-private' effect, gives the total $GFHCF_{16}$ for the late nineteenth century to 2000.

Step 7: Estimating the human capital stock in the second half of the twentieth century

We can now estimate the human capital stock based on equation (5.7). Since we are interested in the human capital stock of individuals aged 16-65, we sum the $GFHCF_{16}$ which we calculated in step 5 and 6 over 50 years while we correct for the percentage change in per capita human capital estimated in step 4.[111] As we sum over 50 years (age 16-65), summation can be done as:

$$\sum_{i=0}^{50} GFHCF_{16,t-i} \qquad \text{where } i = \text{age-15.} \qquad (5.9)^{112}$$

[111] As we link these human capital stock estimates with the estimates of the human capital stock from the household surveys (thus adapting the level of these human capital stock estimates to those of the household surveys), the implicit assumption is a constant mortality of the working age population (age 16 to 65) over time.

[112] This equation is unlikely to be biased by the breaks in human capital developing institution as sketched in chapter 4. Indeed, we do need to pick up these breaks in order to test for the presence of educational institutions in chapter 7. However, first, it is only estimated for circa 50 years (1950-2000) which period knows very little breakpoints as we pointed out in chapter 4. But, second, even if there were breakpoints, these would most likely take place in human capital accumulation. However, this is relatively independent of the breaks in the institutional development. Third, of course, depreciation could

However, the $GFHCF_{16}$ has to be corrected for appreciation/ depreciation (δ) for each age. As we allow for both an appreciation and depreciation, this means that it is possible that $\delta > 0$ or $\delta < 0$. This means that for a person aged 65 (*j*=50) his gross fixed human capital formation when he was 16 has to be multiplied with $(1+\delta_0)$, where δ_0 is the appreciation/depreciation from age 15 to 16 (which is non-existent as we assume that appreciation/depreciation only starts when a person enters the human capital stock at age 16), with $(1+\delta_1)$ for age 16 to 17, with $(1+\delta_2)$ for age 17 to 18,…., with $(1+\delta_{50})$ for age 64 to 65. This means that, as the appreciation/depreciation is only dependent on age (thus independent of time), the total appreciation/depreciation for persons aged θ can be estimated as:

$$\delta_\theta = \prod_{j=0}^{i} \left(1+\delta_j\right) \tag{5.10}$$

Combining equation (5.9) and (5.10), the total human capital stock (H) of a society can be estimated as:

$$H_t = \sum_{i=0}^{50} \left[GFHCF_{16,t-1} \cdot \prod_{j=0}^{i} \left(1+\delta_j\right) \right] \tag{5.11}$$

In other words, equation (5.11) is the more formal version of equation (5.7).

For example, we would like to estimate the human capital stock in 1950. As we defined the human capital stock as consisting of the human capital of all individuals between the ages of 16 and 65 (50 years), this means that the first persons that entered the 1950 human capital stock were 16 in 1900. Next, we apply the appreciation/depreciation figures (from step 4) to their gross fixed human capital formation (from step 6). This means that, if we take Japan, their gross fixed human capital formation appreciated with 3.6% yearly between age 16-20, with 4.9% between age 21-25, etc. In this way we arrive at how much their human capital would be in 1950 (when they were 65). We do the same for persons who are 16 in 1901 (who were 64 in 1950). This we do for all the years up to 1950. Finally, we sum all values to obtain the human capital stock in 1950.

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be influenced by breaks. However, this is much less likely to be the case than for capital accumulation. After all, it is easier to increase the number of schools than to change the human capital depletion (for example because people are retiring) in a factory. Fourth, even if breakpoints affect depreciation, for example at time *t*, than still the possibility exists that only the depreciation of persons entering the labour force after year *t* is affected. Fifth, because we are talking about a stock variable, any minor changes will be smoothed.

Step 8: Estimating the human capital stock in the first half of the twentieth century

Unfortunately, we can only provide estimates for the human capital stock 50 years after the first observation of the $GFHCF_{16}$. In our case the first year in which the human capital stock can be estimated is around 1945. As pointed out at the start of this section, in order to go further back in time we need both the human capital accumulation and the yearly depreciation of the total stock of human capital (see equation (5.8)). For the first we only have the $GFHCF_{16}$, excluding any human capital obtained at age 17-22, when a person may still attend upper secondary school, college, or university. Estimates of the appreciation or depreciation can only be made if we have both the stock of human capital and the total GFHCF ($GFHCF_{tot}$). As we have the stock of human capital in 1945-2002, we first have to estimate $GFHCF_{tot}$.

Therefore, we have to add the human capital formed by persons aged 17-22 in year *t* to the $GFHCF_{16}$ which we estimated in step 5 and 6. Now, if we are confronted with a school system where we have three years of higher secondary education (age 15-17) and with either two years of college education (18-19) or four years of higher education (age 18-21), we can estimate the investment of persons of age 17-21 in year *t* as:

$$HighSecInvest_t = \left(\frac{HighSecEnrolled_t}{3}\right) * \left(\left[(0.7) * ForegoneWage_t\right] + \left[GovExpHighSec_t\right] + \left[PrivInvest_t\right]\right)$$

and

$$CollegeInvest_t = \left(\frac{CollegeEnrolled_t}{2}\right) * \left(\left[(0.8+0.9) * ForegoneWage_t\right] + \left[2 * GovExpCollege_t\right] + \left[2 * PrivInvest_t\right]\right)$$

and

$$UniversityInvest_t = \left(\frac{UniversityEnrolled_t}{4}\right) * \left(\left[(0.8+0.9+2) * ForegoneWage_t\right] + \left[4 * GovExpUniversit_t\right] + \left[4 * PrivInvest_t\right]\right)$$

The three equations above state that the average number of students per year and level of education has to be multiplied by the per capita foregone wages, corrected for the fact that younger children earn less, the per capita government expenditure for that education level, and the per capita private investment. This results in:

$$InvestAge16_t + HighSecInvest_t + CollegeInvest_t + UniversityInvest_t = GFHCF_t$$

, which means that the sum of $GFHCF_{16}$ plus investments of persons older than 16 in higher secondary education, college, and university results in the $GFHCF_{tot}$.

As we now know both the total gross fixed capital formation (including the gross fixed capital formation in year *t* of persons older than 16) and the stock of human capital for the period 1945-2002, we can calculate a yearly changing appreciation/depreciation of the estimated total stock of human capital for 1945-2002 as[113]

$$appreciation / depreciation = \frac{HC_t - HC_{t-1} - GFHCI_t}{HC_{t-1}} \quad (5.12)$$

This has the important advantage that the appreciation of the estimated stock mirrors the changes in the duration of compulsory education. This resulted in an average yearly appreciation of around 0.8% in the 1990s.[114]

Now we have the $GFHCF_{tot}$ for the period 1895-2002 and the yearly appreciation/depreciaton of the stock of human capital for the period 1945-2002. If we assume that the yearly appreciation depreciation remains the same as the average appreciation/depreciation of the period 1950-60 (thus excluding the immediate post-War period), we can estimate the stock of human capital before 1945 as

[113] An alternative method for directly estimating the appreciation/depreciation of the total stock of human capital, using solely the surveys, would be to estimate, using the total, per age, stock of human capital:

$$\frac{\left(\sum_{j=16}^{65} HC_{j,t+1}\right) - \left(\sum_{j=16}^{65} HC_{j,t}\right) - GFHCF_{t+1}}{\sum_{j=16}^{65} HC_{j,t}}$$

, where HC is the total stock of human capital per age *j* and *t* is the year of the survey. In other words, we estimate the percentage difference between the total human capital stock in year *t+1* and the total human capital stock in year t minus the human capital inserted in the stock of human capital in year *t+1*, the Gross Fixed Human Capital Formation (GFHCF). However, this approach gives two problems. First, an obvious drawback is that we can solely calculate the appreciation/depreciation of the stock of human capital for those years for which we have surveys. It is not clear at all, however, that these appreciation/depreciation figures remain the same over time. Second, in section 3 we already mentioned that foregone wages were calculated starting from the age at which compulsory education ended or, when there is no compulsory education, from age 10. This changed in all three countries in the middle of the twentieth century. In turns, this might have changed the rates of appreciation/depreciation. However, in the period before this change in the duration of compulsory education, we do not have surveys from which we can calculate a new figure for the appreciation/depreciation.

[114] This sounds somewhat as a circle argument. We could have estimated the appreciation/depreciation for the human capital from the years we have household surveys and applied it to the preceding years. Instead, we used the per capita appreciation/depreciation to calculate the stock of human capital as indicated in the text. As these per capita appreciation/depreciation figures are also obtained from the household surveys, this is a circle argument if the relation between the gross fixed human capital formation and the estimated human capital stock remains constant over time. Yet, this is unlikely as, for example, it may be argued that the depreciation increases (or appreciation declines) during the War-periods. Therefore, having a stock and a series of human capital accumulation, the decline in the stock in the War-periods is largely attributed to the depreciation. If we use the depreciation figures from the 1990s surveys for the entire period, and given the fact that we had the human capital accumulation data, the decreases (or increases) in depreciation/appreciation during certain periods would be completely reflected in the stock which is quite unlikely as a stock variable by definition is less susceptible to hectic fluctuations.

$HC_t = \frac{HC_{t+1} - GFHCF_{t+1}}{(1+appreciation)or(1-depreciation)}$. The final results are presented in appendix A.9-A.12.

5. PLAUSIBILITY AND DEVELOPMENT OF HUMAN CAPITAL

5.1 Introduction

In the previous sections we introduced our new method for estimating the stock of human capital. This stock, in constant per capita terms, is presented in figure 5.1. Three things are worth noticing. First, all three countries have more or less a straight rising curve. It seems that, before the 1930s, the growth of human capital is larger in Indonesia than it is in India. Between 1930 and 1950 (Indonesia) or 1970 (India) the per capita human capital grows strongly. Afterwards its growth again decreases because the period between 1930 and 1970 was the period of large increases in educational enrolment and attainment. The pattern of first constant, than rising, and finally again decreasing growth of human capital is called logistic. This is a pattern that is commonly

Figure 5.1

Per capita human capital in India, Indonesia, and Japan in log 1990 International USD, converted at PPP.

Source: Appendix A.12.

found for variables in growth studies (see for example Cameron 1989, 16; Astorga, Berges, and Fitzgerald 2005, 770).

The same pattern we also find in Japan except that, based on the observations in chapter 4, the growth of per capita human capital already started long before 1890 (for which we have no data). Consequently, the second important point is that the per capita human capital in Japan was much higher than in India and Indonesia, even around 1900. Whereas in Japan the estimated per capita human capital in 1900 in constant 1990 International dollars was around 2.682 USD, in India it was 361 USD and in Indonesia 130 USD. Interesting is also to note that the per capita human capital in Japan in 1895 is about as high as that of India and Indonesia in 2000. The final point to note is that Indonesia around 1890 had a lower per capita human capital than India. Yet, although they moved around the same patterns, Indonesia's growth in per capita human capital set in earlier than in India and was much stronger. As a result, after surpassing India around 1915, the gap in per capita human capital widened in favour of Indonesia until the 1940s. Afterwards the difference began to shrink until the two countries converged after 1970. A simple explanation would be that mass education set in earlier and was stronger, both qualitative and quantitative, in Indonesia compared to India. This corresponds well with our conclusions in the previous chapter on the Indian focus on secondary and higher education prior to the 1920s.

This development of the estimated per capita human capital stock seems plausible. Indeed, because its development seems to conform to the expectations, and because it is designed to include both the qualitative and quantitive aspects of education, we expect that this stock is a better indicator of human capital than most alternative measures. In this section, we will try to give an impression of its plausibility, both quantitatively and qualitatively.

We will look at the plausibility of the stock of human capital in three different ways. First, in section 5.2 we will look at the subjective margin of error. This shows how reliable the data and estimation methods are **given the definition we use for human capital**. It thus cannot give a definite answer on whether the definition is correct or not. In section 5.3, we will look at the composition of the human capital stock. What is its structure? How do these shares relate to the government expenditure on education or private expenditure? This already gives a gauge of how the stock of human capital relates to the basic inputs, which are also often used in alternative measures of human capital. Finally, in section 5.4, we will look at how the estimated human capital stock compares to GDP and the physical capital stock.[115]

5.2 Subjective margins of error

A first step would be to estimate how reliable the estimated stock is given the definition of human capital employed. Even the estimates of the reliability are necessary flawed but, as Feinstein and Thomas (2001, 14) already pointed out '[h]owever problematical such subjective assessments of unknown errors may be, they are much more informative than general statements formed from some favoured permutation of stock phrases (these estimates are very: 'approximate', 'imperfect', 'unreliable', 'tentative', 'uncertain', 'fragile'; they are: 'a best guess', 'a rough guide', 'an order of magnitude', 'a crude indication'; or, very occasionally, they are: 'reasonably reliable', 'broadly acceptable'; and so on).' We will therefore give some indications of the margins of error in this section.

Indeed, there are a lot of options to estimate such margins. Here, we will estimate for each component the margins of error and than aggregate them. The first step is to attribute margins of error to the rough data we collected in first instance, sometimes with a few modifications: government and private expenditure on education (see chapter 3 and appendix A.8.) and wages (see appendix A.1.). Following Chapman (1953, 231), we attached margins of error of 2.5% to 'firm figures', 7.5% to 'good estimates', 17.5% to 'rough estimates', and 40% to 'conjectures'. However, rather than the 95% confidence interval she used, we chose a 90% confidence interval. As a result, instead of dividing the margins of error by 2 to get the standard error, we divided the figure by 1.645.[116] This gave the errors for the different components of the stock of human capital. However, if the errors are derived independently, some errors will offset each other. As a consequence, the formula for the standard error of the whole, from the combined standard errors of the parts becomes: $\sigma_v = \sqrt{\sigma_x^2 + \sigma_y^2 + 2r_{xy}\sigma_x\sigma_y}$. In other words, if there is no relation between the two components *x* and *y*, the value of the correlation coefficient is 0 and the standard error is the average of the errors of the two

[115] A fourth test would be to place the stock of human capital in a growth regression. However, this will be the topic of the next two chapters.

[116] Given the relatively small samples, we might have to divide by a figure higher than 1.645. However, given the rough nature of these estimates and given that we already use a confidence interval of 90%, we decided not to correct for the small sample sizes.

Table 5.6: Subjective margins of error in the stock of human capital and some components for India, Indonesia and Japan for 1900-1950 and 1950-2000*

	Private and public expenditure on education	Gross fixed human capital formation	Stock
		Japan	
1900-1950	10.6%	19.9%	26.7%
1950-2000	7.2%	8.1%	14.7%
		India	
1900-1950	11.9%	29.3%	37.5%
1950-2000	10.6%	14.4%	43.4%
		Indonesia	
1900-1950	22.6%	22.4%	40.5%
1950-2000	12.6%	13.5%	32.5%

*90% probability.

components. But, if the correlation is positive, the standard error is larger, and if the correlation is negative the standard errors of the components offset each other. Clearly, it can be made far more complicated. However, it would be useless to make an elaborate estimation of the errors because these are also subject to error. The results of the errors of private and public expenditure are given in table 5.6. All fluctuate around 10%, except Indonesia in the 1900-1950 period. This is largely caused by the situation that we attached 40% unreliability to the estimates of private expenditure on education.

The second step is to estimate the margins of error for the gross fixed capital formation. We simply assumed that the surveys we used were ‘firm estimates’. For the period without surveys (the period before circa 1950) we used the extrapolated standard error of the single equation model to estimate the ‘non-private, non-government’ part of the GFHCF back to 1890. Again, summing the expenditure and the ‘non-government, non-private’ effect, and using the correlation coefficients, gave the subjective margins of error as reported in table 5.6 for the GFHCF. These errors are on average about 6 %. (percentage points) higher than those of the private and public expenditure.

For the stock we had to make some more modifications. Indeed, we took ‘firm estimates’ for the stock estimated on the basis of the household surveys. However, these are only for accumulating the several parts of human capital and not for the reliability of these parts themselves. For the underlying data (the gross fixed human capital formation) we took the estimated margins of error and multiplied them with 50 (the years a person remains in the stock of human capital). Again, we used the correlations to arrive at around 20% margin of error for Japan, and around 38% for India and Indonesia. This means for example for Japan that in 1900, when we estimated the stock of human capital to be around 162.4 billion in 1990 International USD, given our definition of human capital the actual stock must be with 90% probability around ± 26.7%, or between 119 and 205.8 billion USD.

Admittedly, these margins of error are large at a first glance. However, compared to most other calculations of historical series our series seem to perform quite well. This has three reasons. First, we set the initial margin of error for the components relatively high. One could easily argue that the components are more reliable, which would decrease the margins of error. Second, even large projects that have more data available may have large margins of error. For example Kuznets (1941, 501-537), for his GDP estimates, arrived at a margin of error of around 20%. Although probably an overestimation, because he did not take into account that the errors of the individual components might be partly uncorrelated which would reduce his margins of error, this figure is still high (Feinstein and Thomas 2001, 7). However, the point is that even the present day estimates suffer from large margins of error. Finally, we have to note that human capital is, contrary to many other time series, unobservable. This is likely to increase the margin of error as well. Given these developments, our series do not perform badly at all.

In sum, the results seem acceptable. For the private and public expenditure on education, we see that the margins of error decrease over time. The same is true for the gross fixed capital formation. In the latter variable, the margins of error are generally somewhat higher. This may be attributed to the situation that the 'non-government, non-private' effect has higher errors than the more visible private and public expenditure. Also for the estimated stock the margins of error decrease. The exception is India which shows a small increase of the error. Yet, this may be attributed largely to the increase in the 'non-government, non-private' effect which was especially strong in the period after 1950. Also we see that the margins of error are lower for Japan than for India and Indonesia. This is caused by the situation that the data for Japan are more reliable than for the other two countries.

5.3 A comparison of human capital and its components

A second step in evaluating the newly estimated stock of human capital is to look at its constituent parts. We chose to divide the stock of human capital into its main components, i.e. public expenditure, private expenditure, and the sum of the foregone wages and 'non-government, non-private effect'. The latter two are strongly interrelated as most of the 'home education' is caused by implicit foregone wages. Also, we decided not to split the 'non-government, non-private' effect into 'experience' and 'home education'. The main reason is that experience is difficult to separate from 'on the job training' and is small compared to 'home education'. Consequently, the bias for experience will be so large that it would not add much to the analysis.[117]

We start by assuming that the per capita depreciation figures are valid for 'government expenditure', 'private expenditure', and 'foregone wages'. The 'non-government, non-private' stock was calculated as the estimated stock of human capital minus the shares of the other parts of the stock. The main reason is that the informal component of human capital, which is what the 'non-government, non-private' effect mostly entails, may be subject to a higher depreciation (or a lower appreciation) than formal education because the latter is generally more intensive. The results are presented in table 5.7. We estimated a figure before and after 1950, because after 1950 the 'non-government, non-private effect' is more directly based on the estimations of the household surveys which is not the case before 1950. The findings below show a strongly different structure of human capital among the three countries.

We first notice that in Japan the percentage of government expenditure in the stock of human capital rises from 11% to 32%. Equally, there is a rise in the share of private expenditure. As a consequence, the final column, 'foregone wages and the "non-government, non-private part"' must decrease. However, if we look at these figures in absolute terms, we see that all categories increased, except the 'non-government, non-private part'. In other words, the decrease in 'non-government, non-private' effect was matched by a rise in formal education, reflected by a comparable increase in public and (to a lesser extent) private expenditure. Compared to Japan, India was on the other extreme. Although, just as in Japan, the share of government expenditure in the stock of

[117] However, for the interested reader: 'experience' plus 'on the job training' is calculated to be on average around 15% in the 1990s. There are also many other options to compare the estimated human capital. For example if we compare human capital by sex, we find that in 1993 for Japan these were 53,549 USD and 55,855 USD per capita for females and males respectively. In Indonesia and India these figures were much more skewed in favour of males. For example in 1993 in Indonesia these figures were 1,561 USD and 2,142 USD for females and males respectively.

Table 5.7: Percentage breakdown of the human capital stock for India, Indonesia and Japan before and after 1950*

	Government expenditure	Private expenditure	Foregone wages and 'non-government, non-private part'
		Japan	
1900-1950	10.8%	3.7%	85.5%
1950-2000	32.4%	14.2%	53.4%
		India	
1900-1950	24.6%	29.9%	45.5%
1950-2000	53.4%	23.4%	23.2%
		Indonesia	
1900-1950	23.7%	19.7%	56.6%
1950-2000	21.9%	11.6%	66.5%

* Under the assumption that the depreciation per age is the same for all forms of human capital. The 'non-government, non-private part' is calculated as 100% minus the rest. The reason is that it is likely that the others have about the same depreciation. However, depreciation is likely to be higher in the 'non-government, non-private part' meaning that if one would take the same depreciation for all, one would overestimate the share of 'non-government, non-private part'.

human capital increased strongly, this was accompanied by a decrease in private spending. The development of Indonesia is between that of India and Japan. Just as in India, we find that there is a reduction of the share of private spending in the stock of human capital. However, just as in Japan, we find a relatively high share of 'foregone wages and non-government, non-private effect'. This is largely caused by the increase in 'foregone wages'.

This pattern suggests, as we found in chapter 4, that most countries go through the same cycle. They start from a less developed state of formal education. In this phase the share of home education, on the job training and private education is large. This corresponds to the situation in India and Indonesia in the first half of the twentieth century. In the second phase, countries move towards the development of mass public education. This public education competes in first instance with private education. As most public education is free, households which used to spend money on private education can now use this money for other purposes. Hence, expenditure on private education declines relative to expenditure on public education (see also Tilak 1984) which is the case in India and Indonesia in the post-World War II period and in Japan in pre-War period. In the third phase, due to economic growth, there is an increasing demand for persons with secondary and higher education. As public expenditure on these levels of education only covers part of their total costs, households must contribute more to the costs of formal education. This corresponds to the post-War period in Japan.

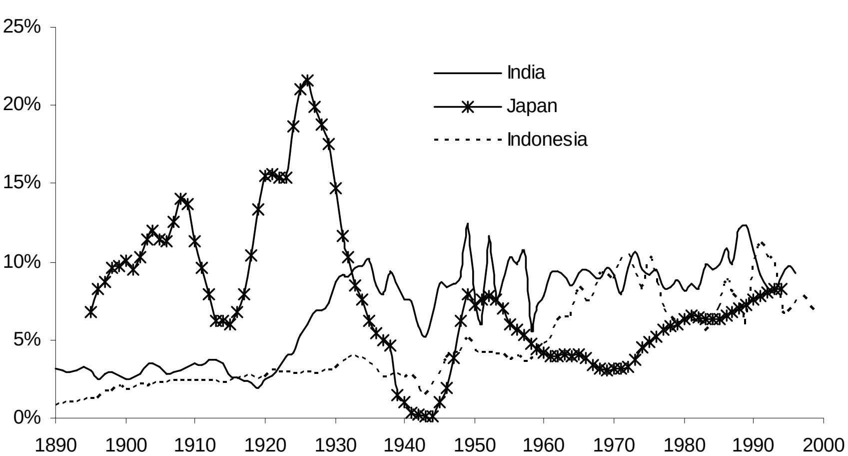
5.4 Some comparisons with GDP and physical capital

In this section we make some observations on the relation between our estimated human capital stock, GDP and the stock of physical capital. The latter two variables offer a consistent framework which we can use to test the plausibility of our estimates over time.

We presented the share of gross human capital formation (in current prices) in GDP in figure 5.4 below. However, there was a problem with the GDP we used. Normally, GDP consists of all forms of capital formation. However, current measures of GDP only include some parts of our human capital formation, most notably public and private expenditure on education. In other words, part of the estimated gross human capital formation is included in GDP, but a part is not. Therefore, we also included the remaining parts of human capital formation in GDP (see appendix A.13). Using this corrected GDP, we notice from figure 5.2 that the share of GHCF in GDP, with one

Figure 5.2

Share of gross human capital formation in human capital corrected GDP for India, Indonesia, and Japan, 1890 -2000 (based on current local prices)



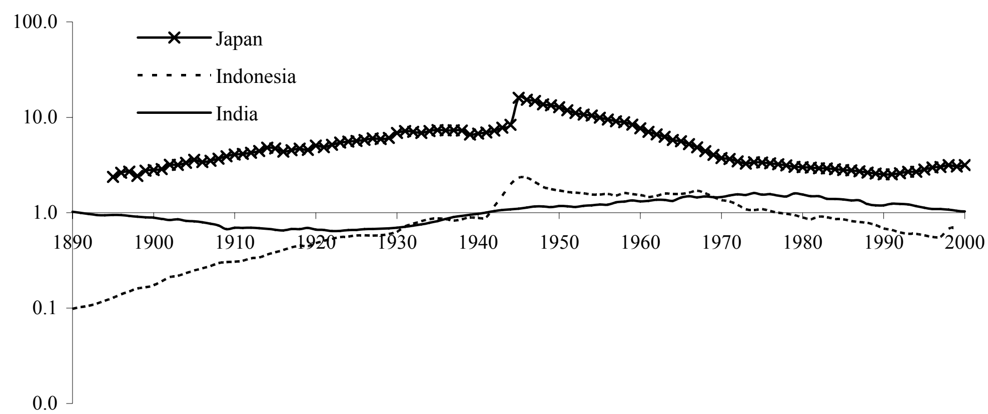
Source: Based on appendices A.9-11 and A.13.

small exception, never exceeds 20% of GDP, which is a likely figure. In addition, Japan clearly exceeds India and Indonesia, at least until the 1930s, in the share of human capital formation in GDP. But afterwards Japan's human capital formation as part of GDP is at, or below, the level of India and Indonesia. Given that Japan's stock of human capital remained well above that of India and Indonesia, this suggest that after gaining an initial lead in human capital, investments as part of GDP may decline while still retaining the lead.

In absolute figures, gross human capital formation in Japan exceeds that of India and Indonesia. This corresponds with Judson (2002, 217) who finds that richer countries have relatively more human capital than poorer ones. Indeed, if we look at the estimated human capital output ratio (see figure 5.3), this clearly is the case. Over the entire century, the human capital-output ratio for Japan exceeds that of India and Indonesia. Except for a peak around 1942, caused by a decline in GDP because of the start of World War II, the Japanese ratio is between 2 and 8. Indeed, this peak is for over 95% caused by a decline in GDP. In India and Indonesia the ratio remains fairly

Figure 5.3

Logarithm of the estimated human capital-output ratio for India, Indonesia, and Japan, 1890 -2000 (based on constant 1990 international USD, converted at PPP)



Source: Appendices A.2 and A.12.

constant at around 1. Just as in Japan, we notice a peak in Indonesia around 1942 which is also caused by the War. India, which was much less hard hit, does not exhibit such a peak in the ratio.

The ratios seem to be in a reasonable order of magnitude. Indeed, for the gross fixed non residential physical capital stock we find capital-output ratios of on average 1 for all three countries.[118] Therefore, especially when keeping in mind that adding residential capital may strongly increase the ratio, the human capital-output ratios do not seem to be implausible. The same is confirmed in some alternative studies on human capital present for Japan and India. For example, Panchamuki (1965, 310) found that the annual average increase in human capital formation was smaller than that of physical capital formation in India in the 1950s. The same development was also found by Gounden (1967, 356). We found that in India the growth of physical capital formation was also higher than that of human capital formation. This is contrary to the observed trends in the USA where human capital formation between 1900 and 1956 rose much stronger than physical capital formation. This seems to be true for developed countries in general, as the Ministry of Education (1963) (see also Dore 1964, 68), just as we did, recorded the same development for Japan.

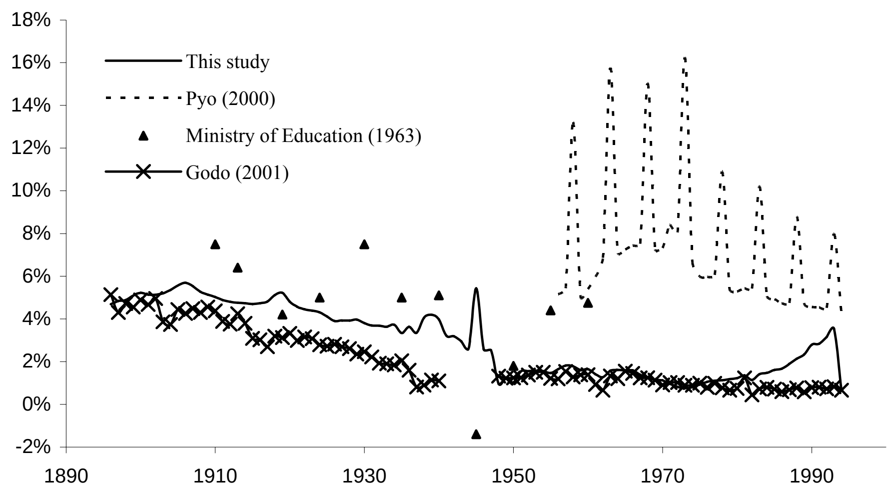
Thus in Japan before 1945, human capital was supposed to grow faster than physical capital while in India the opposite was true. Indeed, this is what we find in figure 5.5. Japan shows an increase in the ratio of human to physical capital up to 1945 while India experiences a small decrease. In Indonesia, however, the ratio remains about constant until the 1940s whereafter it starts to increase. The increase in the ratio of human to physical capital in the 1940-1950 period in Indonesia and Japan is largely caused by World War II which had a negative impact on the stock of physical capital.

However, in the second half of the twentieth century, both countries also experienced a fast decline in this ratio. An objection to this view is raised by Pyo and Jin (2000, 301) who argue that the ratio of human to physical capital in Japan increased in the period 1955-1996. However, their estimates of intangible human capital, based on the method proposed by Kendrick (1976), show implausible growth rates of close to 8 percent on average over the post-War period. The Kendrick method is cost- based, which means that it is largely based on educational expenditure. Yet, we expect that 'true' human capital growth rates must be between measures of the quality of education, which are largely based on educational expenditure (Ministry of Education 1963; Pyo and Jin 2000), and of the of the quantity of education which are largely based on

[118] India exceeds Indonesia and Japan slightly in this respect.

Figure 5.4

A comparison of the growth rates of per capita stock of human capital in Japan, 1895-2000, all monetary variables are based on constant 1990 international USD, converted at PPP



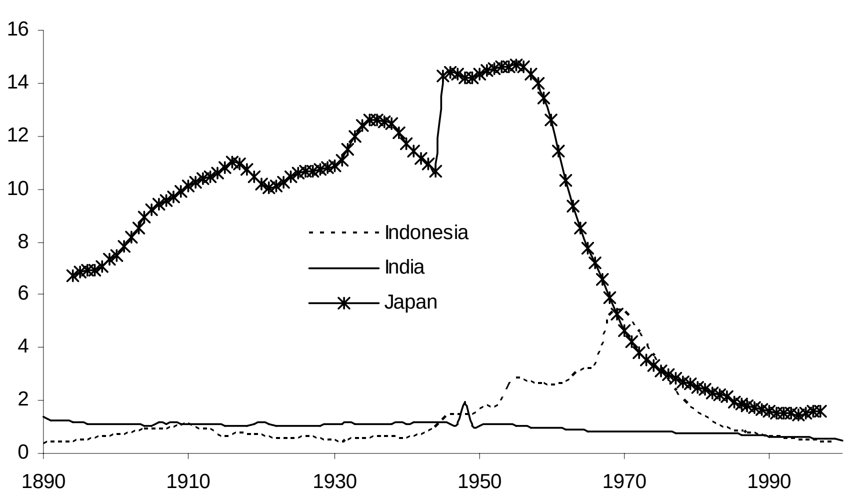
Note: The growth rates of the Ministry of Education (1963) are annualized growth rates based on five- yearly averages

'average years of education' (Godo 2001) (see figure 5.4).

Indeed, Indonesia and Japan started to experience after 1950/1960 a faster

Figure 5.5

Estimated human capital stock-gross fixed non-residential physical capital stock ratio for India, Indonesia, and Japan, 1890 -2000 (based on constant 1990 international USD, converted at PPP)



Source: Appendices A.2 and A.12.

growth of physical compared to human capital (see figure 5.5). This development was not present in India. This is not surprising as India had over the entire twentieth century the highest physical capital-output ratio. In addition, the War harmed the physical capital much more in the former two countries than it did in India. They thus had a relatively small stock of physical capital after World War II, the American occupationand the Dutch police actions respectively.

6. CONCLUSION

This chapter was intended to give a description and analysis of the estimated stock of human capital that we use for our analyses in the next chapters. Our objective was to correct some of the problems with which most human capital proxies are associated. However, we are aware that this alternative human capital stock is also an approximation. Although we hope that it follows the historical development of human capital, it still remains far from perfect.

With these limitations in mind, we constructed an alternative stock of human capital, a human capital stock that solely indicates direct expenditure on human capital (Expenditure HC), and 'average years of education', the latter as given in chapter 3. From our estimates of the alternative human capital stock we can draw two important conclusions. First, it seems that human capital appreciates. To be more specific, if one looks at the human capital of an individual (thus without taking account of mortality), it has an appreciation of around 4.6% for human capital in Japan. In Indonesia and India, this figure is even higher. If we look at the stock of human capital, we see that its appreciation/depreciation is low in all three countries.[119] We estimated that in the 1990s the yearly appreciation in Japan was 0.8%, in India 2.6%, and in Indonesia 3%. These low figures, compared to the much higher depreciation figures of physical capital, are not surprising given that some aspects of human capital appreciate while others depreciate. Second, the growth of the newly estimated per capita stock of human capital is relatively slow at the start and end of the century. The growth increased in the mid-twentieth century. This causes a perfectly logistic curve which is found in many growth studies for social and economic variables.

[119] The yearly appreciation/depreciation is also presented in appendix A.12.

This alone already shows that the newly estimated stock seems to be a reasonably good indicator of human capital. The same follows when we look at some alternative indications of its plausibility. There are three possible indications, namely the subjective margins of error of the data, the division of the stock of human capital in its constituent shares, and a comparison with GDP and physical capital.

First, the subjective margins of error are around 30% for the estimated stocks of human capital. Although this seems large, we have to keep in mind that we are estimating an unobserved variable, a situation which may strongly increase the error. Also, even variables that can be observed directly, like GDP, may suffer from large errors. Furthermore, we find that generally the reliability rises over time and that the reliability for Japan is higher than that for India and Indonesia, which is what we expected to find.

The second method of analysing the stock of human capital was to look at its constituent parts. We found the pattern we have also noted in chapter 4: Japan knew a strong increase in private education which, with a strong rise in public education, compensated for the decrease of the combined share of foregone wages and the 'non-government, non-private' effect in the newly estimated stock of human capital. In India and Indonesia, however, the share of private expenditure decreased. This shows that in developing economies, the rise in public expenditure was nullified by the decrease in private expenditure and 'home education'. Yet, in the latter aspect Indonesia differed from India. The combined share in the stock of human capital of foregone wages and the 'non-government, non-private' effect was in Indonesia much larger than in India.

The third method tries to relate the human capital stock to both GDP and the stock of physical capital. We found that the share of gross human capital formation in GDP was plausible for all three countries, never exceeding 20%. The human capital-output ratio was on average higher than the physical capital-output ratio. Yet, this is partly because we used the gross fixed non-residential physical capital stock, thus excluding residential capital. Including residential capital may lower the human-physical capital ratio considerably.

6. Is Lucas right? On the role of human capital in growth theory

1. INTRODUCTION

In the previous chapters we laid the basis for analysing the applicability of the different growth theories in explaining economic growth. Here we will use the historical analysis and the newly constructed data to distinguish between the different growth models. The outcome has important consequences for the more detailed analysis of economic growth. Not only is it important for the empirical specification, but it also determines the effect institutions have. However, it is only in the next chapter that we will use the growth model, the data, and the historical interpretation to analyse the growth process more thoroughly.

In this chapter we try to distinguish between the new growth models. Basically, two branches have developed, pioneered by Romer (1990) and Lucas (1988). Empirically, the difference between the two groups of theories is that endogenous growth in the theory of Romer (1990) is caused by accumulating technology (or knowledge), thereby establishing a relation between the level of human capital and economic growth. In this vision, human capital is seen as ‘knowledge’ and ‘ideas’ that are non-rival and partly excludable. In the theory of Lucas it is the human capital formation itself that, by non-decreasing marginal returns, creates endogenous growth. In short, to achieve endogenous growth, the effort needed to produce an extra unit of human capital should be the same, independently of the level of human capital. This assumption has been much debated. A possible explanation can be that persons with higher levels of education more easily receive extra knowledge or skills. However, there are other choices like a rising quality of human capital over time and increasing intergenerational transfers of knowledge (L’Angevin and Laïb 2005). In the currently used proxies of human capital, these qualitative causes are rarely accounted for and hence empirical results are biased towards the model of Romer (1990) (see for example Sianesi and Van Reenen 2003, 164). This model thus sees human capital as a factor of production and, consequently, values human capital as ‘skills’ that are to some extent rival and excludable, that is they are part of a physical person.

Yet, the regressions based on these models, as argued by Kibritcioglu and Dibooglu (2001, 12-13), are often “difficult to interpret, unstable, and lack a coherent social science perspective.” The difficulties in estimating and interpreting these regressions, on which Kibritcioglu and Dibooglu (2001) based their (too) strong attack, result from obstacles in empirically distinguishing between the different growth theories. A first obstacle is that current human capital proxies used to estimate the new growth models are often unsuited to distinguish between the different theories. Second, the implications of the different growth theories are much alike making a distinction between them even harder. For example, both theories imply an absence of conditional economic convergence. Third, the model of Romer (1990) is based on technological growth (that depends on the level of human capital), whereas the model of Lucas is based on human capital accumulation (the growth of human capital determines the growth of the economy). But Lucas (1988) did not state through what channels capital accumulation causes endogenous growth. This could well be by easier adaptation of technologies from technological frontier countries meaning that both theories lead to endogenous growth by technological growth. Fourth, it is possible the Lucas (1988) model is just an earlier stage in a development toward the Romer (1990) model. Because the Lucas (1988) model is based on constant marginal returns to human capital accumulation, it is unlikely that Lucasian growth can last indefinitely. As Romer (1990) based his model on the technological frontier country (the USA), it might be possible that endogenous growth moves from Lucasian to Romerian growth when a country approaches the technological frontier.

It is thus likely there are institutional settings both in forming human capital and adopting technologies that cause the growth rate of economies to differ. This is especially visible in India, Indonesia and Japan which were subject to exogenous influences both in technology and human capital development. But, whereas Japan is an example of a successful developer, India and Indonesia lagged behind. The next sections address the differences among these countries. In section 2-4 we use several tests to distinguish between the different growth models. In section 2 we present the human capital:output ratio. Alternatively, in section 3 we test for constant marginal returns to human capital accumulation, a characteristic of Lucasian growth. In section 4 we turn to the relation between per capita GDP growth and, on the other hand, the level and growth of human capital. In section 5 we turn the relation upside down and use the growth theories to explain the difference between the human capital variables. In section 6 we end with a brief conclusion.

2. HUMAN AND PHYSICAL CAPITAL RATIO

It is difficult to distinguish the different growth theories. Yet, because we estimated a new human capital stock in the previous chapter, this allows us to exploit the different predictions of the growth of GDP, physical, and human capital. As we have seen in chapter 2, both the Lucasian and Romerian model predict the growth of GDP and physical capital to be equal on a balanced growth path. However, the model of Lucas predicts that the growth of human capital is almost equal or (due to the positive external effect) slightly lower than that of physical capital and GDP, i.e.

$$\frac{\dot{y}}{y} = \frac{\dot{k}}{k} = \frac{1-\alpha+\gamma}{1-\alpha} B\left(1-u\right) = \frac{1-\alpha+\gamma}{1-\alpha} \cdot \frac{\dot{h}}{h} \qquad (6.1)$$

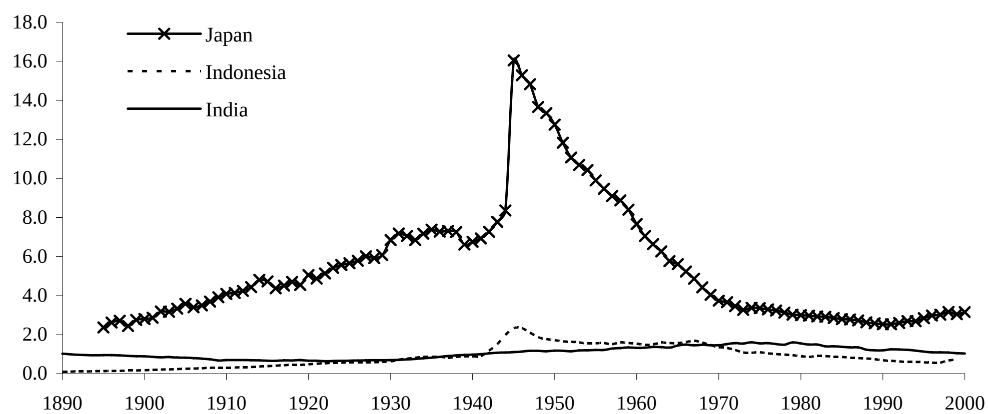
In the Romer (1990) model, however, human capital grows considerably slower than physical capital and GDP:

$$g = \dot{Y}/Y = \dot{K}/K = \dot{A}/A = \sigma H_A \qquad (6.2)$$

In other words, if we find an almost constant ratio between human- and physical capital, or between human capital and GDP, than Lucasian growth dominates. If we find that the human capital:physical capital or human capital:GDP ratio declines markedly, Romerian growth dominates.

In chapter 5 (figure 5.5) we plotted the human-physical capital ratio. We can see that this ratio is almost constant in Indonesia and India. In Japan it increases slightly up to 1950 and decreases afterwards. The increase in the ratio in Indonesia around 1970

Figure 6.1
Human capital:output ratio (based on constant 1990 international USD, converted at PPP)



Source: Appendix A.2 and A.12.

was caused by a decline in physical capital investments, which was independent of GDP. This can be seen in figure 6.1. As the physical capital: output ratio is almost constant in all three countries (hence assuming a balanced growth path), the decline in the human capital:output ratio in Indonesia in the 1970s suggests that the relatively slower growth of physical capital must have been independent of GDP. Equally, the peak in the human capital:output ratio in Japan was caused by a fall in GDP during World War II. Yet, over-all the human capital:output ratio shows about the same pattern as the human:physical capital ratio. This suggests that the growth rates of per capita GDP and physical- and human capital are more or less in correspondence (Lucasian growth). The exception is Japan in the second half of the century, when the growth of human capital was considerably lower (Romerian growth).

3. MARGINAL RETURNS TO HUMAN CAPITAL ACCUMULATION

3.1 Introduction

A second distinctive feature of the theory of Lucas (1988) is that human capital is viewed as a factor of production. In this model, there are two sectors. In the first (productive) sector, human and physical capital is used to create income (or goods). In the second sector only human capital is used to produce human capital which can be employed in the productive (first) or in the human capital producing (second) sector.[120] If there is to be endogenous growth, it has to come from constant or increasing marginal returns to human capital accumulation. These constant or increasing marginal returns can exist in the second sector, where human capital is used as an input to form human capital. If in this second sector there are decreasing returns (the higher the level of human capital employed in this sector, the smaller impact it will have on human capital formation) the system approaches a steady state level of output and zero growth.

If there are constant or increasing returns in the second sector, there is endogenous growth[121] and the Lucas-Uzawa model (Lucas 1988; Uzawa 1965) may be applicable to economic development. This model can be applied even if there are decreasing returns in the second sector. In the last century the time spent on human capital accumulation ((1-u), see equation (6.3)) grew steadily, sometimes at an explosive rate, almost everywhere in the world. Even with diminishing returns, this may

[120] In Rebelo's (1991) model physical capital is employed in the second sector as well.
[121] In other words, if the growth rate of the human capital that is formed in the second sector does not depend on the level of human capital employed (constant returns), there is endogenous growth.

have led to an increased growth rate. We will therefore test whether constant or increasing marginal returns are present in the second sector and, if decreasing returns are present, if there still is Lucasian growth.

We start with the standard equation in which per capita human capital formation takes place with human capital as an input. If an increase in the stock of human capital requires an identical effort no matter whatever level previously attained (non-decreasing marginal returns), and assuming constant returns to scale:

$$\dot{h}c_t = h_t B\left(1-u_t\right)-\delta h_t \tag{6.3}$$

, where $\dot{h}$ is the increase of per capita human capital, and δ is its depreciation. Further, $B(1-u_t)$ indicates human capital accumulation. In other words, B is a technical parameter indicating factors that influence the efficiency of investment in human capital and $(1-u_t)$ is the time spent on human capital accumulation. We can rewrite equation (6.3) independent of its level:

$$\dot{h}_t / h_t = g_h = B\left(1-u_t\right)-\delta \tag{6.4}$$

In other words, we have to estimate a regression in which the growth of the per capita human capital stock is regressed on the time spent on acquiring human capital (here assumed to be 'average years of schooling') and a constant (capturing depreciation).

In sum, there might be a connection between the growth of per capita human capital and the time spent on human capital formation. If B is positive, constant or increasing marginal returns are present.[122] Yet, whether this relation is stable or even constant, is questionable. Thus we start with plotting this relation over time. Then, we move on to a regression analysis.

3.2 The relation between the growth of human capital and time spent on human capital formation

One has to be aware of a drawback of the above method.[123] It assumes constant marginal returns. Without constant marginal returns, equation (6.4) must be written as:

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[122] In this specification it is not possible that *B* is negative because we argue that 1-u increases the stock of human capital. *B* must be positive for this.

[123] Another drawback is that we used a human capital variables expressed in monetary units. However, Lucas used a multiplier, basically indicating how much one unit of labour in 1900 would be in, for example, 1990. In this respect, the use of attainment or 'average years of education' as a human capital proxy comes closer to this multiplier. Yet, this would create other problems. First, above equations cannot be estimated as we lack a proxy for the time spent on human capital accumulation. Second, if we use 'average years of education' in a growth regression not only must we use the level instead of the

$$\dot{h}_t / h_t = g_h = B(1-u_t)^{\beta} h_t^{\beta-1} - \delta \tag{6.5}$$

, where $\beta > 1$ gives increasing returns, $\beta < 1$ diminishing returns, and $\beta = 1$ constant returns. This means that one can estimate (6.3) (without depreciation) as:

$$\Delta \ln h_t = \ln B + \beta \ln(1-u_t) + (1-\beta) \ln h_t \tag{6.6}$$

Here, *1-u* is proxied by 'average years of education'. If $\beta = 1$, or $(\beta - 1) = 0$, there are constant marginal returns. Yet, Lucas' model is a theoretical construction. Therefore, it might be difficult to assume that non-linearities are captured by a double-log equation. Constant returns can also emerge with other specifications. Therefore, we prefer to use the more general scatterplots (figure 6.2-6.4).

As pointed out, constant or increasing marginal returns to human capital accumulation mean that if the time spent on education rises by the same unit, the growth of the stock of per capita human capital remains the same, or rises. In other words, in equation (6.4) the *B* is positive. This is made visible in figures 6.2-6.4 below. These figures plot on the horizontal axis 'average years of schooling', (*1-u*), and on the vertical axis the growth rate of the per capita human capital stock ($\dot{h}_t / h_t$). They thus show the development of *B* over time, assuming depreciation constant.

However, as Monteils (2002) assumes, following Lucas (1988) that *B* is constant, this means that if the coefficient *B* of equation 6.4 decreases, this is because the relation between (1-u) and the growth of human capital is non-linear. In other words, if she finds a negative coefficient, this cannot be caused by decreasing efficiency (*B*) as this was assumed constant, thus it must be caused by the situation that $\beta < 1$, i.e. diminishing marginal returns. Equally, a positive coefficient would mean that $\beta > 1$, thus suggesting increasing marginal returns. Following the line of reasoning of Monteils (2002), we may infer that if the trend in figures 6.2-6.4 is downwards, there are decreasing marginal returns, if it is upward, there are increasing marginal returns, and if the relation in insignificant (a horizontal line), there are constant marginal returns to an investment in human capital.

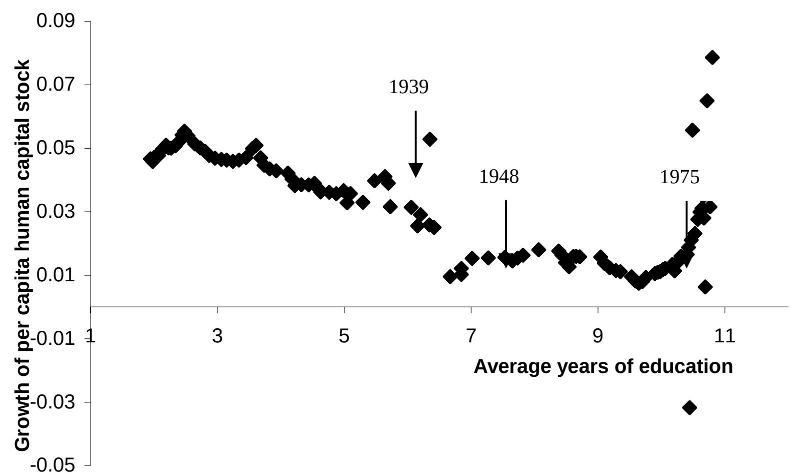
growth rate in the Lucas theory (as it indicates the time spent on human capital accumulation) but also the coefficient would be equal to $\beta \cdot B \cdot \lambda$, where we used λ to distinguish the factor share of human capital from the factor indicating the presence of constant marginal returns to human capital accumulation. As the factor share is likely to be around 0.3-0.6 and both β and B are likely to be on occasion smaller than 1, this might be one of the reasons why in the literature often a small coefficient (factor share) for the growth of human capital is found. For these reasons we prefer to use a human capital stock in monetary terms.

The figures show a remarkable pattern. Figure 6.2, for Japan, shows an almost constant relation until around 5.6 years of education and a fast declining trend between 5.6 and 6.7 years of education in the population. As we move forward in time, the ‘average years of education’ also rises. So, this figure displays a development where 5.6 years of education corresponds to circa 1939 and 6.7 years to 1948. After 1975 there is a clear upward trend.

The same pattern can be found in figures 6.3 and 6.4 for Indonesia and India. For Indonesia we find a decreasing trend until around 1957, a flat line between 1957 and 1987 and a strong increase afterwards. In India we found a rising trend until 1953, a declining trend from 1953 to 1981, and an increase from 1981 to 1997.[124] All three

Figure 6.2

Relation between average duration of training and growth rate of the per capita human capital stock in Japan

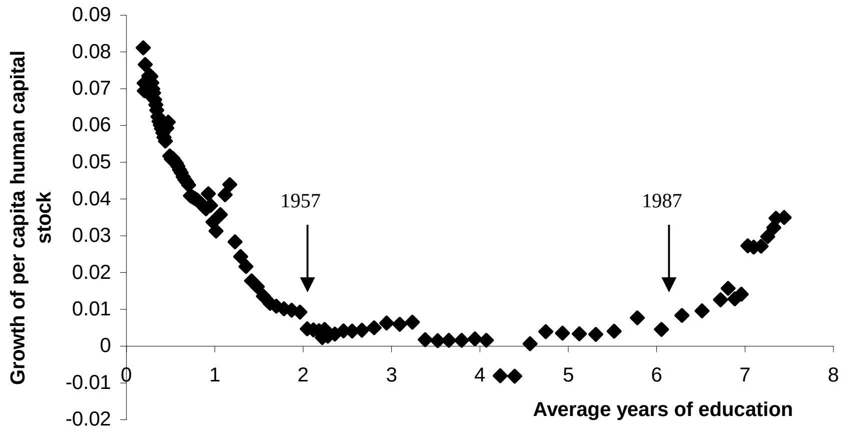


Source: Appendix A.7 and A.12

[124] It is likely that this different pattern for India is the result of the focus on secondary and higher education at the start of the twentieth century.

Figure 6.3

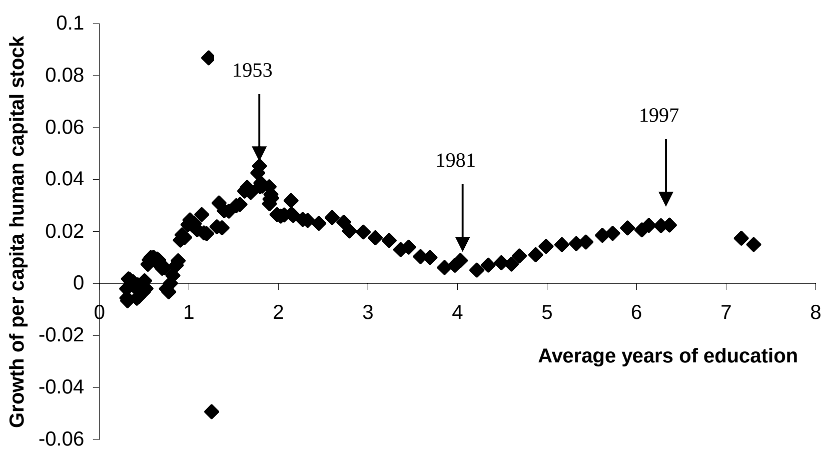
Relation between average duration of training and growth rate of the per capita human capital stock in Indonesia



Source: Appendix A.7 and A.12

Figure 643

Relation between average duration of training and growth rate of the per capita human capital stock in India



Source: Appendix A.7 and A.12

countries thus show periods of decreasing, constant, and rising trends in *B*.[125] This means that in all three countries there are periods of increasing, decreasing, and constant marginal returns to human capital accumulation.

3.3 Regression analyses

The results so far thus indicate that there are at least periods of Lucasian growth in all three countries. However, as pointed out, non-linearities in the relation between 'average years of education' and the growth of human capital may also have other causes than the presence of constant or decreasing marginal returns. One reason may be that the efficiency of human capital accumulation, *B*, is not constant over time. To provide a brief interpretation, we extend the method proposed by Monteils (2002) to capture these non-linearities. This is a simple method with many drawbacks, but, although not providing definitive proof, it shows that it is important to keep account of the efficiency of human capital accumulation.

We start, following Monteils (2002), by estimating equation (6.4). Using this equation, Monteils found strong evidence in favour of decreasing marginal returns to human capital in France. Yet, there are two problems with her findings. First, as indicated in the previous section, she assumes the efficiency of human capital accumulation (*B)* constant. This is a strong assumption as it is often argued in the literature that, especially for less developed countries, there was a decreasing efficiency of human capital accumulation in the decades after World War II (Stewart 1996, 332; Van der Kroef 1960). Second, she uses illiteracy as a measure of human capital. Illiteracy does not pick up the complete effect of human capital, especially not for periods when the process of increasing mass education had been completed and was replaced by increasing secondary and higher education. Consequently, using illiteracy data in such an analysis, one is bound to find decreasing marginal returns to human capital accumulation.

[125] Although this is an assumption which we cannot test here, we expect that the pattern of decreasing and later increasing marginal returns to human capital formation can be detected in most developing countries in the twentieth century. The reason is that they start with mass education in the first half of the twentieth century with generally low financial means, low quality of education, and a strong substitution of non-formal for formal education. The actual growth of the stock of human capital is thus far lower than the rise in 'average years of education'. This is different in the 1960s-1980s when those countries as well as foreign institutions strongly invested in education. Furthermore, most substitution of non-formal into formal education had by then already taken place.

Using this regression method, table 6.1 reports for India and Japan a negative coefficient of ‘average years of schooling’ (the first regression for each country). Indeed, if we would draw a trend line through figures 6.2-6.4, we would find a decreasing trend (and therefore decreasing marginal returns). However, it does not decline as fast as Monteils finds for France. In addition, we even find a positive coefficient for Indonesia. Therefore, it is clear that our results differ from those of Monteils (2002) mainly because we estimated a new human capital stock that includes

Table 6.1: Estimation of the marginal returns to human capital accumulation*

EXPLAINED VARIABLE, $\Delta ln h_t$: Growth of human capital stock

	Japan				Indonesia				India			
	(1)		(2)		(1)		(2)		(1)		(2)	
	Coefficient	t-value	Coefficient	t-value	Coefficient	t-value	Coefficient	t-value	Coefficient	t-value	Coefficient	t-value
Duration of training	-0.020	-11.3	-0.028	-16.1	0.011	13.9	-0.016	-8.81	-0.010	-8.55	-0.040	-8.05
Squared duration of training			0.001	7.71			0.003	15.2			0.003	6.22
R^2	0.87		0.92		0.92		0.97		0.71		0.79	

*The dummies, constant (picking up depreciation), and trend are not reported

aspects such as the quality of human capital, thus making the existence of constant or increasing marginal returns more likely.

The results of these regression analyses are thus more in accordance with the existence of constant or increasing marginal returns. This provides some evidence against the literature that criticizes the assumption of constant marginal returns (see for example Gong, Greiner, and Semmler 2004; Monteils 2002). Indeed, many other authors have argued there are good arguments for assuming constant marginal returns (Bratti and Bucci 2003; Glaeser 1994). However, we can bring this one step further as even the finding of periods with decreasing, increasing, and constant marginal returns is subject to a problem. As pointed out, it assumes the efficiency of human capital accumulation, *B*, to be constant. Indeed, it has even been brought forward that the apparent decrease in marginal returns is actually caused by a decrease in efficiency (*B*) of the second sector (the sector in which human capital is formed). For example Földvári and Van Leeuwen (2006) argue that *B* may change, and there might be non-constant returns simultaneously. So with a 2nd order polynomial, one captures the latter directly. [126]

To capture this effect, we estimated an alternative specification, including 'average years of schooling' squared as suggested by Földvári and Van Leeuwen (2006). The results are presented in table 6.1 (the second regression for each country). The interpretation is simple. Taking the marginal product results in the situation that only the coefficient of 'average years of schooling' squared indicates the relation between the time devoted to human capital accumulation and human capital formation. Only if this is positive and significant, there are increasing returns.[127] Table 6.1 shows that for all three countries these coefficient are positive and significant which shows that, without the possible inefficiency, Lucasian growth would be present in all three countries.

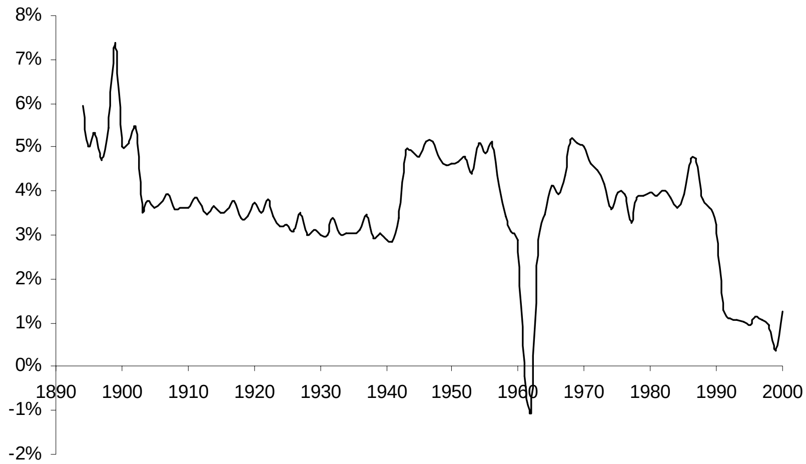
However, the estimated model is of course much too simple. Therefore, the question remains whether technical efficiency of the second sector indeed decreases in the mid-twentieth century. Looking at figures 6.2-6.4, it is difficult to escape the idea that technical inefficiency in the second sector plays an important role in all three countries. In Indonesia, the strongest decline occurred in the period up to 1957 while in India the decline only started after the Second World War. For both countries these years marked periods of increasing mass education. Hence, given the periodization of the peaks and troughs, we expect that a decline in *B* is caused by a shift from mass education to a focus on secondary education as all troughs (except for Japan which

[126] Admittedly, rewriting this into equation 6.2 gives strange results. However, empirically this is the easiest way to solve the problem. If Lucas's assumption of constant returns in the second sector holds, the marginal effect of *(1-u)* on the growth of the human capital stock equals *B*. Monteils (2002) estimates the equation $\Delta ln\, h = B(1-u)$, and argues that if *B* decreases while *(1-u)* grows, there must be decreasing returns, i.e. no endogenous growth. However, this is only true if the only factor that influences the marginal effect of *(1-u)* on the growth of human capital has decreasing returns. This becomes different if we allow for a 'technical efficiency' (productive efficiency in the second sector). Therefore, when we use $B(1-u)+a(1-u)^2$, the marginal effect of *(1-u)* on the growth of human capital becomes $B+2a(1-u)$. Thereby we decompose the observed marginal effect into two parts: an effect not directly dependent on *(1-u)*, denoted by *B* (technical efficiency), and a part which directly depends on the level of (1-u) denoted by 2*a* (marginal returns). If 2*a* is positive and significant, the larger level of (1-u) leads to increasing growth of the human capital stock, i.e. increasing returns (endogenous growth). If 2*a* is negative and significant there are decreasing returns (thus no endogenous growth, at least not without positive external effects) and, if 2*a* is insignificant, there are constant returns (thus Lucas' assumption holds and this results in endogenous growth).

[127] As we take the marginal product of a squared variable, we have to multiply the coefficient with 2 in order to get the actual effect of time on human capital formation. However, this does not change the finding of the sign or significance of the coefficient.

Figure 6.5

Growth of average years of education in Indonesia, 1890-2000



Source: Appendix A.7

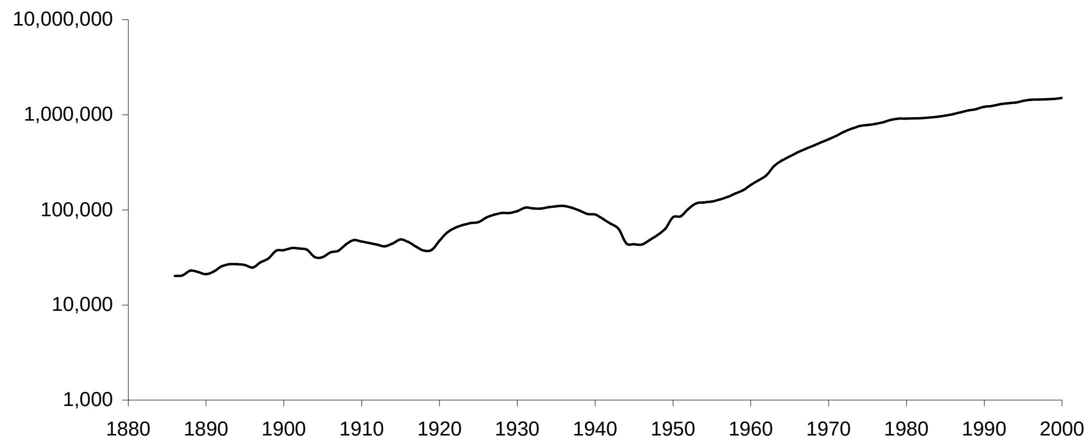
developed its education system earlier) signal periods of slower growth of education levels. This can clearly be seen in Indonesia in figure 6.5.[128] Comparing figure 6.5 with 6.3, we see that for the period 1940-1990 there was a fast increase in average years of education combined with an increase in technical efficiency while in the pre-1940 period there was a slower increase in mass education combined with a decrease in technical efficiency.

This increase in technical efficiency may also be partly caused by a decrease in per capita spending on education that took place in that period. The average per student expenditure on education in 1990 rupiah decreased from 156,000 in the 1930s to 28,000 in the 1950s after which it slowly increased again. The same patterns can also be found in India where per student public and private expenditure decreased from 875 constant 1990 Rupee per student in the 1930s to 569 Rupee in the 1940s. Hence, in India and Indonesia periods of fast growth of average years of education, combined with a decrease in per capita spending on education, coincided to a large extent with periods with decreasing technical efficiency in the human capital forming sector. In Japan, however, the faster growth of 'average years of schooling' had already taken place before 1950 (2.3% versus 0.8%). Equally, in Japan there was no significant decline in

[128] Here, the dip in the growth of 'average years of schooling' is mainly caused by the turmoil surrounding the coup against Sukarno in the early 1960s. During this periods, many secondary schools where closed.

Figure 6.6

Log of the sum of per student private and public expenditure on education in constant 1990 yen in Japan, 1886-2000



Source: Appendix A.8

per student expenditure on education. As figure 6.6 shows, both before 1936 and after 1945 there was an increase in per student expenditure, with a temporary decrease during World War II. Thus whereas in India and Indonesia the decreasing marginal returns may be attributed to decreasing technical efficiency in human capital accumulation as signalled by lower growth in average years of education and higher per student expenditure on education, this was not the case in Japan.

The analysis in this section suggests three things. First, in India and Indonesia, during a period in which the strong rise of formal education took place (and per capita expenditure on education decreased), it is likely the technical efficiency of human capital accumulation, *B*, increased. When formal education declined and the per capita expenditure on education increased, *B* was likely to decline. Using the model of Monteils (2002), this can result in falsely rejecting the presence of constant marginal returns. Second, it remains unclear, however, if the correction for the increase in technical inefficiency is enough to correct for diminishing marginal returns caused by a decline in the quality of human capital. Nevertheless, whether or not diminishing returns are present in India and Indonesia in this period, Lucasian growth remains present as, as we noted in section 3, the time devoted to human capital accumulation increased strongly during this period thus creating economic growth.[129] This increase in the time devoted to human capital accumulation, even without constant marginal returns, can be argued to be an engine of endogenous growth although this growth asymptotically approaches zero. Third, neither an increase in the growth of 'average years of schooling' nor a decline in per student expenditure on education took place in Japan during this period. As a decreasing technical efficiency of human capital accumulation cannot explain the diminishing marginal returns in the second half of the twentieth century, combined with an accelerating economic growth, this means that no Lucasian growth was present. Or, as we will see in the next section, where in India and Indonesia the level of our newly estimated human capital stock, which includes both the quantity (average years of schooling) and the quality (expenditure on education) of human capital, will not significantly be correlated with per capita GDP growth, this relation is likely to be positive and significant in Japan.

4. LEVEL AND GROWTH EFFECTS OF HUMAN CAPITAL

4.1 Introduction

So far, we have found some evidence which favours the theory of Lucas (1988) as an explanation of the effect human capital has on economic growth, at least for India and Indonesia. In Japan, however, after the 1940s, the diminishing marginal returns to human capital accumulation could not be explained by inefficiency in human capital accumulation or a decrease in quality of human capital. Yet, there is a third distinction between the Lucas-Uzawa and Romer models.[130] As pointed out in chapter 2, Romer (1990) views human capital as an input in the R&D sector, thus creating technological change. So, the level of human capital determines the rate of growth; it is not a factor of production. Lucas (1988), on the other hand, sees human capital as a factor of production, limited to the individual who possesses it (human capital is rival and excludable) (Barro and Sala-i-Martin 2004). In other words, the growth of human capital causes economic growth.

[129] One could also argue that these are periods of Solowian growth.

[130] Another way to distinguish growth theories is to insert initial GDP in the equation to test for convergence. If the coefficient on initial GDP is negative, countries with a higher level of GDP show less economic growth, i.e. there is convergence. In theory only the neo-classical growth model exhibit convergence. Therefore, this method is used in many studies as a test for the presence of endogenous growth. However, also the neo-classical theory can sustain divergent economic development, for example if countries have changing adaptation and absorption capabilities of technology. Equally, the new growth theories have recently be argued to be able to also capture convergence.

Empirically we can test the difference between the two theories by regressing the per capita GDP growth on the level and the growth of the per capita stock of human capital. If the model of Romer is correct, we expect to find a positive and significant effect of the level of human capital on the growth of per capita GDP (see equation 6.2). But, if Lucas is correct, we expect to find a positive and significant effect of the growth of human capital on economic growth (see equation 6.1). Of course, these two theories are not mutually exclusive.[131]

4.2 Unit-roots and cointegration

If we want to test whether the level (Romer) or the growth (Lucas) of human capital in the long run affects economic growth, we first have to determine if both variables are stationary. If they are not, for example if they are trending upwards, regression analysis is likely to find a relation where in fact none exist. The only exception is if there is a steady long-run relationship between two non-stationary variables, hence the residual of the regression is stationary. In other words, if there is cointegration.

There are two options. First, the log-level of per capita human capital and GDP are both first order integrated, I(1). In this case, and if they are also cointegrated, Lucasian growth is likely.[132] Second, if the log-level of per capita GDP is one order more integrated than the log level of per capita human capital (for example I(1) and I(0) or I(2) and I(1)). In that case, there is a long-run relationship between the growth of GDP and the log-level of human capital, hence Romerian growth.[133]

The results of the (augmented) Dickey-Fuller test for the presence of stationarity are presented in table 6.2 and 6.3 below. We included a trend a constant and estimated it before 1940 and after 1950 in order to avoid data problems caused by World War II. Not surprisingly, stationarity is rejected for all level variables. To determine the

[131] It is worth noting that Romer (1990) included human capital also as a factor of production in his specification. Therefore, in itself, the finding of a positive and significant coefficient of the growth of human capital is not enough to dismiss the Romer model. Yet, given our previous discussion on marginal returns and given our finding (see table 6.2-6.4) of the long-run effects between human capital and growth, we think that we might interpret these regressions as a test between the Romer (1990) and Lucas (1988) models.

[132] Please note that the equation $\Delta \ln y_t = \alpha + \beta \Delta \ln h_t + \varepsilon_t$ is equal to $\ln y_t = \alpha + \beta \ln h_t + \varepsilon_t$ if there are no breakpoints.

[133] Please note that we excluded physical capital. As in both the theories of Romer and Lucas also include physical capital, this may lead to an omitted variable bias which may bias the estimates of the presence of cointegration.

Table 6.2: (Augmented) Dickey-Fuller test for India, Indonesia, and Japan, 1890-2000 (I(0))

Unit-root null hypothesis: $\rho = 1$.

		India		Indonesia		Japan	
		$ln\,h_t$	$ln\,y_t$	$ln\,h_t$	$ln\,y_t$	$ln\,h_t$	$ln\,y_t$
±1890-1940	Sample size	29	29	37	41	31**	44**
	Lag order	4	1	5	1	11	2
	Estimated value of $\rho - 1$	-0.016	-0.084	0.001	-0.330	-0.006	-0.011
	Test statistic: tau_c(1)	-0.535	-1.213	0.063	-3.010	-2.369	-0.324
	Asymptotic p-value	0.982	0.907	0.997	0.129	0.151	0.919
±1950-2000	Sample size	26	26	21	21	36	36
	Lag order	1	0	1	3	1	1
	Estimated value of $\rho - 1$	-0.007	-0.769	-0.062	-0.388	-0.028	-0.035
	Test statistic: tau_c(1)	-0.484	-2.788	-0.642	-2.989	-1.370	-1.225
	Asymptotic p-value	0.984	0.214	0.976	0.135	0.870	0.905

* Significant at 10%, hence unit-root rejected (the variable is stationary).
** Japan 1890-1940 includes only a constant because the trend is not significant..
Notes:
Including constant and trend
p-values based on MacKinnon (1996).

order of the integration we also present a unit root test of the first difference in table 6.3. Here we can see that all variables are I(1) with the exception of the level of per capita

Table 6.3 (Augmented) Dickey-Fuller test for India, Indonesia, and Japan, 1890-2000 (I(1))

Unit-root null hypothesis: $\rho = 1$.

		India		Indonesia		Japan		
		$\Delta ln\,h_t$	$\Delta ln\,y_t$	$\Delta ln\,h_t$	$\Delta ln\,y_t$	$\Delta ln\,h_t$	$\Delta ln\,y_t$	$\Delta^2\,ln\,y_t$
±1890-1940	Sample size	41	41	43	43	35	38	
	Lag order	5	0	1	4	1	1	
	Estimated value of $\rho - 1$	-0.526	-1.037	-0.480	-1.375	-0.352	-1.632	n.a.
	Test statistic: tau_c(1)	-3.904	-4.235	-3.291	-4.460	-3.172	-6.893	
	Asymptotic p-value	0.012*	0.009*	0.068*	0.002*	0.090*	0.000*	
±1950-2000	Sample size	31	31	26	36	21	31	21**
	Lag order	4	3	1	5	1	1	0
	Estimated value of $\rho - 1$	-0.784	-2.289	-0.564	-0.963	-0.901	-0.589	-1.818
	Test statistic: tau_c(1)	-4.314	-4.133	-3.163	-3.147	-3.338	-2.952	-4.829
	Asymptotic p-value	0.003*	0.006*	0.092*	0.096*	0.088*	0.161	0.005*

* Significant at 10%, hence unit-root rejected (the variable is stationary).
** Japan 1950-2000 is second order stationary.
Notes:
Including constant and trend
p-values based on MacKinnon (1996).

GDP in Japan in the second half of the century which is I(2). In other words, per capita growth accelerated in Japan after 1950 until the 1980s.

These findings suggest the following long-run relation in India and Indonesia in the entire, and in Japan in the first half of the century: $\ln(y_t) = \alpha + \beta \ln(h_t) + \varepsilon_t$, hence, there is Lucasian growth. In Japan in the second half of the century the long-run growth

Table 6.4: Engle-Granger test: (Augmented) Dickey-Fuller test on the residual of the cointegrating regression $ln\, y_t = \alpha + \beta\, ln\, h_t + \gamma trend + \varepsilon_t$.

Unit-root null hypothesis: $\rho = 1$.

		India	Indonesia	Japan
±1890-1940	Sample size	23	34	41**
	Lag order	5	4	0
	Estimated value of $\rho - 1$	-0.643	-0.670	-0.552
	Test statistic: tau_c(1)	-3.650	-3.578	-3.427
	Asymptotic p-value	0.070*	0.083*	0.057*
±1950-2000	Sample size	24	33	29***
	Lag order	0	4	1
	Estimated value of $\rho - 1$	-1.087	-0.446	-0.988
	Test statistic: tau_c(1)	-3.955	-4.281	-4.214
	Asymptotic p-value	0.077*	0.012*	0.014*

* Significant at 10%, hence unit-root rejected (the variable is stationary) and there is a long-run (cointegrating) relationship.
** Japan 1890-1940 includes only a constant because the trend is not significant..
***Japan 1950-2000 uses $\Delta ln\, y_t$ instead of $ln\, y_t$. Hence, the cointegrating regression becomes $\Delta ln\, y_t = \alpha + \beta\, ln\, h_t + \gamma trend + \varepsilon_t$.
Notes:
Including constant and trend
p-values based on MacKinnon (1996).

is $\Delta ln\, y_t = \alpha + \beta\, ln\, h_t + \varepsilon_t$ (Romerian growth). To test whether these long-run relations actually exists, we have to test for cointegration. In other words, we have to test if the residual, ε_t, of both long-run relations, is stationary. These results are reported in table 6.4. We see that for all countries and periods a long run relation exist between $\ln(y_t)$ and $\ln(h_t)$, hence $ln\, y_t = \alpha + \beta\, ln\, h_t + \gamma trend + \varepsilon_t$. This means that for those countries and periods Lucasian growth seems to be present. The exception is Japan in the second half of the century when there is a cointegrating relation between $\Delta ln\, y_t$ and $ln\, h_t$, hence Romerian growth.

5. COMBINING LEVEL AND GROWTH EFFECTS WITH CONSTANT MARGINAL RETURNS: THE ROLE OF *AVERAGE YEARS OF EDUCATION*

5.1 Introduction

In the previous section our finding was that, with the exception of Japan after 1950, there was a long run relation between the level of GDP and human capital, hence Lucasian growth. However, in many studies focusing on human capital, the result is that the level of human capital affects the growth of GDP (see for example table 2.1 in chapter 2), hence these studies find Romerian growth. Why is this the case?

In more recent studies, often ‘average years of education’ is used to proxy human capital development. However, in a recent paper, Földvári and Van Leeuwen (forthcoming) show that ‘average years of education’ is, on a macro level[134], not a proxy of the level of human capital, but of the time devoted to human capital accumulation and, consequently, of the growth of human capital. This has two consequences. First, as we saw in table 6.3 that the growth of human capital was generally stationary, this means that the level of ‘average years of education’ must also be stationary. Second, as ‘average years of education’ is already a proxy for the stationary growth of human capital, we cannot estimate a cointegrating relation (because in that case both variables need to be I(1) and it is impossible to turn the level of ‘average years of education’ in a proxy for the level of human capital). Hence, instead of using:

$$ln\, y_t = \alpha + \beta\, ln\, h_t + \gamma trend + \varepsilon_t \qquad (6.7)$$

we have to use

$$\Delta\, ln\, y_t = \alpha + \beta\, ln\, edu_t + \gamma trend + \varepsilon_t \qquad (6.8)$$

, where *edu* is a ‘average years of education’ and thus proxies the growth of human capital, $\Delta\, ln\, h_t$. This explains why in the literature often a positive effect of the level of human capital (proxied as ‘average years of education’) on economic growth is found while we, using an alternative human capital stock, find a relation between $ln\, y_t$ and $ln\, h_t$.

Földvári and Van Leeuwen (forthcoming) based their results solely on the use of ‘average years of education’ and relating the coefficients to economic theory. They indeed found that when ‘average years of education’ is interpreted as the growth of

[134] At a micro level this is not necessarily true.

human capital, all (theoretically strange) results from the literature could be explained. However, here we have both 'average years of education' and estimates of an alternative stock of human capital which allows us to review the role of 'average years of education' more directly.

5.2 Unit-root and and a Mincer equation

As indicated in section 5.1, if Földvári and Van Leeuwen (forthcoming) are correct, this means that the level of 'average years of education' should be stationary as it proxies the growth of human capital which was found to be stationary in table 6.3. The result of this test is presented in table 6.5 below. Indeed, the results are as expected. All series

Table 6.5: (Augmented) Dickey-Fuller test for India, Indonesia, and Japan, 1890-2000 (human capital proxied by *average years of education*)
Unit-root null hypothesis: $\rho = 1$.

		India	Indonesia	Japan
		$\ln edu_t$	$\ln edu_t$	$\ln edu_t$
±1890-1940	Sample size	26	35**	31**
	Lag order	5	4	3
	Estimated value of $\rho - 1$	-0.359	-0.018	-0.023
	Test statistic: tau_c(1)	-3.345	-2.625	-2.825
	Asymptotic p-value	0.059*	0.088*	0.055*
±1950-2000	Sample size	42	21	51**
	Lag order	5	1	5
	Estimated value of $\rho - 1$	-0.180	-0.363	-0.064
	Test statistic: tau_c(1)	-3.182	-3.405	-3.340
	Asymptotic p-value	0.088*	0.051*	0.013*

* Significant at 10%, hence unit-root rejected (the variable is stationary).
** With constant but without trend because the trend is not significant.
Notes:
Including constant and trend unless otherwise indicated.
p-values based on MacKinnon (1996).

are I(0) and, hence, one order less integrated than those of human capital.

Ignoring the Romerian growth in Japan, we may summarize that both the growth of per capita GDP and the level of 'average years of education' are stationary. Thus, if we want to estimate the long-run relation we cannot use cointegration but we have to revert to an alternative such as the macro-Mincer equation.

Although some criticisms have been levied against the macro-Mincer[135], it is still a relatively simple way to gauge the effect of the level and the growth of the per capita stock of human capital. We start with a basic equation:

$$\Delta Lny_t = \alpha + kt + \beta_1 \Delta Lny_{t-1} + \beta_2 Lny_{t-1} + \beta_3 edu_{t-1} + \beta_4 \Delta edu_{t-1} + \varepsilon_t \qquad (6.9)$$

, where *y* is per capita GDP, *edu* 'average years of education' in year *t*, *t* is the trend, and ε is the error term.[136] We used independent variables with one time lag to avoid simultaneity.[137] If we include 'average years of education in the regression without logarithm, as a result of the underlying assumptions this is equal to inserting a monetary variable such as newly estimated human capital stock with a logarithm.[138]

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[135] Macro-Mincer regressions generally exclude variables indicating 'experience'. Clearly this is a problem. It is argued that variables as life expectancy are almost certainly related to the standard of living. As a consequence, inserting average experience, which is related with life expectancy, would create a simultaneity bias. This would reduce the effect of human capital on economic growth as part of this effect works through life expectancy (Krueger and Lindahl 2001:1109-1110). Please note that the opposite might also be true: by omitting life expectancy, the effect of human capital on economic growth might be overestimated because part of the effect of life expectancy works through human capital. Another worry concerning the macro-Mincer equation is that it excludes physical capital. Just as with 'experience', excluding physical capital may cause a rise in the effect of human capital on economic growth.

[136] Admittedly we ignore many possibly relevant variables such as openness to external trade. Given our focus we assumed this here to be constant over time, an assumption which may be very well modified in the future. Another important variable we omit here is physical capital. Not only is it theoretically necessary to include it (see chapter 2 section 3) but also it might be related to foregone wages (see chapter 5) meaning that omitting it may also bias the results. However, it does not seem the case that the bias is particularly strong as we can see in chapter 7 section 4.

[137] This means that human capital may influence growth, but growth may influence human capital as well. Of the different possible options to correct this, we chose to simply use a proxy variable under the assumption that 1) the independent variable is intertemporal correlated and 2) both the first lag of the independent variable and the error term of the regression of the X-variable on its first lag are uncorrelated with the error term of the regression.

[138] Generally, studies nowadays include 'average years of education' in a regression (without a logarithm). We, on the other hand, also have an estimated human capital stock in monetary terms which we include in logarithmic form in the equation. So, how do we compare these two different human capital coefficients? First we look at why the variable 'average years of education' is inserted without a logarithm. This method is advanced by, among others, Krueger and Lindahl (2001), Soto (2002), and Topel (1999), who argue that the profit in year t from human capital depends on the profit in year 0 multiplied with the discount rate and the years elapsing, i.e.

$$h_t = h_0 \left(1 + r\right)^I$$

, where *I* are the number of years of education. The subscript 0 indicates that we have the initial per capita stock of human capital, for example in 1970. Now taking logarithms, we get:

$$Lnh_t = Lnh_0 + I \, ln\left(1 + r\right)$$

Now if $\alpha = h_0$ and $\beta_3 = \ln(1 + r)$, we can express the level of human capital as

$$Lnh_t = \alpha + \beta_3 I$$

Thus, if we want to estimate a regression where we want to regress the growth of per capita GDP on the log-level of the per capita stock of human capital, we get:

$$\Delta Lny_t = \alpha + \beta_3 I$$

, where *I* is the 'average years of education' and β_3 indicates the elasticity (how much percent the growth of per capita GDP rises as *I* rises with 1 year). As a consequence, when taking one time lag, above equation is equal to equation 6.9 with the exclusion of the growth of human capital and the lagged y-

We know that most periods and countries in our sample are dominated by Lucasian growth. This means that only if there is a relation between 'average years of education' and GDP and if 'average years of education' is indeed a proxy of the growth of human capital, we expect β_3 to be positive and significant.

The results are presented in table 6.6.[139] For all regressions, normality is not rejected. Equally the goodness of fit is between 36% and 87%. Basically, the results confirm the findings from the literature. The coefficient of the level of 'average years of education', β_3, is positive, significant, but small, being between 1.5% and 4%. This is

Table 6.6: Results from a macro-Mincer equation for India, Indonesia, and Japan 1890-2000 using 'average years of education' as estimates of the growth and level of human capital*

Dependent variable: $\Delta \ln y_t$

	The variable h = average years of education **					
	India		Indonesia		Japan	
	Coefficient	t-value	Coefficient	t-value	Coefficient	t-value
Constant	0.292	1.99	0.431	2.88	0.362	5.51
Trend	-0.0001	-0.571	0.00002	0.055	-0.002	-2.16
$\Delta ln\, y_{t-1}$	-0.074	-0.855	0.394	5.67	0.018	0.454
$ln\, y_{t-1}$	-0.047	-1.92	-0.064	-2.85	-0.058	-5.80
Δedu_{t-1}	-0.040	-1.29	0.006	0.065	-0.027	-0.689
edu_{t-1}	0.020	3.95	0.015	2.31	0.039	4.85
R^2	0.364		0.703		0.876	
Obs.	109		107		110	
AR1-1 (prob)	0.172		0.271		0.961	
Normality(prob)	0.997		0.154		0.050	

*Dummies not reported
**'average years of education' is inserted in the equation without logarithms.

in accordance with the findings from the literature (see table 2.2 in chapter 2). It also confirms that 'average years of education' must be interpreted as a proxy of the growth of human capital. Indeed, this also explains why the coefficient of the growth of human capital (proxied by 'average years of education') is often found to be insignificant in the literature. The aim is to estimate the relation between $\Delta ln\, y_t$ and $\Delta ln\, h_t$, hence Lucasian growth. However, because 'average years of education' is actually a proxy of the growth of human capital, what one actually measures is:

variables, i.e. $\beta_3 I$ corresponds to $\beta_3\, ln\, h_{t-1}$. This means that in both cases what the equation actually says is that the growth of per capita GDP depends on the log-level of the stock of human capital.

[139] Although this specification is much used, some problems remain. For example, the data may exhibit breakpoints and the equations may suffer from an omitted variable bias, mainly due to the exclusion of for example physical capital.

$$\Delta Lny_t = a + kt + \beta_4 \Delta^2 \ln h_t + \varepsilon_t \tag{6.10}$$

Or, assuming no breakpoints:

$$Lny_t = a + kt + \beta_4 \Delta \ln h_t + \varepsilon_t \tag{6.11}$$

Hence, a permanent increase in the growth of human capital causes only a one-time increase in the level of human capital. This means that for permanent economic growth, the growth of human capital must continually accelerate. As this obviously is not the case, β_4 is either positive or negative, but in both cases insignificant.

5.3 Connecting the use of 'average years of education' as a human capital proxy to constant marginal returns to human capital accumulation

In the literature (Foldvari and Van Leeuwen, forthcoming), using unit–root tests in the previous sections, and using a Mincer-equation, it is suggested that 'average years of education' must be interpreted as a proxy for the growth of human capital. Indeed, in table 6.6 we found that the level of 'average years of education had a positive effect on economic growth while table 6.4 showed it was the growth of our newly estimated human capital stock that effected economic growth.

Limiting ourselves to the theory of Lucas (1988), this means that if the growth of human capital determines economic growth while it is the level of 'average years of education' that affects economic growth, the level of 'average years of education' must determine the growth of the newly estimated stock of human capital. This is easy to see. We start with

$$\frac{\dot{y}}{y} = \alpha + \beta \frac{\dot{h}}{h} \tag{6.12}$$

, where the growth of per capita GDP depends on the growth of the per capita estimated human capital stock. This is roughly the equation describing the long-run growth in the model of Lucas (1988). However, if we look at the level of 'average years of schooling', we get:

$$\frac{\dot{y}}{y} = \gamma + \varphi educ \tag{6.13}$$

, where *educ*, the level of 'average years of schooling', determines the growth of per capita income. This is the regression following from the theory of Romer (1990). However, combining equation (6.12) and (6.13) leads to:

$$\gamma + \varphi educ = \alpha + \beta \frac{\dot{h}}{h} \tag{6.14}$$

, which can be rewritten in the following fashion:

$$\frac{\dot{h}}{h} = \frac{\alpha - \gamma}{\beta} + \frac{\varphi}{\beta} educ \tag{6.15}$$

Therefore, the growth of human capital depends on the level of 'average years of schooling'. If we, as we have done in section 3 of this chapter, see 'average years of schooling' as a proxy for the time devoted to human capital accumulation, we end up with exactly what Lucas argues to be the main source of endogenous growth: constant (or increasing) marginal returns to human capital accumulation which is present in India and Indonesia (see equation 6.4). Completing this way of thinking, one may (somewhat exaggerating) argue that studies that find evidence in favour of Romer's theory from regressions based on average years of schooling as a proxy for human capital, basically confirmed Lucas' theory without being aware of it (see for example Benhabib and Spiegel 1994; Krueger and Lindahl 2001; Portela *et al.* 2004).[140]

6. CONCLUSION

We tried to apply the two main branches of the new growth theories on economic development. To this end, we used two formal tests to find out which growth theory best described the link between human capital and economic growth.

[140] As we pointed out in section 3.2 of this chapter, our estimated human capital stock is in monetary terms. This made it possible to directly estimate the Lucasian second sector which by definition means, as we can see in the text, that when the level of 'average years of education' is inserted in a growth equation, this is in fact a partial test for the Lucas theory. It is partial because 1) also Romer allows for the possibility that human capital is a factor of production and 2) The coefficient of this sort of regression is not equal to the factor share of human capital, but to the factor share of human capital multiplied with the efficiency of human capital accumulation and an indicator of constant marginal returns to human capital accumulation.

The situation that our estimated human capital stock is in monetary terms also allows for an extra test for the distinction between Romerian and Lucasian growth. Most studies assume that there are constant returns to scale in a production function. This means that, if we have $Y = K^{\alpha} H^{\beta}$, $\alpha + \beta = 1$. However, we have both physical and human capital in monetary units (for example USD). Consequently, if there are increasing returns to scale, for example, $\alpha + \beta = 2$, Y is expressed in dollars squared. Only if there are constant returns, Y is expressed in USD (to the power 1). Interestingly, our estimates are performed with solely human capital, thus excluding physical capital. We thus have only one production factor. In this case, the marginal returns to human capital accumulation (second sector) is equal to the returns to scale (first sector). As we pointed out, in order to have GDP in the right unit (USD) it is necessary that there are constant returns to scale and thus constant marginal returns to human capital accumulation. In above regressions this cannot be observed. However, in chapter 7 we run regressions for sub periods in which the human capital coefficient increases significantly and is often close to 1 meaning Lucasian growth.

The first way to evaluate the growth model is to look at the human: physical capital ratio and the human capital: output ratio. For Lucasian growth these ratios should be almost constant while they should decline during Romerian growth. The latter is found in Japan in the second half of the century while in the remaining countries and periods Lucasian growth dominated. This is confirmed by a second test, following Monteils (2002), which is based on the situation that in the theory of Lucas there are two sectors. In the first sector, human capital is used to produce output while in the second sector human capital is used to create new human capital. Therefore, if one ignores positive external effects of human capital, endogenous growth can only be possible if there are constant or increasing marginal returns to human capital accumulation. We found extended periods with constant or increasing marginal returns. This evidence supports the applicability of the Lucasian growth. If efficiency in the second sector has the shape of a trough parabola, we found for all three countries increasing returns. However, though rising growth of 'average years of schooling' and a decreasing quality of human capital can explain the diminishing marginal returns in India and Indonesia, this cannot provide an explanation for Japan in the second half of the twentieth century. Therefore, though India and Indonesia suffered from periods with increasing, constant, and diminishing marginal returns without leaving the phase of Lucasian growth, Japan moved from Lucasian growth in the first half of the century to Romerian growth in the second half.

Hence, in the first and second test there were indications that Romerian growth dominated in Japan in the second half of the century and Lucasian growth in the other countries and periods. This was confirmed in the third test. Here we estimated whether there was a long-run relation between human capital and economic growth. Given that Lucas (1988) saw human capital as a factor of production, the growth of human capital should have a positive influence on economic growth. As Romer saw human capital only as an input in the R&D sector, in his theory the level of human capital should have a positive effect on economic growth. Indeed, we found, with the exception of Japan after 1950, that there was a long-run relation between the level of GDP and human capital, i.e. Lucasian growth. For Japan after 1950 we found a relation between the growth of GDP and the level of human capital, hence Romerian growth.

Consequently, the three tests suggests that there are strong indications of a shift from Lucasian to Romerian growth in Japan while such a shift was absent in India and Indonesia. Some possible reason implicitly touched upon in this chapter included the lower quality of education in the latter two countries and the higher level of human capital in Japan. This leads to a significantly different effect both in human capital formation and in the relationship between human capital and economic growth. As suggested in chapter 4, these differences may to a large extent be attributed to differences in the development of educational institutions. This resulted in two hypotheses on the relation between human capital and economic growth. Taking the growth model as outlined in this chapter, we will test these hypotheses in order to determine the effect of institutional development on cross-country growth divergence.

7. The contribution of human capital to growth: some estimates

1. INTRODUCTION

So far we have noted that human capital seems to affect economic growth mainly through capital accumulation. As a consequence, human capital had to be interpreted as a factor of production in the Lucas (1988) theory. The exception was Japan in the second half of the twentieth century where we found Romerian growth. However, the estimates in chapter 6, based on the often used macro-Mincer equation, were of a general nature. Although they allow differentiating between the theories of Lucas (1988) and Romer (1990), these estimates still do only partly account for a possible imbalance effect and are only partly adapted to the historical development paths of the different countries. This may be the cause of the low coefficients of the growth of per capita human capital which we found.

In this chapter we will address these two issues in a provocative way. This is not intended to provide 'true' answers but only to indicate some possible directions in which research can progress. However, before doing so, we first have to elaborate on the empirical model. Since in the previous chapter we already compared the two branches within the new growth theory, here we will only discus some extensions and implications.

Second, we turn to the institutional effects. In our analysis in chapter 4 we distinguished two hypotheses on the ways in which the institutional development may affect the relationship between human capital and economic growth expressed as the human capital coefficient: the existence of comparable educational regimes in all three countries, and a more efficient relation between human capital and economic growth (and thus a higher coefficient) in Japan. If such institutional effects are present, they may cause non-linearities in the regressions. Because most studies using regressions with human capital use cross-section or panel data, they are confronted with differences in the efficiency of human capital and regimes among countries. In such cases, possible non-linearities may be attributed to cross-country institutional differences or changing phases in educational development (or a non-human capital related factor). Yet, these factors are difficult to disentangle. For example, if the educational phases in Japan precede those in India, are the observed non-linearities in the human capital coefficient caused by institutional differences or by educational regimes? Nevertheless, it is important to disentangle them. Not only is it crucial to be able to interpret the coefficients, but it is also necessary in order to insert the right variables. As argued in chapter 4, it were the developed countries such as Japan which experienced an educational development that was closely connected with both their societal and economic development. However, in developing countries the development of the education system was largely influenced by external factors, creating a less strong connection with their national economies. Consequently, the relation between human capital and economic growth in the latter countries is likely to be less efficient. In such cases, a country dummy (or a developing country dummy) might be the appropriate way to deal with these non-linearities. However, if there are non-linearities because the countries included in the sample are in a different educational phase, including a country dummy will not correct for the phases but for the relative development level. In those cases it would be more appropriate to either estimate regressions over shorter periods in order to avoid breakpoints, or to include a multiplicative dummy for each educational phase.

Third, we will elaborate on the imbalance effect. Although, in this study, we are not interested in the imbalance effect *sec*, we discuss it because its inclusion in the regressions not only influences the human capital coefficient[141], but it is also directly related to the inclusion of physical capital in the regression, and because it offers an alternative way of testing the difference between Lucasian and Romerian growth. The basic notion behind imbalance effect is that under optimal choice, the ratio of human to physical capital is constant. Any deviations from this ratio may affect the growth rate of output. Theoretically, there is a U-curve where an excess of human or physical capital increases the growth rate of output. Yet, in practice it is also possible that an excess of physical capital leads to a reduction in economic growth (Barro and Sala-i-Martin 2004, 246). Because in some periods there will be an excess of human- and in other periods an excess of physical capital, in the long run its effect on growth fluctuates around zero. So, although in the long run, there should be no effect, if we estimate shorter regressions (as we will do in section 3 to correct for possible breakpoints) it is possible that the effect for some periods is positive and for other periods negative. This means that in the long run it is necessary to include a polynomial of the log-level of the ratio of human to physical capital to capture these effects. Theoretically, as this is an imbalance effect, the average marginal effect on economic growth should be close to zero. But it is

[141] It is necessary to include, besides the steady state, also the imbalance effects. If one excludes the latter, the effects of the steady state may be distorted (See for example Nili 2002, 1).

possible, as we will briefly argue in section 5, that that a low elasticity of substitution between skilled and unskilled labour leads to an on average negative effect on long run growth. If this is true, omitting the imbalance effect might affect the human capital coefficient.

It is necessary to note, however, that the imbalance effect is characteristic of the Lucas (1988) model. Therefore, we can use the presence of an imbalance effect as an additional test for the existence of Lucasian growth. We must simply include the growth of physical capital, next to the growth of human capital, as an independent variable.[142] If the combined effect of the coefficients of the growth of human and physical capital equal that of the coefficient of the growth of human capital (when inserted in an equation without the growth of physical capital) than this provides another indication of the presence of an imbalance effect and therefore of Lucasian growth.

Above three points will be discussed in this chapter. We start in section 2 with extending the empirical model. In section 3 we turn to the effect the historical development of human capital generating institutions has on the relation between human capital and economic growth. Using time series analysis to avoid cross-country differences, we try to determine the effect of the institutional development of human capital in India, Indonesia, and Japan. Do the breakpoints in the coefficients correspond with the phases in found in chapter 4? Is there a time lag of India and Indonesia compared to Japan? Are the coefficients in Japan indeed higher than those in India and Indonesia? In section 4 we will use the basic model, extended for the imbalance effects, to look at the effect this has on the previously obtained estimates. In addition, we provide an extra test for the existence of an imbalance effect. Section 5 discusses some possible explanations for the different growth patterns we found in India, Indonesia, and Japan. We end in section 6 with a brief conclusion.

2. THE MODEL

2.1 Introduction

We started in chapter 6 with the macro-Mincer equation (equation (6.9)):

$$\Delta Lny_t = \alpha + \beta_1 \Delta Lny_{t-1} + \beta_2 Lny_{t-1} + \beta_3 \ln h_{t-1} + \beta_4 \Delta \ln h_{t-1} + \varepsilon_t \qquad (7.1)$$

[142] Some authors have argued that the inclusion of the growth of per capita physical capital, $\Delta \ln k_t$, decreases the human capital coefficient (De la Fuente and Doménech 2000, 18; Krueger and Lindahl 2001, 1126; Soto 2002, 14). However, excluding the stock of physical capital may also cause problems.

, where *y* is per capita GDP, *h* is an indicator for the per capita stock of human capital in year *t*, ε is the stochastic error term, and a one-period lag of the independent variables was included to avoid simultaneity. Before turning to the regressions in section 3 and 4 we will discuss some extensions and interpretations of this empirical model.

The standard function of Lucas (1988) is:

$$Y_t = N_t c_t + \dot{K}_t = AK_t^{\beta}\left[u_t h_t N_t\right]^{1-\beta} h_{at}^{\gamma} \tag{7.2}$$

, where β is an indicator of the returns to scale of physical capital, *K*, $1-\beta$ gives the returns to human capital, and γ indicates the positive external effect of the per capita stock of human capital, for example if someone's production increases because his or her co-worker has a higher level of human capital. The subscript *a* is preserved in the per capita human capital in order to indicate that the positive external effect is homogenous. However, it is assumed that all labour is essentially homogenous and therefore there is no difference between the two per capita stocks of human capital in the equation. Technology, *A*, is assumed to be constant, *N* is population and c_t is per capita consumption.

Equation (7.2) has two important consequences. First, together, the returns to human and physical capital (excluding the positive external effect) sum to 1. Because in this production function human capital accumulation (with non-decreasing marginal returns to human capital formation) replaces the labour input, it is possible to have endogenous growth even without positive external effects. In other words, even if the effect of positive externalities (γ) is 0 (that is, h_{at}^{γ} is removed from equation (7.2)) endogenous growth is still possible if human capital has non decreasing marginal returns to human capital formation. Second, equation (7.2) also indicates that any positive external effects are solely contributed to human capital.

2.2 The imbalance effect

If there is Lucasian growth, this also means that there is an imbalance effect: an excess of human or physical capital which may increase or decrease per capita GDP growth. The presence of such an effect is easy to see. We start with a simple production function with constant technology, physical, and human capital:

$$Y = AK^{\alpha}H^{1-\alpha} \tag{7.3}$$

Taking the marginal product of both *K* and *H* gives:

$$\frac{\partial Y}{\partial K} = \alpha A K^{\alpha-1} H^{1-\alpha} \quad (7.4)$$

$$\frac{\partial Y}{\partial H} = (1-\alpha) A K^{\alpha} H^{-\alpha} \quad (7.5)$$

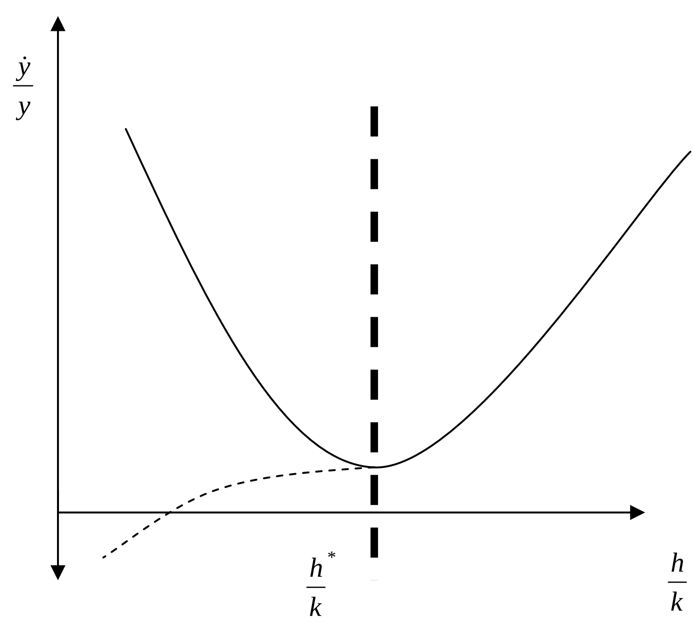
Now we can set equation (7.4) and (7.5) equal. This can be done because producing both physical (K) and human (H) capital costs GDP (Y). Then, using dynamic optimization will result in the optimum condition that their net marginal product (gross marginal product minus depreciation) must be equal. This gives the ratio of physical to human capital

$$\frac{\alpha}{1-\alpha} = \frac{K}{H} \quad (7.6)$$

This means that an excess of either human or physical capital may increase the growth

Figure 7.1

Imbalance effect in the Lucas theory



rate of output (see figure 7.1). However, as indicated by the downward sloping dashed line, empirically an excess of physical capital may also have a neutral or even negative effect on GDP growth.

Therefore, we have to adapt equation (7.1) in order to capture these non-linear effects. The model now becomes:

$$\Delta Lny_t = \alpha + \kappa t + \beta_1 \Delta ln\, y_{t-1} + \beta_2\, ln\, y_{t-1} + \beta_4 \Delta ln\, h_{t-1} + \beta_3\, ln\left(\frac{h}{k}\right)_{t-1} + \beta_5 \left(ln\left(\frac{h}{k}\right)\right)^2_{t-1} \quad (7.7)$$

This equation is equal to the Mincer-regression from equation (7.1), except that we inserted a second degree polynomial of $ln\left(\frac{h}{k}\right)_{t-1}$.[143] This polynomial is intended to pick up the imbalance effects caused by technology through the level of human and

Table 7.1 Estimation of the effect of the growth of human capital on economic growth in India and Indonesia over the twentieth century*

Dependent variable: $\Delta ln\, y_t$

	India				Indonesia			
	1		2		1		2	
	Coefficient	t-value	Coefficient	t-value	Coefficient	t-value	Coefficient	t-value
Constant	0.446	2.34	1.502	0.83	0.501	4.56	0.590	3.90
Trend	0.001	1.90	0.000	0.02	0.002	5.30	0.002	4.74
$\Delta ln\, y_{t-1}$	-0.003	-0.04	-0.031	-0.35	0.309	5.01	0.311	5.03
$ln\, y_{t-1}$	-0.072	-2.28	-0.055	-1.29	-0.089	-4.84	-0.097	-4.74
$\Delta ln\, h_{t-1}$	0.034	0.19	0.128	0.60	0.931	2.62	0.853	2.32
$ln\left(\frac{h}{k}\right)_{t-1}$	-0.081	-2.69	n.a.		-0.011	-1.50	n.a.	
$\left(ln\left(\frac{h}{k}\right)\right)^2_{t-1}$	0.099	2.63	n.a.		-		-	
$ln\, h_{t-1}$	n.a.		-0.923	-1.05	n.a.		-0.020	-1.55
$ln\, k_{t-1}$	n.a.		0.551	1.00	n.a.		0.012	1.66
$(ln\, h)^2_{t-1}$	n.a.		0.230	1.39	n.a.		-	
$(ln\, k)^2_{t-1}$	n.a.		0.125	1.45	n.a.		-	
$(ln\, k \cdot ln\, h)_{t-1}$	n.a.		-0.325	-1.36	n.a.		-	
R^2	0.415		0.438		0.839		0.841	
Obs.	109		109		109		109	
AR1-1 (prob)	0.436		0.922		0.952		0.999	
Normality(prob)	0.905		0.846		0.733		0.820	

*Dummies not reported

[143] The presence of an imbalance effect during Lucasian growth also suggests that that the ratio h/k must be stationary. This can be seen in chapter 6, section 2, where we showed that the human-physical capital ratio remained almost constant during Lucasian growth. Therefore, during Lucasian growth, this ratio should be stationary. For all periods for which Lucasian growth is present, using an Augmented Dickey-Fuller test, a unit root is rejected with 10% significance.

physical capital which may change over time.[144]

Now we estimate equation (7.7) for the entire century. The results are reported in table 7.1 (India and Indonesia) and 7.2 (Japan). The regression for Japan is somewhat more complicated because, as we argued in the previous chapter, in the first half of the twentieth century Lucasian growth dominated while in the second half Romerian growth dominated. After some testing we decided to capture these effects by multiplicative variables. Hence, the growth of human capital and the imbalance effect

Table 7.2 Estimation of the effect of the growth of human capital on economic growth in Japan over the twentieth century*

Dependent variable: $\Delta ln\, y_t$

	Japan			
	1		2	
	Coefficient	t-value	Coefficient	t-value
Constant	0.453	4.63	0.454	4.46
Trend	0.002	1.58	0.002	1.48
$\Delta ln\, y_{t-1}$	-0.024	-0.54	-0.025	-0.54
$ln\, y_{t-1}$	-0.068	-3.40	-0.068	-3.24
Lucasian growth				
$D1890-1945 \cdot \Delta ln\, h_{t-1}$	2.428	1.68	3.17	1.15
$D1890-1945 \cdot ln\left(\frac{h}{k}\right)_{t-1}$	-0.226	-2.20	n.a.	
$D1890-1945 \cdot \left(ln\left(\frac{h}{k}\right)\right)^2_{t-1}$	0.081	2.27	n.a.	
$D1890-1945 \cdot ln\, h_{t-1}$	n.a.		-1.247	-0.77
$D1890-1945 \cdot ln\, k_{t-1}$	n.a.		1.580	0.75
$D1890-1945 \cdot (ln\, h)^2_{t-1}$	n.a.		-0.555	-0.50
$D1890-1945 \cdot (ln\, k)^2_{t-1}$	n.a.		-1.271	-0.63
$D1890-1945 \cdot (ln\, k \cdot ln\, h)_{t-1}$	n.a.		1.700	0.57
Romerian growth				
$D1950-2002 \cdot ln\, h_{t-1}$	0.007	3.69	0.007	3.61
R^2	0.850		0.852	
Obs.	103		103	
AR1-1 (prob)	0.174		0.199	
Normality(prob)	0.163		0.183	

*Dummies not reported

[144] Alternatively one can insert the log-level of either human-or physical capital. We ran some regressions using a polynomial of the level of per capita human capital and the results suggest that, although the coefficients shift slightly, if one lacks enough data on either human-or physical capital the insertion of only one of the two to capture the imbalance effect is a fair approximation.

variables are multiplied with a dummy that is 1 in the period until 1945 and zero otherwise. The log- level of human capital is multiplied with a dummy that is 1 after 1950 and zero otherwise. In sum, this assumes Lucasian growth in the first half and Romerian growth in the second half of the century.

The regressions seem to improve compared with the results in the previous chapter. The coefficients in all three countries are as expected with positive values for the coefficient of the growth of human capital in periods with Lucasian growth and a positive effect of the log-level of human capital in periods with Romerian growth. We also find an increase in R^2 from the macro-Mincer model from table 6.2. This suggests that correcting for the imbalance effect may have a positive effect on the estimated coefficients. One objection, however, could be the presence of multicollinearity. The correlation matrices indicate that no serious problems exist. With the exception of the correlation between $ln\left(\frac{h}{k}\right)_{t-1}$ and $ln\left(\frac{h}{k}\right)^2_{t-1}$ almost all correlation coefficients are significantly below 0.8. The main problem rests in the inclusion of the quadratic imbalance effect for India and Japan. Yet, there are four reasons why this is less a problem as it may seem on first sight. First, as the inclusion of a quadratic term in principle does not cause a linear correlation, in the strictest sense this does not cause multicollinearity which assumes a linear correlation. In addition, even the correlation within the imbalance effect is on average only just above 0.9. Second, in tables 7.1 and 7.2 we do not observe small t-statistics which would, combined with a large R^2, be indicative of multicollinearity. Third, if we exclude the quadratic term we obtain for India a coefficient of $ln\left(\frac{h}{k}\right)_{t-1}$ of -0.053. From table 7.1 (regression 1) we can calculate that the marginal effect when we include the quadratic term is $\beta_3 + \beta_5 \cdot 2 \cdot ln\left(\frac{\overline{h}}{k}\right)_{t-1}$. If we take the average of $ln\left(\frac{h}{k}\right)_{t-1}$ over the period 1890-2000, the marginal effect thus becomes -0.081+0.099*2*-0.042 = -0.089. Hence, the difference when including the quadratic term is not very large. In the same way we can calculate including the quadratic term for Japan does not essentially alter the marginal effect and can thus be inserted in the equation. Fourth, we can test whether the inclusion of the first and second degree polynomial improves the model. The F-statistics show that for all three countries we can reject the 0-hypothesis of no improvement in the model.[145]

Given the applicability of the h/k ratio in above regressions, we may notice three things about the imbalance effect. First, it is interesting that this specification allows us to take a closer look at the imbalance effect which we do in the second regression for each country. Assuming that an imbalance effect exists makes it necessary to include the (polynomial of the) ratio of human to physical capital in the specification. Yet, this assumes a specific pattern of the coefficients of this imbalance effect. For example, if we have a one degree polynomial, $\beta_3 \ln\left(\frac{h}{k}\right)_{t-1}$, we can rewrite it as $\beta_3 \ln h_{t-1} - \beta_3 \ln k_{t-1}$. Hence the coefficients of the log-level of per capita physical and human capital should in absolute terms be equal and have the reverse sign. This becomes more complicated in a second degree polynomial, $\beta_3 \ln\left(\frac{h}{k}\right)_{t-1} + \beta_5 \left(\ln\left(\frac{h}{k}\right)\right)^2_{t-1}$, as we have for both India and Japan. In this case we can write the imbalance effect as $\beta_3 \ln h_{t-1} - \beta_3 \ln k_{t-1} + \beta_5 (\ln h)^2_{t-1} + \beta_5 (\ln k)^2_{t-1} - 2\beta_5 (\ln h \cdot \ln k)_{t-1}$. Hence, just as in the one-degree polynomial the coefficients of the log-level of per capita human and physical capital should be the same in absolute value and have the opposite sign. In addition, the coefficients of the squared terms should have the same height and be of the same sign while the coefficient of the multiplicative term should be twice as high as that of the squared terms and have the reversed sign. Although not statistically significant, the coefficients in tables 7.1 and 7.2 (second regression for each country) show this pattern. This suggests that an equilibrium relationship exists between human and physical capital and, hence, an imbalance effect.

Second, the coefficient of the logarithm of the ratio human to physical capital switches sign for each degree of the polynomial. This indicates that the level of human capital behaves as an imbalance effect that has a cyclical pattern. Given that a second degree polynomial is inserted, the length of the cycle must be close to 100 years. Consequently, the periods with either growth above or below the long-runs steady state

[145] Japan: $F(2,90) = 2.600$ [0.0798].
India: $F(4,97) = 2.584$ [0.0418]
Indonesia: $F(1,92) = 2.238$ [0.1381]
This means that the hypothesis that the inclusion of the ratio ln(h/k) and, in the case of Japan and India, ln(h/k) squared, have no effect on the model is rejected at 10% (Japan), 5% (India), and at 15% (Indonesia).

level last for about 50 years which means that if one estimates this equation over shorter periods, the imbalance effect might well have a positive or negative effect on economic growth.

Third, it is important to note that the variables of the polynomial are in levels, which means that they are generally non-stationary, I(1). However, as pointed out, we have to take the polynomial of the levels of per capita human capital together to analyze the imbalance effects. As the average is by definition zero[146], the combined effect must be stationary. Consequently, in this specification, except for the case of Romerian growth where the level of human capital and per capita GDP growth may be cointegrated, we have to use an alternative interpretation of equation (7.7).

2.3 A Koyck model

Because in the Lucas (1988) model the growth of human capital affects the growth of per capita GDP, the steady state growth part of equation (7.7) is given by

$$\Delta Lny_t = \beta_2 \Delta \ln y_{t-1} + \beta_4 \Delta \ln h_{t-1} \tag{7.8}$$

This equilibrium growth path is in first differences and therefore I(0). This is a Koyck model (Koyck 1954). Consequently, we have to interpret equation (7.8) as an autoregressive equation with one autoregressive term ($\Delta \ln y_{t-1}$).[147] Assuming we have the optimum long-run per capita stock of human capital, $\Delta \ln h^*_{t-1}$, then we can estimate:

$$\Delta Lny_t = \chi \Delta \ln h^*_{t-1} \tag{7.9}$$

However, since $\Delta \ln h^*_{t-1}$ is not directly observable, we assume:

$$\Delta \ln h^*_{t-1} - \Delta \ln h^*_{t-2} = \eta \left(\Delta \ln h_{t-1} - \Delta \ln h^*_{t-2} \right) \tag{7.10}$$

, where η determines how fast the economy returns from its disequilibrium. Now we can rewrite equation (7.10) also as:

$$\Delta Lny_t = \left(1-\eta\right) \Delta \ln y_{t-1} + \eta\chi \Delta \ln h^*_{t-1} \tag{7.11}$$

Now if we say that $(1-\eta) = \beta_2$ and that $\eta\chi = \beta_4$, then we have equation (7.8) back. In other words, the short run effect of the growth of the per capita stock of human capital

[146] In section 5 of this chapter we suggested that in countries with a high elasticity of substitution between skilled and unskilled labour the imbalance effect might be slightly positive in the long run while in countries with a small elasticity of substitution the long-run effect might be negative.

[147] Ideally one should estimate an autoregressive moving average model to capture the moving average in the error term (Franses and Van Oest 2004). However, we find that this generally does not alter the coefficients. In addition, this is generally disregarded in the literature and therefore we will not elaborate on it.

on the growth of per capita GDP is $\eta\chi = \beta_4$, while the equilibrium long-run value is equal to $\frac{\beta_4}{1-\beta_2} = \frac{\eta\chi}{1-(1-\eta)} = \chi$.

3. REGIMES IN HUMAN CAPITAL AND ECONOMIC GROWTH

3.1 Breakpoints in the relation between human capital and growth

Using the model from the previous section, we shall now look at the effects institutional development in the formation of human capital has on the relation between human capital and growth. To do this, we will make use of the hypotheses derived from our analysis in chapter 4. These hypotheses say something about breakpoints in the relation between human capital and growth (this section) and the strength of the coefficients (section 3.2). The results are interpreted in section 3.3.[148] We will restrict ourselves to time series analyses in order to avoid cross-country differences which, as indicated in the introduction to this chapter, may in some cases be difficult to disentangle from the effect of the country-specific institutional development of human capital.

The theses mentioned in chapter 4 all relate to presence of educational regimes. These may lead to structural different human capital coefficients over time. Therefore, the first step is to look whether there indeed are breakpoints in the relation between human capital and economic growth. To that end, we will use the regressions as presented in tables 7.1 and 7.2.

There are several ways to test for the presence of breaks in the relation between human capital and growth. However, because of the small sample, we will restrict ourselves to some simple analyses. A common way is to look at the recursive graphs. Because of their recursive nature, it is possible to see where and when the coefficients move so strong from one steady value to another that they cross a certain border of significance. This allows us to determine breakpoints with some certainty. For example,

[148] Although we are convinced that the analysis of hypotheses from chapter 4 about the effect the educational institutions have on the relationship between human capital and economic growth clarifies some important points, we are aware that this analysis is very limited. It would be valuable to extend these theses with a further (econometric) analysis which we will touch upon in the ‘suggestions for further research’ in the next chapter. However, most of the alternative econometric analyses are cross-section in nature. Given that this study only focuses on three countries, it would be impossible to run such a regression because it is based on the effect that past institutions have on present economic development. In addition, the use of alternative variables and institutions such as government policies, property rights, and settler mortality are not directly related to our main question which focused on human capital and educational institutions. Finally, we use time series analysis and it is doubtful that variables such as property rights show much fluctuation over the period in our study. Although no doubt some change is present, it is exactly their path dependence and stability that makes them suited to proxy for institutions.

Figure 7.2

Recursive coefficient of $\Delta \ln h_{t-1}$ from table 7.2 for Japan (+/- 2 standard errors)

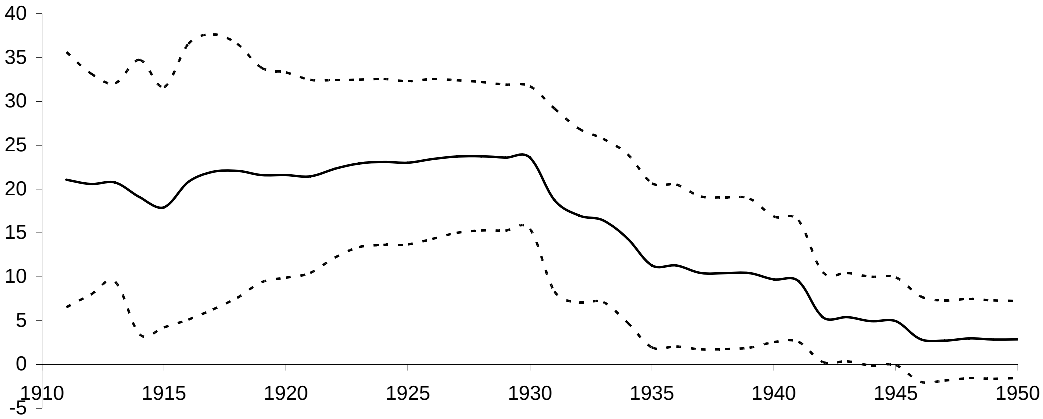


figure 7.2 shows the recursive coefficient of $\Delta \ln h_{t-1}$ for Japan. Around 1940 there is a break in the data (in that period the recursive value of the coefficient drops below the confidence interval of the previous period). Indeed, where until around 1940 the effect

Figure 7.3

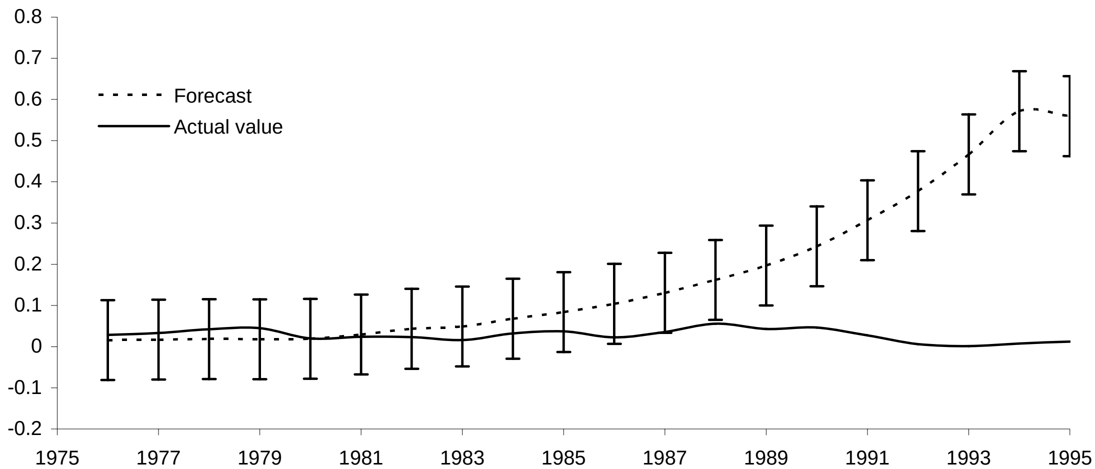
Recursive coefficient of $\ln h_{t-1}$ from table 7.2 for Japan (+/- 2 standard errors)

of the growth of human capital was dominant (see figure 7.2) after 1950 there is a stable effect of the coefficient of the level of human capital (figure 7.3).

However, there is one point of concern. As these estimations are recursive, it is likely that if there is more than one break present, the last break(s) will not (or only in a limited way) be observed. For example, in figure 7.2 we notice a strong break around 1945. However in figure 7.3 we do not notice a break even though there is a clear upward trend in the value of the coefficient of $ln\,h_{t-1}$ in the period after 1975. Indeed, if we plot the actual values and the forecasts for Japan between 1976 and 1995 (figure 7.4), we see that it diverges strongly from the actual values around 1988. We can determine this because from around 1988 the error bars do not overlap with the actual values of the growth of per capita GDP. Hence, the relation that existed before 1988 was different from the relation that existed afterwards. Therefore, the relation before

Figure 7.4

20-step forecasts for $\Delta \ln y_t$ (SE based on error variance only) for Japan, 1976-1995

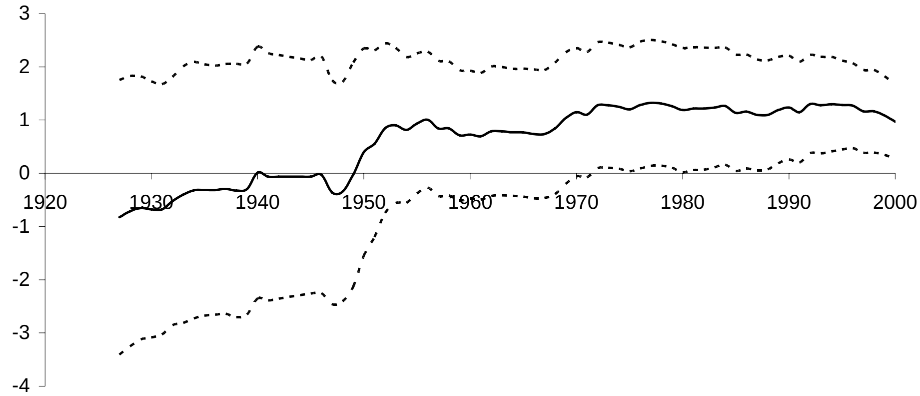


1988 cannot provide a good forecast of the development of per capita growth after 1988. This means that we indeed also have a breakpoint in the period around 1990, although this is not indicated in figure 7.3.

In the same way, we determine the breakpoints for Indonesia and India. Figure 7.5 shows the recursive coefficient of $\Delta ln\,h_{t-1}$ for Indonesia. We can see that there seems to be a break around 1950. Just as in Japan, the break in the mid-twentieth century dominates. However, if we look at the forecasts, other breaks are also present. Figure 7.6 shows that in Indonesia, the error bars of the forecasted value did no longer overlap with the actual value of per capita GDP growth around 1915. Hence, the relation that existed before 1915 was different than that existed after 1915, i.e. there is a

Figure 7.5

Recursive coefficient of $\Delta \ln h_{t-1}$ from table 7.1 for Indonesia (+/- 2 standard errors)



breakpoint. The same we see in figure 7.7. This clearly shows that one cannot forecast

Figure 7.6

15-step forecasts for $\Delta \ln y_t$ (SE based on error variance only) for Indonesia, 1909-1925.

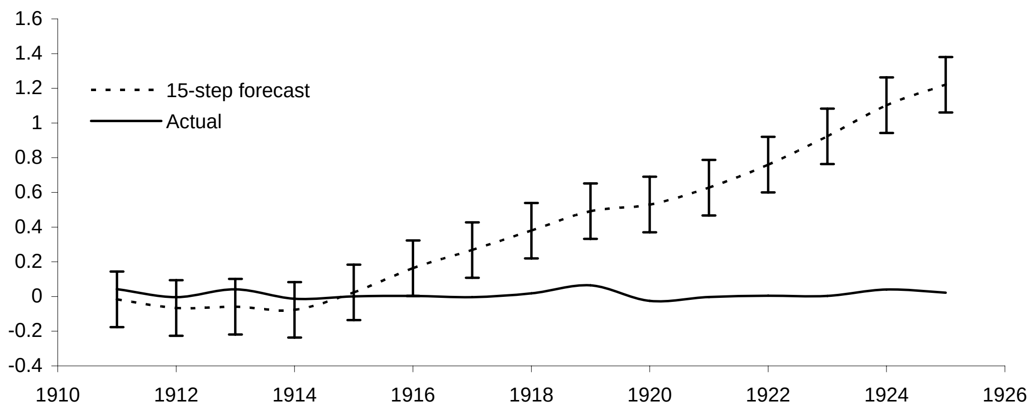
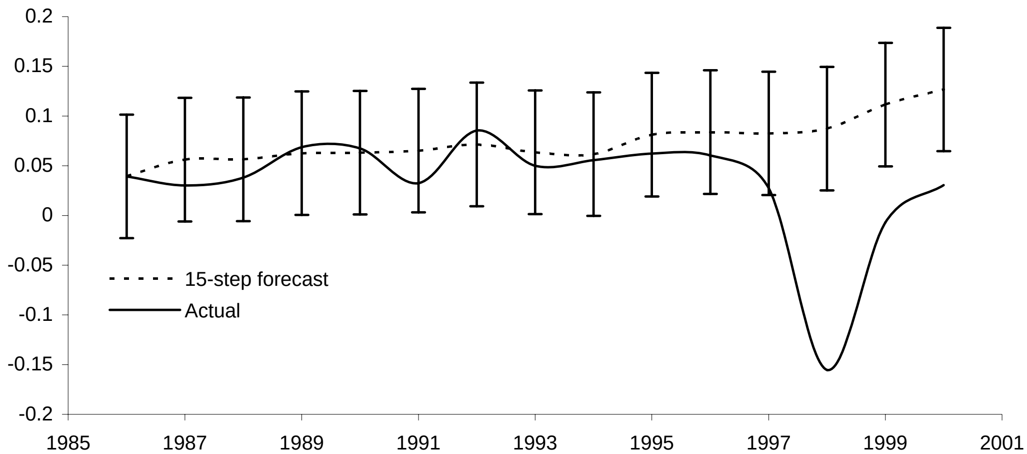


Figure 7.7

15-step forecasts for $\Delta \ln y_t$ *(SE based on error variance only) for Indonesia, 1986-2000.*

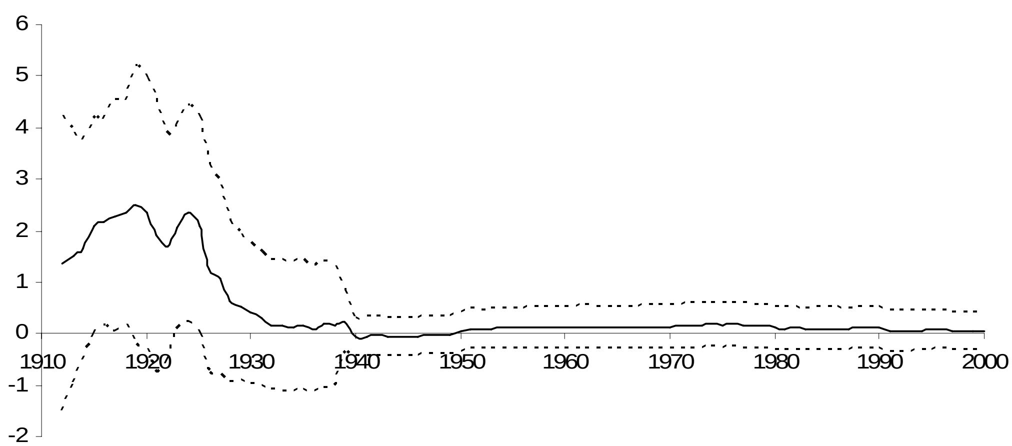


the development of per capita GDP growth after 1997 based on the relation between per capita human capital and per capita GDP growth between 1950 and 1990.

In India, there is a clear break in the recursive human capital coefficient in the 1920s (figure 7.8). However, les obvious breaks are also present. This is confirmed if we look at the forecasted value in figure 7.9 which shows a break in the 1940s when the

Figure 7.8

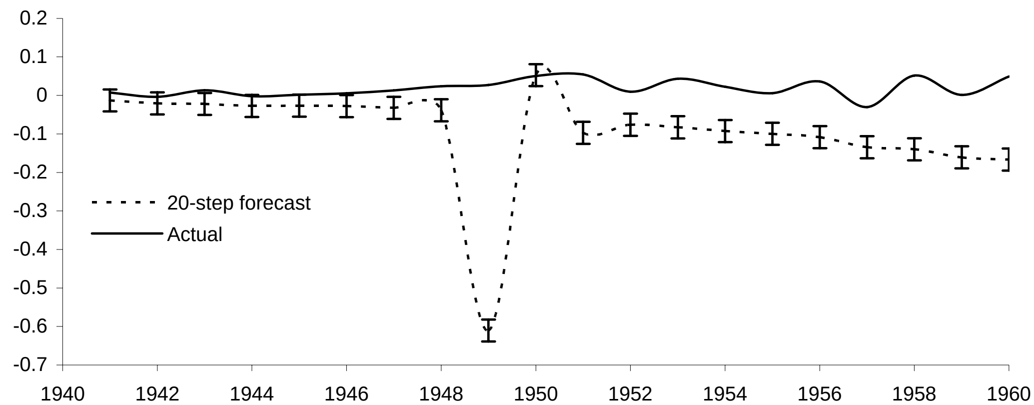
Recursive coefficient of $\Delta \ln h_{t-1}$ *from table 7.1 for India (+/- 2 standard errors)*



effect of the human capital coefficient starts to increase again after a drop in the 1930s. A final break one can distinguish in the 1990s. This is less visible because already two

Figure 7.9

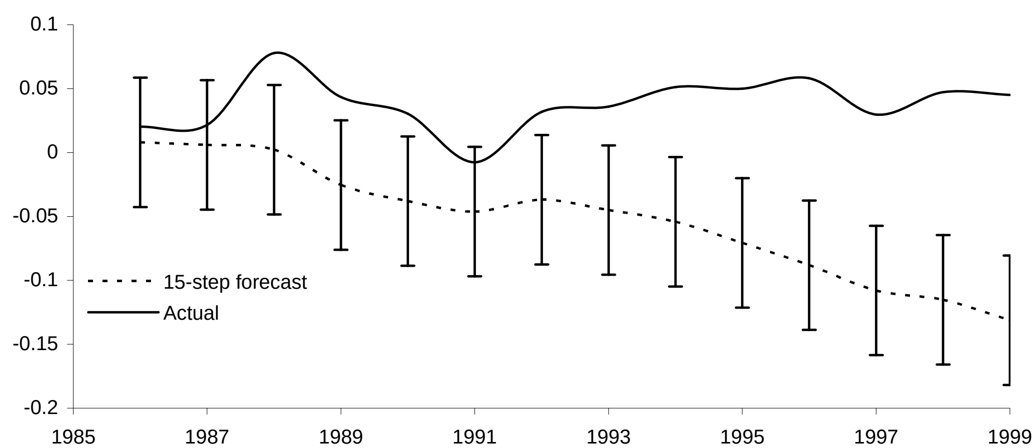
20-step forecasts for $\Delta \ln y_t$ *(SE based on error variance only) for India, 1941-1960.*



breaks preceded it. Yet, in figure 7.8 we still find a minor decline in the effect of human capital on economic growth. This is also confirmed in figure 7.10 which shows that the forecasted values diverge considerably from the actual values since the early 1990s.

Figure 7.10

15-step forecasts for $\Delta \ln y_t$ *(SE based on error variance only) for India, 1986-1999.*



In addition, the breakpoints for these three countries are confirmed when we include multiplicative dummies, i.e. variables that indicate 0 or 1 before or after a certain year and which are multiplied with the human capital coefficient. If they are significant, this means that the effect of human capital is significantly different in the two periods.[149]

In sum, we found breakpoints for Japan around 1945 and 1990. In Indonesia and India, however, we found no less than three breakpoints. In Indonesia the first one was present in 1915, the second around 1960 while there was also an indication of a break in the 1990s. In India there were changes in the value of the human capital coefficient around 1920, 1950, and 1990. These breakpoints correspond well with the breaks found in chapter 4 (around 1940 for Japan [to higher education]; around 1920 [to secondary education] and 1960 [to higher education] for Indonesia; around 1920 [to primary education], 1940s [to secondary education] and 1990 [to higher education] for India).[150]

3.2 Estimates

Breakpoints as found in section 3.1 may have a strong impact on he size of the coefficient. To correct for these breakpoints, we will estimate equation (7.7) for the several educational phases. Three points are worth remarking here. First, we excluded physical capital because it creates more problems than it solves. This will be elaborated upon in section 4. We did run some regressions with the growth of per capita physical capital, however, but this did not significantly alter the results. Second, we ran regressions for several time periods. However, in two cases these time periods do not follow up (there are some years after the end of one regime and the start of the following), i.e. in India 1942-1950 and in Japan 1945-1950. In both cases these were periods of great turmoil influencing both human capital and economic development (India during the Second World War and independence and Japan during the American occupation). Third, we included a polynomial of the level of per capita human– and

[149] We included multiplicative dummies for all three countries for all years. For each year we ran a separate regression. We found significant multiplicative dummies for 1950 and 1970 for Japan, for 1920, 1950, and 1970 for Indonesia, and for 1920, 1940 and 1970 for India. With some minor differences this seems to conform well to the breaks found using the recursive graphs. Of course, we have to be aware that the methods are also somewhat different. As the breaks do not take place from one year to the other (it is likely to take at least a decade) the use of a multiplicative dummy will be exactly between the two values of the human capital coefficient. Depending on how the human capital coefficient changes during the break, this can be both at the beginning and at the end of the break. As the recursive graphs indicates when the value of the coefficient moves out of its significance border, the exact place of the break depends on a) how the value of the coefficient changes (for example first slowly and then fast), and b) if other breaks have preceded this break.

[150] For India the enrolments compositions are fairly stable. However, the indicated breakpoints show mainly a shift in government focus to the respective education levels, often combined with a small increase in the share of enrolments (and a far greater rise in the absolute enrolments figures) at that level.

physical capital only where applicable. As we saw in table 7.1 and 7.2, generally we only include a second degree polynomial in a time series regression over 100 years. This means that the length of the cycle is around 100 years and, consequently, the peaks and troughs will each last for about 50 years. As the regimes found in the previous sub-section are around 30 or 40 years, this means that we generally have to include at most a first degree polynomial, i.e. only the level of the human- to physical capital ratio. Only if the regime covers a period where the coefficient of the imbalance effect is both above and below the average imbalance effect, a second degree polynomial is appropriate.

This brings us to the regression results, reported in table (7.3-7.5), which show an improvement over the earlier regressions in chapter 6 and in table 7.1-7.2. The first difference we note is that the R^2 increased in almost all cases, the sole exception being Indonesia between 1960 and 1992.[151] Second, in all regressions, normality of the residuals cannot be rejected. Consequently, we can interpret the *t*-values, even given the small samples, in the usual way.[152] Third, the coefficient of $\Delta \ln hc_{t-1}$ is far more stable, indicating that the regime changes have disappeared. Indeed, plotting some recursive

Table 7.3 Estimation of the effect of human capital in India between 1892 and 1990, corrected for breakpoints*

Dependent variable: $\Delta ln\, y_t$

	1892-1920		1920-1942		1950-1990	
	Coefficient	t-value	Coefficient	t-value	Coefficient	t-value
Constant	3.813	4.66**	1.611	2.45**	2.591	4.07**
Trend	0.012	4.76**	-0.006	-6.57**	0.013	4.51**
$\Delta ln\, y_{t-1}$	0.167	1.01	-0.280	-1.70	-0.085	-0.685
$ln\, y_{t-1}$	-0.662	-4.65**	-0.221	-2.16**	-0.554	-4.29**
$\Delta ln\, h_{t-1}$	1.964	2.01**	1.906	4.12**	4.289	4.37**
$ln\left(\frac{h}{k}\right)_{t-1}$	0.271	3.02**	-		-	
R^2	0.765		0.795		0.629	
Obs.	29		23		41	
AR1-1 (prob)	0.422		0.732		0.986	
Normality(prob)	0.699		0.875		0.112	

*Dummies not reported
** Significant at 10% (because of the small sample the t-values must be bigger than 1.645 in order to be significant)

[151] Although interesting, this is not entirely surprising as the smaller sample sizes increase the R^2.
[152] Again, we must be aware that the small sample size makes it necessary to use higher t-values to determine the significance of individual variables.

Table 7.4 Estimation of the effect of human capital in Indonesia between 1892 and 1992, corrected for breakpoints*

Dependent variable: $\Delta ln\, y_t$

	1892-1920		1920-1960		1960-1992	
	Coefficient	t-value	Coefficient	t-value	Coefficient	t-value
Constant	10.168	6.55**	0.613	2.86**	-0.060	-0.43
Trend	0.025	6.81**	0.002	1.62	n.a.	
$\Delta ln\, y_{t-1}$	0.766	3.78**	0.459	5.09**	0.118	0.782
$ln\, y_{t-1}$	-1.622	-6.60**	-0.108	-4.46**	0.012	0.625
$\Delta ln\, h_{t-1}$	1.455	2.10**	1.552	1.77**	1.483	1.11
$ln\left(\frac{h}{k}\right)_{t-1}$	-0.254	-6.35**	-		-	
R^2	0.906		0.943		0.577	
Obs.	29		41		33	
AR1-1 (prob)	0.054		0.358		0.738	
Normality(prob)	0.120		0.554		0.223	

*Dummies not reported
** Significant at 10% (because of the small sample the t-values must be bigger than 1.645 in order to be significant)

Table 7.5 Estimation of the effect of human capital in Japan between 1896 and 1990, corrected for breakpoints*

Dependent variable: $\Delta ln\, y_t$

	1896-1945		1950-1990	
	Coefficient	t-value	Coefficient	t-value
Constant	2.472	3.54**	-11.451	-3.56**
Trend	0.011	4.78**	-0.015	-5.41**
$\Delta ln\, y_{t-1}$	-0.048	-0.387	0.338	3.54**
$ln\, y_{t-1}$	-0.403	-3.95**	-0.038	-0.734
$\Delta ln\, h_{t-1}$	4.601	2.43**	-1.130	-0.580
$ln\left(\frac{h}{k}\right)_{t-1}$	-		n.a.	
$ln\, h_{t-1}$	n.a.		1.243	3.43**
R^2	0.883		0.887	
Obs.	50		41	
AR1-1 (prob)	0.706		0.328	
Normality (prob)	0.515		0.905	

*Dummies not reported
** Significant at 10% (because of the small sample the t-values must be bigger than 1.645 in order to be significant)

graphs showed no sign of breakpoints.[153] Fourth, almost all coefficients have the right sign. The growth of human capital, $\Delta \ln hc_{t-1}$, has a positive sign and always exerts an important influence on economic growth. Japan in the second half of the century proves an exception (due to Romerian growth) as its coefficient of the growth of human capital is negative, although not significant. The coefficient of the level of human capital, which is only present in Japan in the post World War II period due to Romerian growth, is positive and significant. Fifth, the value of the coefficients of the growth of human capital increases strongly when correcting for breakpoints and proves rather stable over time. On average (again with the exception of Japan after 1950) the coefficients are above 1. As we excluded the growth of physical capital, the coefficient should indicate the effect of capital on growth plus a possible positive external effect (see section 2 in this chapter). This means that in most cases we come close to constant returns to scale.

Finally, the effect of the long-run coefficient of the growth of human capital, $\Delta \ln y_{t-1}$, is in somewhat more than half of the cases insignificant, which means that we have come close to identifying the equilibrium growth path of $\Delta ln\, h_{t-1}$ after filtering out the imbalance effects of the level of the per capita stock of human capital. In other words, because the coefficient of $\Delta ln\, h_{t-1}$ indicates the equilibrium growth path, we expect the short and long-run coefficients to be equal. In over 60% of the cases this is indeed the case. However, even in those cases where a long run effect exists, 90% of the effect has taken place within 2 years.

3.3 An interpretation of the results

The analysis of the breakpoints and the regression results can be used to evaluate the two hypotheses on the effect of the historical development of human capital forming institutions on economic growth, i.e. that a changing relation between human capital and economic growth exists over time, and that the relation between human capital and economic growth is more efficient in Japan than it is in India and Indonesia.

First, institutional changes cause breakpoints in the relation between human capital and growth. Hence, the breaks found in chapter 4 must correspond to the breaks found in section 3.1 of this chapter. Indeed, we already mentioned that this seems to be the case. Although this provides strong evidence in favour of this hypothesis, it still does not give definitive proof. For this to be the case each phase must have a unique

[153] The same goes for the coefficient of the growth of physical capital when we inserted it.

human capital coefficient. This also means that, as we found in chapter 4 that the education development in India was the reverse of that in Indonesia, the changes in the human capital coefficient over time are also reversed. We can determine this by looking at the results of the regressions in tables 7.3-7.5. However, before doing so, it is important to be aware that we estimated a dynamic model as we included lags of the independent variables in order to avoid a simultaneity bias. Yet, the original production function (equation (7.2)) is a static model. Fortunately, we can transform the coefficients of $\Delta ln\, h_{t-1}$ in such a way that we can interpret them as a static model. The results, based on a method described in appendix A.14, are presented in table 7.6.

The modified coefficients of $\Delta ln\, h_{t-1}$ in table 7.6 do not significantly differ from those in tables 7.3-7.5. We thus find, as expected, that the pattern in India and Indonesia is exactly the reverse. Whereas in Indonesia the coefficient of $\Delta ln\, h_t$ increases in the mid-twentieth century and declines in the final decades of the century, in India we witnessed a decline and later an increase. As their educational structure is also the reverse, this means that for both countries the phase with a relatively large increase in primary enrolments had the lowest human capital coefficient. Unfortunately,

Table 7.6: Conversion of the coefficients of the growth ($\Delta ln\, h_{t-1}$) of human capital (dynamic model) to the coefficients of $\Delta ln\, h_t$ (static model)

	$\Delta ln\, h_{t-1}$	
	Uncorrected β_4	Corrected $\beta_4 = 1+\gamma$
Japan		
1896-1945	4.60	4.64
1950-1990	-1.13	-1.09
Indonesia		
1892-1920	1.45	1.46
1920-1960	1.55	1.58
1960-1992	1.48	1.06
India		
1892-1920	1.96	1.85
1920-1942	1.91	1.82
1950-1990	4.29	4.12

Source: coefficients table 7.3-7.5, method: appendix A.14.

we cannot confirm this for Japan, as the phase with a large relative increase in primary enrolments ended around 1870, i.e. before the start of our data. Nevertheless, the finding of a low human capital coefficient during the phase of a relatively increasing share of primary enrolments may be explained by the situation that this period witnessed the highest increase in human capital growth. Consequently, a higher growth of human capital leads to a less firm connection with the economy and, consequently, a lower human capital coefficient.

The second hypothesis about the relation between human capital accumulation and economic growth is that the educational regimes are more firmly embedded in society and economics in Japan than in India and Indonesia. This has two consequences. First, because human capital is less well connected to society in India and Indonesia and, to a large extent, has a colonial origin, the development of mass education took place later than in most developed countries. Hence, the breakpoints in India and Indonesia should more or less coincide and they should lag behind those of Japan. Indeed, it seems that each regime has its unique effect on economic growth. This was especially prevalent in the case of the regime dominated by a relative increase of primary enrolments. This phase was still present in Indonesia around 1900. However, Japan was already in the phase dominated by a relative increase in secondary enrolments. Thus Japan was leading in educational development compared to Indonesia (and India) as the first regime had already ended before the 1890s. This seems to confirm our finding in chapter 4 that the first phase had ended in Japan already in the 1870s, at the time that the rise of mass education started in Indonesia. We attributed that partly to the efficiency of human capital accumulation in Japan. Because Japan experienced an educational development based on its own economic and social developments while India and Indonesia did not, it is logically that this development set in earlier in Japan and was only later copied by India and Indonesia.

The second consequence of the hypothesis of a higher efficiency of institutions in Japan is that the human capital coefficients will also be higher for Japan. Looking at table 7.6 we note that the human capital coefficient of Japan for the pre-1950 period is higher than those for India and Indonesia (after 1950 in Japan the coefficient of $\Delta ln\, h_t$ declines and that of $ln\, h_t$ rises, which we attributed to a shift from Lucasian to Romerian growth). In addition, we find that the human capital coefficients for India are higher than those for Indonesia. This suggests that in Japan human capital is better connected to the economy than in India and Indonesia, while India in turn outperforms Indonesia. This finding is partly confirmed by our back of the envelope estimates in section 4 in chapter 5 which indicated that the quality of human capital is highest in Japan, followed by India and Indonesia respectively.

The acceptance of these two hypotheses and their consequences for breaks in the relationship between human capital and growth and for the height of the human capital coefficient, straightforward as they are, is important for any study on the relation between human capital and growth. As we have seen, keeping account of breakpoints strongly increases the coefficients. However, the height of the coefficient is also dependent on the efficiency of human capital accumulation, the type of growth (Romerian or Lucasian), and the educational phase a country is in. Although these factors are all interdependent, it is still difficult to correct for them using either dummy variables or fixed effect panel regressions.

4. IMBALANCE EFFECTS

4.1 The imbalance effect

The results from the previous section are also interesting in another respect: they give information with respect to the imbalance effect. As we already pointed out, cycles in the imbalance effect take around 100 years. This means that, as our samples only stretch over about 30 to 50 years, mostly only at maximum a first degree polynomial has to be inserted to capture either the positive or negative effect on per capita GDP growth. This is indeed the case in tables 7.3-7.5. Although a very interesting topic, here we will use the imbalance effect solely to introduce two other important topics which we neglected so far and which relate closely to the imbalance effect, namely the inclusion of physical capital in the regressions as a separate factor of production and the correction of the dependent variable, $\Delta ln\, y_t$, for the inclusion of human capital. In addition, as the imbalance effect is often considered to be present during Lucasian growth, we might consider the presence of such an imbalance effect an extra test for the existence of Lucasian growth.[154]

4.2 A test for the presence of imbalance effects

The presence of an imbalance effect might be indicative of Lucasian growth. Of course, the cyclical fluctuations of the coefficient of the human- to physical capital ratio, and the polynomial which switches signs for every degree, are strong indications of the

[154] Please note that the main reason why in the Romer (1990) theory there is no imbalance effect is that human capital formation seems to come at no cost. However, such an assumption is doubtful.

presence of such an effect. In addition, some preliminary evidence on the presence of an imbalance effect was offered in section 2.2 of this chapter. However, in this section, we propose an alternative test by inserting the growth of physical capital in the equation.

Inserting the growth of per capita physical capital, $\Delta \ln k_{t-1}$, into equation (7.7) also has an additional advantage. In the literature, there is a debate on the effect the inserting of per capita physical capital growth in the growth regression has on the human capital coefficient. Many studies have argued that physical capital has a strong impact on growth. One demanding reason not to include physical capital is that we only have a limited number of observations in our time series. Consequently, including an extra variable reduces the degrees of freedom. However, on a more theoretical basis we can also argue that physical capital can be left out from the regression. In general, following Krueger and Lindahl (2001, 1126), the conclusion seems to be that 'unless measurement error problems in schooling are overcome […] cross-country growth equations that control for capital growth will [not] be very informative insofar the benefit of education is concerned.' Yet, excluding the growth of physical capital from this equation may result in an omitted variable bias because the standard production function, equation (7.2), requires the presence of physical capital in the empirical model.[155]

Indeed, the only case when physical capital may be left out of the equation is when the growth of human and physical capital is equal, i.e. $\Delta \ln y = \Delta \ln k = \Delta \ln hc$. For this restriction to hold, and therefore to legitimize omitting physical capital from the equation, two assumptions have to be satisfied:

[155] An alternative to including physical and human side by side in an equation might be necessary because of correlation between these two variables. Therefore, when we start with the assumption that the coefficients of the growth of human-and physical capital together are the same of the coefficient of the growth human capital when inserted alone in an equation:

$$(1-\beta+\gamma)\Delta \ln hc_{t-1} + \beta \Delta \ln k_{t-1}$$

We can also write:

$$(1+\gamma)\Delta \ln hc_{t-1} - \beta \Delta \ln hc_{t-1} + \beta \Delta \ln k_{t-1}$$

Rearranging, we get:

$$(1+\gamma)\Delta \ln hc_{t-1} + \beta(\Delta \ln k_{t-1} - \Delta \ln hc_{t-1})$$

As a consequence, it is no longer necessary to insert physical capital side by side with human capital in one regression. However, in general, we find that this modification is not necessary because the correlation between the growth of physical and human capital is relatively low.

1) The stocks of human and physical capital have a constant ratio. This is only the case if an imbalance effect is present. If there is no constant ratio, the imbalance effects will cause faster growth of either $\Delta \ln k_{t-1}$ or $\Delta \ln h_{t-1}$.[156]
2) In the long run the positive external effect, γ, equals zero and there is no problem with the productive efficiency (the efficiency of human capital in creating per capita GDP growth).

Under these two assumptions it is possible to say that, given our basic regression ($\Delta \ln y_t = \alpha + trend + \beta_4 \Delta \ln h_{t-1}$), β_4 is in principle 1 and we can therefore omit $\Delta \ln k_{t-1}$. This has the interesting property that, whereas in the basic production function (equation 7.2), the standard equilibrium growth was:

$$g = g_k = (1-\beta+\gamma)g_h / (1-\beta) = B(1-\beta+\gamma)(1-u)/(1-\beta) \quad (7.13)$$

It now becomes (assuming that β is in principle 0, which means that $1-\beta=1$):

$$g = g_k = (1+\gamma)\, g_h = B(1+\gamma)(1-u) \quad (7.14)$$

This means that the human capital coefficient equals $1+\gamma$ (or, when assuming no positive external effects ($\gamma = 0$), that $g = g_k = g_h$). This means that there is no need to include physical capital in the equation.[157]

However, it is hardly likely that these two assumptions will be satisfied. One may argue that in the long-run positive external effects are incorporated in the stock of human capital. For example, if a labourer increases his productivity because he profits from the higher skill level of his co-worker, he will be inclined to offer his children the chance to also increase their skills and thus increase their productivity and earnings even further. However, it is unlikely that the productive efficiency of human capital is equal in all three countries as we have seen under hypothesis 2 in section 3.3.

But what happens if we look at the first assumption? We start by re-estimating the regressions from tables (7.3-7.5) with the per capita growth of physical capital as an extra independent variable. The results are presented in table 7.7.[158] Comparing the sum of column 1 and 2 in table 7.7 with column 2 in table 7.6, we find that the coefficients of the growth of human and physical capital together sum to about the same values as

[156] This condition can of course also be met if technical and institutional factors keep the ratio permanently out of equilibrium.
[157] The growth of per capita GDP equals $B(1+\gamma)(1-u)$ (or $B(1-u)$ when there is no positive external effect).
[158] The results are (as far as the human capital coefficients are concerned) converted into a static model. We also included the physical capital coefficients that were not significant.

the coefficients in the situation where we only included $\Delta ln\, h_{t-1}$ (table 7.6). This means that, if there are no breaks in the data, or a correction for breaks is applied as we did in section 3, the ratio of human to physical capital must be constant. This is easy to see.

Table 7.7: Coefficients of the growth of per capita stock of human capital, converted to a static model, and the coefficients of the growth of per capita physical capital. Both are presented in a regression with the standard GDP and with GDP corrected for total human capital accumulation for India, Indonesia, and Japan.

	Normal GDP		Human capital corrected GDP	
	$\Delta ln\, h$	$\Delta ln\, k_{t-1}$	$\Delta ln\, h$	$\Delta ln\, k_{t-1}$
	(1)	(2)	(3)	(4)
Japan				
1896-1945	3.27	0.52	4.18	0.60
1950-1990	-1.15	-0.01	-1.46	-0.004
Indonesia				
1892-1914	1.39*	0.06	1.28*	0.07
1920-1960	1.86*	0.10*	1.79*	0.10*
1960-1992	1.06	0.00	1.16	0.00
India				
1892-1920	1.83*	0.23*	1.69*	0.22*
1920-1942	1.81*	-0.01	1.43*	-0.08
1950-1990	4.19*	0.04	5.46*	0.01

* Significant at 10% (because of the small sample the t-values must be bigger than 1.645 in order to be significant)

The basic equation, excluding imbalance effects, is:

$$\Delta Lny = \alpha + \beta_4 \Delta ln\, h + \gamma \Delta ln\, k \qquad (7.15)$$

, where *k* is the per capita gross fixed non-residential stock of physical capital. Now, as we have seen, the coefficients of human and physical capital taken together are equal to the coefficient of the growth of human capital if the latter is inserted in the equation without the growth of per capita physical capital. Therefore, we can rewrite equation (7.15) as:

$$\Delta Lny = \xi + \left(\beta_4 + \gamma\right) \Delta ln\, h \qquad (7.16)$$

Combining equation (7.15) and (7.16):

$$\xi + \left(\beta_4 + \gamma\right) \Delta Lnh = \alpha + \beta_4 \Delta \ln h + \gamma \Delta \ln k \qquad (7.17)$$

Simplifying:

$$\gamma \Delta Lnh = \left(\alpha - \xi\right) + \gamma \Delta \ln k \qquad (7.18)$$

Rewriting:

$$\Delta Lnh = \frac{\left(\alpha - \xi\right)}{\gamma} + \Delta \ln k \qquad (7.19)$$

Now, assuming there are no structural changes in the first right-hand term of equation (7.19) (there are no technological or institutional changes [the parameters do not change]), this means that the growth of per capita human capital equals the growth of per capita physical capital. **This seems to prove that there is a constant ratio of human to physical capital** which in turn makes the existence of imbalance effects, as argued in section 2, plausible.[159]

This finding has two consequences. First, because an imbalance effect seems to be present, assumption 1 is satisfied. If this imbalance effect is present, if it has a U-curve, and if the economy is at the left hand side of the equilibrium ratio (see figure 7.1), the coefficient of the growth of human capital will be negative and that of physical capital positive (Pritchett 2001).[160] This might explain some of the negative human capital coefficients found in the literature.[161] Second, even though assumption 1 seems to be satisfied, this is only partly the case for assumption 2. This means that only under exceptional circumstances, if you are looking at the extremely long-run so that no positive external effects are present or if you are looking at a homogenous group of countries with an equal efficiency of human capital, $\Delta \ln k_{t-1}$ may be excluded from the regression.

4.3 Correcting GDP for human capital accumulation: a final extension

A final problem, which may influence both the inclusion of the growth of per capita physical capital and the presence of the imbalance effect is the inclusion of the total estimated human capital accumulation in GDP. The reason is that in current GDP estimates, based on the system of national accounts (SNA), only part of human capital formation is included (most notably foregone wages, experience, and home education are not included). Inclusion of these omitted factors in GDP may distort the estimates as the dependent variable, the growth of per capita GDP, changes. Therefore, we start by

[159] In addition, it might even be possible that in the long-run the ratio tends to 1. However, the only thing we can say is that figure 5.5 gives some evidence that the ratio moves to a value close to 1. However, this is only meager proof as this may also indicate that there is no steady state ratio because the ratio clearly changes over time. On the other hand, this changing ratio may be attributed to changes in educational phases.

[160] Pritchett (2001) argues that human capital is applied to activities that, although increasing wages, do reduce growth. Obvious examples are wasteful government bureaucracies. Although not explicitly stated, this may correspond to the left side of the imbalance effect from figure 7.1.

[161] However, if the economy is on the left side of the equilibrium ratio and the imbalance effect is downward sloping, the coefficient of $\Delta \ln hc_{t-1}$ is positive and that of $\Delta \ln k_{t-1}$ is negative (or insignificant in case no disinvestment of physical capital takes place).

looking how GDP changes and then move on to look at the effect on the human capital coefficients.

The inclusion of human capital formation in GDP especially increases GDP in the mid-twentieth century (see table 7.8). Here we see that in Japan the peak lies around

Table 7.8: Increase in GDP when corrected for human capital formation in Indonesia, India, and Japan, 1890-2000 using the expenditure approach

	Japan	India	Indonesia
1890-1900	*10.20%	1.50%	0.20%
1900-1910	14.02%	1.48%	1.30%
1910-1920	15.30%	1.68%	1.41%
1920-1930	16.17%	3.15%	1.34%
1930-1940	13.61%	5.28%	1.30%
1940-1950	13.06%	4.70%	2.60%
1950-1960	9.04%	5.87%	2.08%
1960-1970	4.42%	5.91%	3.31%
1970-1980	2.24%	5.96%	2.11%
1980-1990	2.82%	7.24%	1.04%
1990-2000	2.92%	6.14%	2.17%

* 1895-1900
Source: Appendix A.2 and A.13

1920-30, while in Indonesia it is around 1930-40 (and at the end of the century) and in India around 1970-80. This corresponds with the lagged development of these two countries. In other words, for all three countries we see that the increase in GDP, when corrected for human capital formation, increases most strongly in the period when the growth of secondary education was strongest. This period was also the height of the substitution of private (including home education) for public expenditure on education. In other words, the share of human capital formation not in GDP decreased as it was replaced by formal (state or private financed) education.[162]

The question is now how this change in GDP influences the coefficients of the growth of physical and human capital. The results of this exercise are presented in table 7.7 in columns 3 and 4. In general the effect of $\Delta \ln k_{t-1}$ on GDP remains about the same: it declines somewhat for India, remains the same for Indonesia, and increases slightly for Japan before 1950 and decreases after 1950. This effect might partly be caused by the increased growth rates of per capita GDP after the inclusion of total

[162] Obviously, the introduction of compulsory education was an important factor. Remember that in chapter 5 we pointed out that we included only ‘foregone wages’ as from the end of compulsory education. The introduction of compulsory education thus strongly reduces foregone wages, and thus reduces the share of human capital formation not included in GDP.

human capital formation for India, while the introduction of all forms of human capital formation in GDP caused a decline in growth rates in Japan. In Indonesia the growth rate of per capita GDP remained about the same. In other words, if the growth rate of per capita GDP increases, the coefficient of $\Delta \ln k_{t-1}$ decreases (India) and *vice versa* (Japan).

The effect of the change in GDP growth rates on the human capital coefficient is less clear. In some cases it increases the human capital coefficient (or remains about constant) and in other cases it decreases it. No clear pattern can thus be discerned and it will require a much larger database to give some definitive answers on this matter. However, our impression is that this has something to do with the imbalance effect. Inserting human capital in GDP will sometimes move the U-curve of the imbalance effects upwards (India) and sometimes downwards (Japan). Consequently, in the case of India, if the economy is on the left side of equilibrium ratio, the coefficient of $\Delta \ln k_{t-1}$ will increase and the coefficient of $\Delta \ln hc_{t-1}$ will decrease.[163] However, if the economy is relatively human capital abundant (right of the equilibrium ratio), the coefficient of $\Delta \ln hc_{t-1}$ will increase and that of $\Delta \ln k_{t-1}$ will decrease. In Japan, the situation is of course directly the reverse while Indonesia is between Japan and India.

5. SOME INTERPRETATIONS OF THE REASONS BEHIND ECONOMIC DEVELOPMENT IN JAPAN, INDIA, AND INDONESIA

5.1 Introduction

In chapter 6 and in the present chapter we have stressed that Japan, India, and Indonesia started from Lucasian growth at the start of the twentieth century. However, where India and Indonesia remained confined to Lucasian growth, Japan moved to Romerian in growth after World War II. Given that the institutional developments in these three countries mirrors the breakpoints in the relationship between human capital and growth, this suggests that the institutional development and its practical consequences such as the later human capital development in India and Indonesia, and the lower effect of human capital on economic growth, may offer important explanations for why these three countries economically diverged.

[163] This story changes if the left side has a downward sloping curve. In that case if Japan and India are both on the left side of the equilibrium ratio (physical capital abundant), in Japan the curve moves downward causing a lower human capital coefficient and in India upward causing a higher human capital coefficient.

5.2 A successful developer: Japan

Why did Japan develop faster than India and Indonesia, a situation that was emphasized because it was the only country that moved to Romerian growth in the mid-twentieth century? We distinguish four points. A first point is that the efficiency of the education system was higher in Japan than it was in India and Indonesia. In Japan, education was better connected to society and economy than was the case in India and Indonesia which was partly due to, besides the ideal of creating a strong state, economic and social developments that led to educational development in Japan after the Meiji restoration in 1868. In India and Indonesia, as in most developing economies, it were largely ideas of 'creating an indigenous class of literati', a 'moral duty of the colonizer country', nationalism, and, after World War II, the 'idea of progress by education', 'lack of finances', and 'policies of international organisations' that drove their educational development. In other words, it were often global, or at least external, factors that influenced the education systems of India and Indonesia (Ramirez and Boli 1987, 10; Stewart 1996).

The differences in the efficiency of the education systems have three implications for economic development. First, being a technical problem, in section 3 in chapter 6 we noted inefficiency (in *B*) in the second sector to be present in India and Indonesia in the mid-twentieth century. Given the test used, this caused diminishing marginal returns to human capital accumulation. Yet, after correcting for inefficiency in *B*, we found increasing marginal returns. But no such inefficiency seems to be present in Japan. Thus we cannot argue, as we did for India and Indonesia, that other factors caused the diminishing returns and that Lucasian growth remained present. Second, because Japan experienced a more economy centred development, its education system started to develop earlier than was the case in India and Indonesia. This we also saw in chapter 5 where we noted that the per capita stock of human capital of Japan around 1900 far exceeds that of India and Indonesia. Because Japan already had a far higher education level around 1950, further educational growth was unlikely to be accompanied by constant marginal returns. For example, if there are already 10 teachers for each student, to add an eleventh teacher will not add much to human capital accumulation. Third, a better educational development also raises incomes, especially because there was a closer connection between human capital and the labour market. A higher income per head in turn created the opportunity to keep expanding educational spending even in the 1950s and 1960s. So, whereas India and Indonesia were trapped in vicious cycles of low per student spending and fairly low growth, Japan was in a virtuous cycle with high growth and fast rising educational spending. Therefore, Japan did not only develop earlier but also faster in education.

This brings us to the second point why Japan experienced a shift from Lucasian to Romerian growth. It is likely that, because Japan developed earlier and faster, it did not have to face constraints that were present for later developers. As pointed out in section 2 of chapter 6, Lucasian growth implies human capital accumulation. But this can also affect economic growth through adopting (foreign) technologies. As has been argued by O'Neill (1995, 26), the rise in the level of education causes convergence among countries. However, this convergence is reversed for developing countries by human capital biased technological growth, which increases the rate of return for higher education and thus favours the developed world. In other words, because technological development nowadays requires secondary and higher education, in which the developed countries have a relative advantage, developed countries profit more from new technologies than do developing countries. As Japan is clearly ahead in education development compared with India and Indonesia, the adoption and creation of new technologies will also likely be faster. Indeed, in 1950 the average years of schooling in Japan was 6.9 years against 1.8 in India and 1.5 in Indonesia.

Third, unlike India and Indonesia, Japan had an educational development large enough to create an extensive manufacturing sector. Initially Japan witnessed a dual economy where artisan industries coexisted with modern industries. This caused an equal division of wages and thus of educational development. This combination of artisan with modern industries was special for Japan compared to India and Indonesia. This is combined with the situation that Japanese agriculture is labour intensive because of the small plots of land (Buchanana 1923, 550). Many professions, which did not require access to land such as blacksmiths, day workers, or cotton mill workers, were filled as agricultural by-employment. In effect, wages in these professions remained almost equal to farm wages. Therefore, the growth of manufacturing was possible by low wages and a high availability of skills, which in turn created the opportunity to acquire more technology (Mayer 2001, 19).

Because of the technological and human capital development, as a fourth point Japan came increasingly closer to the technological frontier. The government sponsored industrialisation and rising skill levels caused a separation of not only factory industry but also artisan industries from agriculture. As a result, wages diverged and the demand for higher skills became more pronounced. For example, in the 1920s and 1930s as a rule only those who had finished the six year elementary course were employed at the mills (National Confederation of Industrial Associations of Japan 1937, 7). This made it preferred to create new technologies to reduce the wage bill and increase productivity. This approach of a threshold level is also acknowledged by Kim and Oh (1999, 13) when they argue that "[f]or economies in which government take initiatives for industrial development, their lion share of resources is usually allocated to strengthen the supply side of technology, such as training manpower, supporting basic science, and establishing public R&D institution. (…) Once their accumulated level of capability reaches a certain level of supply, (…) then the demand for technology will be motivated indigenously." They find that Japan had passed this threshold level in the second half of the twentieth century.

5.3 Late-comers in economic development: India and Indonesia

In India and Indonesia Lucasian growth seems to be present over the entire twentieth century. Figures 6.2 and 6.3 show for both countries extended periods of increasing and diminishing marginal returns. But table 6.2 shows a positive effect of the growth of human capital, suggesting Lucasian growth. Also, regression 2 in table 6.1 showed that in a primitive way correcting for inefficiency in human capital development results in the removal of diminishing marginal returns. This suggests that either there were no periods with diminishing marginal returns or the periods that were present did not mark an end to Lucasian growth as was the case in Japan.

But why was this the case? First, in chapter 6 we argued that, using the Monteils (2002) model, just as in Japan there are troughs in the marginal returns. But unlike Japan, this can be explained by increasing inefficiency in human capital formation (*B*).

Second, as we argued in chapter 4, in Indonesia and India human capital is only loosely connected to the labour market. For example, in Indonesia before independence, there was a dual educational structure for Indonesians and Europeans. Yet, it was difficult for educated Indonesians to enter the labour market. Indonesian enterprises were largely artisan and, as a result, generated not much demand for formally educated Indonesians. As a consequence, educated Indonesians were almost entirely working in the Government sector and the remainder in the European industries. Only a few were self-employed or had jobs in Indonesian enterprises. This vision is confirmed in a report about the metal industry at Surabaya in 1926. This industry was largely European, but employed many Indonesians. Of these Indonesians there are data about their education level, not only of western but also of Indonesian education (see table 7.9). Interestingly, we see that a low level of only 7% of the Indonesian employees had any formal

Table 7.9: Education level of indigenous employees in the metal industry in Soerabaja in 1926*

Education level	% employees
No education	92,6%
Indonesian primary school	5,4%
European primary school	0,7%
Dutch-Indies school	0,6%
K.E.S. Secondary technical school	0,0%
Indonesian vocational school	0,1%
Burgeravondschool	0,2%
Other schools	0,3%

* 28 enterprises
Source: A.G. Vreede (1926, 10)

education. We also see that from this 7% by far the largest share had been enrolled in Indonesian education. Because the metal industry demanded a relatively high level of education, this figure is higher than it would be for most other industries. Therefore, it is not likely that Western, or Indonesian education for that matter, for Indonesians was a way to develop the indigenous economy (Hollandsch-Inlandsch onderwijs-commissie 1930, 26).

Third, Lucasian growth means that productivity per employee grows if human capital grows. This can be reached by adopting new technologies. But, clearly, India and Indonesia lagged behind the western countries and Japan. This makes it difficult to adopt new technologies, not only because technology is often biased toward higher education in which developed countries often have a comparative advantage (see O'Neill 1995), but also because it is often politically difficult to modernize as this will cause social unrest.[164] An interesting example can be found in textiles in India and Indonesia. In India, caused by high wages, labour unrest, taxation policy, and bureaucratic control, it were the wages of handloom weavers and the small powerloom operators that experienced rapid growth during the 1960s while the larger-scale sector (textile mills, mainly found in the metropolitan areas) declined. Wages in mills, for example, could be up to three times as high compared with more modern small scale

[164] For example, Clark (1987, 168-169) argues that the local environment has a strong influence on whether workers are willing to adopt more or different machines.

powerloom operators (RoyChowdhury 1995, 233). In the mid 1980s more market forces were let in but this did not reverse the trend. The same was true in Indonesia where the textile industry, which had known already a large growth after the 1930s partly because of a protective policy of the colonial government, continued to grow under the same policy after independence. Because of the lack of competition, however, the number of powerlooms, even after independence, remained small compared with handlooms. At the end of the 1950s and the start of the 1960s this industry was using only some of its capacity. Problems were the shortage of spare parts, lack of skilled labour, and especially the shortage of raw material (raw cotton and yarn) (Palmer and Castles 1965, 41). This was because the spinning industry could not supply enough yarn. And, much yarn, imported by the State Trading Corporations, was sold on the free market, reducing its availability. Also, the yarn that did enter the producers' hands directly through quota had to be paid for in advance. Many smaller producers could not pay the quota and worked for intermediaries who paid the quota, or sold their quota to larger and more efficient producers. In this way the larger producers got more raw materials (Palmer and Castles 1965, 43). Under Sukarno's licensing system it was thus profitable to have a license for a loom even though it was a handloom. Then one could obtain a quotum of yarn, which could be sold to larger and more efficient producers (Boucherie 1969, 55). This allocation system was abolished in 1967 and the channelling of yarn was left to market forces. Nevertheless, productivity rose only slowly, even in the modern (powerloom) sector. In the larger factories that could have had economies of scale there were old looms, often from the 1930s and 1940s, while the smaller factories used more modern looms but had no economies of scale (Boucherie 1969, 58). These two examples suggest that political and technological barriers for later developers could be an important reason of lower efficiency and growth in these countries.

But there is also a fourth reason why these countries suffer from lower growth. Barro and Sala-i-Martin (2004) intuitively developed an imbalance effect of the stocks of human and physical capital in the Lucas model which we discussed in section 2 of this chapter. When the ratio of physical to human capital exceeds the equilibrium ratio (there is too much physical relative to human capital), the rate of economic growth declines. When the ratio of physical to human capital rises (there is too much human relative to physical capital), economic growth accelerates (this means assuming a downward sloping line as indicated in figure 7.1).[165] If one wants to increase economic growth, it is thus preferable to have an excess of human capital. But an excess of either human- or physical capital reduces the returns on the abundant factor and therefore more will be invested in the scarce factor. Yet, whether countries can get a growth bonus in this way is also dependent on technology. If technology is labour biased, which it usually is, then in countries where the elasticity of substitution between skilled and unskilled labour is small, the price effect dominates and technology is directed at the scarce factor of production. That is, if human capital is abundant relative to physical capital, technology is directed at unskilled labour and *vice versa*. But in countries with a high elasticity of substitution, the market effect dominates and technology is directed toward the abundant factor (Acemoglu 2002).

As pointed out, countries with a higher educational development (and a higher economic development) show Romerian growth which does not know an imbalance effect.[166] Indeed, if we, like Grandville (1989, 479), see the elasticity of substitution as 'a measure of the efficiency of the productive system', we may argue that countries with a lower efficiency of human capital (or a less strong connection between human capital and the economy) suffer from a low elasticity between skilled labour (as a measure of human capital) and unskilled labour. So, it is likely that developed countries have a higher elasticity[167], but, as we have seen for Japan, they also may be in a phase of Romerian growth where this imbalance effect is of less importance.

This has the interesting result for developing economies that, when there is an excess supply of physical capital, technology is focused at skilled labour (which is the scarce component in the relation between skilled and unskilled labour). This increases the productivity of skilled labour, increasing its returns, and thus slows down investments in human capital to arrive again at the equilibrium ratio of human to physical capital. Conversely, if there is an excess supply of human capital, technology will again be directed at the scarce factor (unskilled labour). As physical capital is not

[165] Theoretically (Barro and Sala-i-Martin 2004) it is also possible that in both cases economic growth increases. However, in empirical studies generally a positive relation is found between the human capital-physical capital ratio and economic growth (see Duszynski 2003).
[166] This is, at least in theory, the case.
[167] A low elasticity of substitution seems to be especially prevalent in developing economies. We found that the elasticity between the skill premium and the skilled wage (and as a consequence the elasticity between unskilled and skilled labour) was much higher in Japan than in India and Indonesia. However, elasticities above 1.4 between skilled and unskilled wage (between high school and college labour) were also found for the United States, Canada, and the United Kingdom by Katz and Murphy (1992: 72) and Card and Lemieux (2001: 734).

necessarily solely embodied in unskilled labour, there is no reason investments in physical capital are slowed down. Therefore, in countries with a low elasticity of substitution, adapting to the equilibrium ratio from an excess supply of human capital will be faster than from an excess of physical capital. As the former increases growth while the second reduces it, the overall long-run effect will be negative. In other words, a low elasticity of substitution between skilled and unskilled labour as is likely to be found in developing economies causes a decline of their steady state growth because the positive effects of the imbalance effect are outweighed by the negative effects.[168]

6. CONCLUSION

In this chapter we turned to some alternative methods to estimate the effect of the growth of the per capita stock of human capital on the growth of per capita GDP. We found, as outlined in the previous chapter, that the Lucas theory fits the actual relation between human capital and economic development quite well. Indeed, when estimating this model all coefficients of the growth of human capital turn out to be positive and significant. The inclusion of an imbalance effect and the use of alternative estimates of the stock of human capital also caused an increase in human capital coefficient. Where in table 2.1 (chapter 2) we saw that the coefficient fluctuated between -0.07 and 0.05, the inclusion of the newly estimated stock of human capital and an imbalance effect increased the coefficient in tables 7.1-7.2 in this chapter to between 0.03 and 2.4. In addition, also the other coefficients have the right sign. The exception is Japan in the period after 1950 when we found evidence in favour of Romerian growth. Second, we also found evidence of the presence of an imbalance effect as might be present in the model of Lucas (1988).

Using the hypotheses derived from our historical analyses in chapter 4 and using time series regression to avoid some of the problems associated with cross-section data, we arrived at several breakpoints in the relation between $\Delta ln\, h_t$ and the growth of per capita GDP. These breakpoints corresponded to a large extent to the shifts in the phases of human capital accumulation in chapter 4. This seems to indicate that the historical development of human capital is crucial when one wants to estimate the effect of human capital on economic growth. In addition, the hypotheses we derived in chapter 4

[168] Indeed, that a higher elasticity of substitution may increase steady state growth is also argued, for the Solow model, by Rainer Klump and Harald Preissler (2000). The main difference is that we argue that it works through the imbalance effect.

from the presence of these regimes were also confirmed. Each human capital phase had a unique human capital coefficient. This was especially prevalent in the phase with an increasing relative share of enrolments in primary education. This led to the lowest coefficients. Because India developed from higher to lower to higher education and Indonesia from lower to higher education, we expected that the human capital coefficient of Indonesia would increase and for India decrease from the first to the second phase, what it actually did. Also we found that the educational phases in Japan were leading in time compared to India and Indonesia. This might be caused by an educational development that was better connected to the economy. Indeed, we also found the human capital coefficients to be structurally higher in Japan than in India and Indonesia, confirming this interpretation.

These findings did not change if we included the growth of per capita physical capital in the equation nor if we corrected GDP for the shares of human capital accumulation that had not been part of the standard GDP, nor if we added an imbalance effect. Indeed, for periods with Lucasian growth, the inclusion of an imbalance effect seems important. We also tested this by inserting $\Delta \ln k_{t-1}$ in the equation. As the coefficient of the growth of human and physical capital together equalled that of the coefficient of human capital when inserted without physical capital, this led to the conclusion that a constant ratio between human and physical capital and, as a consequence, an imbalance effect, is likely to be present.

Institutional development thus seems to have an important effect on the relation between human capital and economic growth and, hence, on economic divergence. In section 5 we addressed this divergence, and, more specifically, the question why Japan moved from Lucasian to Romerian growth and India and Indonesia did not. We attributed this to three causes. First, in India and Indonesia, the education systems were less connected to the economy and thus less efficient. Second, because Japan developed earlier, obstacles in acquiring technologies were less pronounced. We referred to economic obstacles (a bias of technology to higher education in which developed countries have a comparative advantage) and political obstacles (institutions and policies that are harmful for technological modernisation). Third, in developing countries, technologies may be biased toward the scarce factor of production. In combination with an imbalance effect caused by Lucasian growth, this may in some cases result in an on average negative effect on steady state growth.

The findings in this chapter are of course very limited due to the small sample of countries. On the other hand, our findings seem to be supported by the historical development outlined in this and in the previous chapters. Nevertheless much research is still needed to confirm all the claims made here. To give an overview of our findings, we will present these briefly in the follow chapter. There, we will try to look at the consequences for between country growth patterns and try to provide some suggestions for further research.

8. A historical interpretation of the new growth theories: an overview

1. INTRODUCTION

The main question in this thesis was whether the new growth theories can explain why Japan was a successful economic developer compared to India and Indonesia. Similar questions, why some countries are poor any why others are wealthy, have fascinated historians and economists alike.

The Solowian neo-classical growth theory provided both economists and historians a way to analyze the growth paths of economies. However, already in the 1960s it became clear that also human capital played an important role. This led to the creation of the new growth theories which explained long-run growth from the availability of human capital. Yet, the increasing mathematical sophistication, coupled with the assumption of perfect markets in many of these models, made their use unattractive to many historians. On the other hand, economists remained with models that due to the assumption of perfect markets, made it difficult to explain cross country differences in the relation between human capital and growth.

The lack of testable models in the historical, and the lack of room for country-specific institutional developments in the economic method, made it difficult to answer our main question. Therefore, we had to combine the historical and economic approach. In that process, we ran into three obstacles. First, data, as Behrman (1999, 148) argues, "are essential for empirical analysis, limit the extent to which analyses can be undertaken, and shape most of the estimation problems." Indeed, human capital proxies which exclude aspects as 'experience' or the quality of human capital may bias the estimation results toward the branch of the new growth theories pioneered by Romer (1990). Second, we need to choose an empirical model that can determine the effect of human capital on economic growth. Third, we have to make a historical analysis that determines the differences in the development of educational institutions among India, Indonesia, and Japan from which we can derive some hypotheses on the changes in the relation between human capital and growth. These hypotheses can be used to see what effect institutional differences among countries have on economic growth and convergence.

There is both a historical and a data-centered thread in this thesis. The data, as pointed out in chapter 6, had an influence on the choice of the empirical model. We argued that the choice of data (including or excluding the quality of education) was important for the choice between the Lucas (1988) and Romer (1990) models of endogenous growth. In chapter 7 we argued that the changing institutions had a distinct impact on the relation between human capital and growth in India, Indonesia, and Japan. Hence, even if a plausible model is used with suitable data, it is still necessary to identify institutional developments or else regressions will be unstable.

In section 2, we start with the effects the data have on the choice of the empirical model. In section 3 we turn to the role of cross-country educational institutional changes in the relation between human capital and economic growth. Based on these estimates, we turn in section 4 to a brief analysis of cross-country economic con/divergence. The analysis so far still leaves much room for improvement, therefore in section 5 we make some suggestions for further research, followed by some final comments in section 6.

2. THE EFFECT OF DATA ON THE RELATIONSHIP BETWEEN HUMAN CAPITAL AND GROWTH

The choice of the human capital variable affects the choice of the growth model. We based our human capital estimates on a slightly modified definition of the OECD (2001, 18). We excluded innate ability so that our definition became ‘the knowledge, skills, and competencies embodied in individuals that facilitate the creation of personal, social and economic well-being’, or, in other words, all forms of knowledge gathering. This allowed us to construct new human capital stock estimates for India, Indonesia, and Japan for the period 1890-2000. The main advantage of this estimation method is that it takes account of all available data, takes all forms of acquiring knowledge into account, and is expressed in monetary units and can therefore be compared over time, across countries, and with other variables such as physical capital.[169]

[169] Of course the choice of estimation technique also has its drawbacks. We tried to include as much data as possible, without restricting ourselves too much in the period over which we can estimate the series. For example, some data on ‘on the job training’ exist for later periods, but this is certainly not the case for many developing countries, especially not if one goes further back in time. Consequently, we tried to estimate this indirectly. In addition, some parts of the human capital stock such as ‘experience’ and ‘home education’ could only be approximated. The main weaknesses, however, are the use of the

This definition has the important advantage that it allows us to better test the Lucas (1988) model. To obtain endogenous growth in this model, the effort needed to produce an extra unit of human capital should be the same, independently of the level of human capital. Possible reasons are that persons with higher levels of education more easily obtain extra knowledge or skills, the quality of human capital rises over time, and there is a rising intergenerational transfer of knowledge (L'Angevin and Laïb 2005). In all cases, the quality of human capital and factors such as 'home education' are important. Because these are left out from 'average years of education', studies using this variable are biased toward the Romer (1990) interpretation.[170]

We used our newly estimated human capital stock to test for the Lucas (1988) and Romer (1990) models. Using the method proposed by Monteils (2002), we found periods with increasing and decreasing marginal returns to human capital accumulation in all three countries. But, while the decreasing returns to scale in India and Indonesia could be explained by the decreasing quality of education or by deteriorating technical efficiency in the Lucasian second sector, this was not the case for Japan after the 1940s. This was confirmed by regressions of per capita GDP growth on the growth and the level of the estimated per capita stock of human capital. In both Indonesia and India we found a negative coefficient for the level and a positive one for the growth of per capita human capital, while in Japan the level of the human capital stock yielded a positive coefficient.

We can conclude from these results that India and Indonesia showed the symptoms of Lucasian growth over the entire twentieth century while in Japan economic growth switched from Lucasian to Romerian growth in the mid-twentieth century. That Japan made this transition while India and Indonesia did not is not surprising if we look at what Lucasian and Romerian growth actually entails. With the risk of oversimplifying, the difference between the two growth models rests on technological leadership. If a country is a technological frontier country, it cannot adopt technologies from other

depreciation/appreciation figures to calculate the stock and the regression to backcast the unobservable components of the human capital stock in the period before circa 1950. However, this regression showed a high R^2. Equally, the fluctuations in the series do not correspond with the changes in estimation technique. Consequently, it is unlikely that these factors have seriously biased the estimates.

[170] Admittedly, although this human capital stock is not directly related to the 'ideas' in the Romer model, it still can be used as an input in the R&D sector. Indeed, the investments in R&D estimated for Japan by Kim and Oh (1999) for the 1970s and 1980s have a highly significant correlation of 0.99 with gross fixed human capital formation as estimated here.

countries. Hence, technology must be endogenous. In those countries, a part of human capital will be used to create new technologies and a part to use these technologies in the productive process (Romerian growth). However, in the follower countries, technologies are adopted from other countries. Hence, human capital is used solely to apply these technologies in the productive process (Lucasian growth).[171] This basically means that if human capital passes a certain threshold level, a switch is made to Romerian growth because the country has become a frontier country in technological development. All factors that reduce GDP (and thus investments in education) and the growth of human capital thus retard the switch to Romerian growth. Although in chapter 7 we extend our argument a little further, in sum we offer three very tentative explanations why Japan moved from Lucasian to Romerian growth and India and Indonesia did not. First, in India and Indonesia, the education systems were less connected to the economy and thus less efficient. Second, periods where we found decreasing marginal returns to human capital accumulation coincided with periods which were likely to be subject to a lower efficiency of human capital accumulation. This means that, for those periods, constant marginal returns were possibly falsely rejected. Third, because India and Indonesia developed later, obstacles in acquiring technologies were more pronounced. To give just two examples, there are economic obstacles (a bias of technology to higher education in which developed countries have a comparative advantage) and political obstacles (institutions and policies that are harmful for technological modernisation).

[171] To phrase this differently it is sometimes argued that a certain level of human capital (or technological externalities with a threshold property (Azariadis and Drazen 1990)) has to be reached before Romerian growth takes place. Therefore, it is possible that Lucasian growth is a transition phase between pre-modern economic growth and Romerian growth. We can also interpret it as a shift from using the increasing personal human capital (Lucas 1988) for adapting or creating new technologies, which can either be sold or made to good practise by the innovators, to large scale R&D departments. In the long run there is a tendency to increase human and physical capital inputs in the innovation process. This makes it necessary to accommodate the innovation process in R&D departments in large scale enterprises (see for example Schumpeter (1950) and for some criticisms Lamoreaux and Sokoloff (1997)). A second argument in favour of the idea that Lucasian growth is a phase in the development toward Romerian growth is that Romer (1990) also inserted human capital as a factor of production in his model. A third way in which we tested the applicability of both models was by estimating in chapter 7 that in all periods in India and Indonesia the coefficients of the growth of human and physical capital together were as large as the coefficient of growth of human capital when inserted in the growth equation without physical capital. This suggested the presence of an imbalance effect just as is present in Lucas theory (Duczynski 2003; Barro and Sala-i-Martin 2004).

3. THE EFFECT OF CHANGING HUMAN CAPITAL FORMING INSTITTIONS ON THE RELATIONSHIP BETWEEN HUMAN CAPITAL AND GROWTH

3.1 Introduction

Both the Lucas (1988) and the Romer (1990) models are human capital models in the sense of chapter 4, i.e. they assume perfect markets and homogenous labour on a national level. Consequently, these models have difficulties in explaining the difference in the relationship between education and growth both between countries and over time. These differences are, however, important both on an economic and econometric level and from a policy-making perspective.

Economically, an analysis of the institutional developments is important because prior knowledge of these developments is necessary to be able to interpret the coefficients of the regressions. For example, if there are two groups of countries of which one group lags behind the other in educational development, inserting country dummies will result in the dummy picking up the effect of the difference in educational development on per capita GDP growth. However, if such breaks are not confirmed and identified in historical analysis, it is difficult to interpret the coefficient of the dummy in this way because it also might pick up the effect of other cross-country differences.

Econometrically, knowledge of these institutional developments is important to determine which variable to add to the regression. For example, most studies either use cross-section or panel analyses. However, when using such techniques, is a change in human capital coefficient between two countries caused by a change over time in which one country is lagging or are there cross-country differences? In the last case, a country dummy will suffice. In the former case it is possible that a country which lags in human capital development also lags in economic development. Inserting a country dummy thus may result in, for example, collinearity with initial GDP if that is inserted to test for conditional convergence.

Finally, although we did not pursue this argument in this thesis, from a policy point of view institutional developments and their effect on economic growth are important because they provide a way to increase growth by modifying these institutions.

3.2 The effect of educational development on economic growth

In chapter 4 we derived two hypotheses about the effect the institutional development has on economic growth. First, the changes in the enrolment composition are to a large extent the cause of the changing relation with economic growth. In other words, in phases dominated by increasing primary enrolments, human capital has a different relationship with economic growth than in phases dominated by increasing secondary or higher enrolments. Second, in India and Indonesia educational institutions developed largely as a result of external factors compared to a development based on an economic and societal demand in Japan. This had to consequences. First, in India and Indonesia, human capital forming institutions are less efficient than in Western countries and Japan.[172] Hence, in the former two countries the coefficient of the relation between education and growth is lower but still changing with the enrolment composition. Second, even though efficiency is less in Indonesia, it still forms the same pattern of educational enrolments as Japan (from increasing primary to increasing secondary and increasing higher education) only with a time lag. In India, however, educational development was top down. A relatively high share of secondary and high enrolments in total enrolments in the late nineteenth century was followed by an almost equal increase in on the one hand primary, and on the other secondary and higher enrolments.

These two hypotheses with their implications for the pattern of the human capital coefficients were discussed in chapter 7. First, the phases we found in the enrolment composition in chapter 4 corresponded well with the breakpoints in the relationship between human capital growth and per capita GDP growth, suggesting that each phase has its unique effect on economic growth. This became especially clear in case of India, which, having a reverse educational development compared to Indonesia, had a reverse structure of human capital coefficients.

[172] We indeed regularly argued that Japan was not colonized, therefore, after taking over some aspects of the Western education system, it could integrate these into her own social and economic structure. This was not the case in many colonies which had the same educational structure but not the same nationally based development. This recurring distinction was important in our study. However, one may argue that, if we go further back in time, the Europeans conquered Indonesia and India around 1600 but not Japan. In other words, Japan apparently had the means to effectively stand up against the Europeans. This may make the introduction of the ‘European model of education’ in India and Indonesia in the mid-nineteenth century in itself indirectly endogenous.

Second, the phases in educational enrolments started later in Indonesia and India than in Japan. While we found a rise in mass education in Indonesia around 1900, in Japan this had already ended around 1870. It is remarkable that it is exactly in this phase that we find the lowest human capital coefficient. This suggests that in phases when the human capital grows the most, human capital has the lowest effect on per capita GDP growth. Since the coefficient in Japan declined over time while its educational development was bottom-up, we may assume that the first educational phase, characterized by a relative increase in primary enrolments, had already ended when our data started in the 1890s.

Third, we argued that Japan was more efficient than Indonesia and India which would result in on average higher human capital coefficients. Indeed, we found that Japan exceeded India and Indonesia in the magnitude of the human capital coefficient. Of course we have to ignore the coefficients of the second half of the twentieth century in Japan when Romerian growth took place as this cannot be compared directly with the human capital coefficient in Lucasian growth.

These findings indeed suggest that 1) there were comparable educational phases in Japan, India, and Indonesia, 2) Japan is ahead of India and Indonesia in educational development, and 3) Japan has a higher productive efficiency of human capital (higher human capital coefficients).

4. A SIMULATION OF CROSS COUNTRY GROWTH DIVERGENCE: ROMERIAN VERSUS LUCASIAN GROWTH

The institutional developments were thus important to create a development in Japan from Lucasian to Romerian growth. On the other hand, in India and Indonesia they were part of the reason why no transition to Romerian growth was made. The main criticism we levied against some of the economic literature is that it takes the relation between human capital and growth as homogenous among countries. Therefore, it is now important to take a brief look at the share in cross country income divergence that might be explained by these institutional differences.[173]

[173] It is important to note that, although we focus on human capital forming institutions, other factors may have an effect on economic growth as well. However, studies in this field have shown little effect of a

In the previous section we identified three ideas about how human capital forming institutions may influence growth. These were a relatively high level of education in Japan already in the late nineteenth century (thus India and Indonesia are lagging to Japan), a higher efficiency of human capital in Japan, and a changing human capital formation over time due to changing educational enrolments. These three ideas are

Table 8.1: Human capital structure in Japan, India, and Indonesia in the 20th century

			Japan	Indonesia	India
Early start	(per capita human capital stock)	1890	2,761*	65	364
Efficiency	(human capital coefficient)	1890	4.60	1.46	1.96
		1930	4.60	1.55	1.91
		1960	-1.13**	1.55	4.29
		1990	-1.13**	1.48	4.29
Level accumulation	(growth of per capita human capital)	1890	4.8%	7.0%	-0.1%
		1930	3.9%	4.4%	1.5%
		1960	1.5%	1.3%	3.1%
		1990	2.5%	1.5%	1.5%

* 1894
**These coefficients are negative because in these years Japan moved on to Romerian growth. Therefore, the coefficient of the level of human capital became important which was 1.24.
Source: Growth of human capital, Appendix A.12; Efficiency, tables 7.3-7.5; Early start, Appendix A.12.

represented in table 8.1 as the level of human capital in 1890, the human capital coefficient, and the growth of human capital respectively. A fourth factor influencing the relation between human capital and growth is the transition towards Romerian growth. However, this only applies to the second half of the twentieth century.

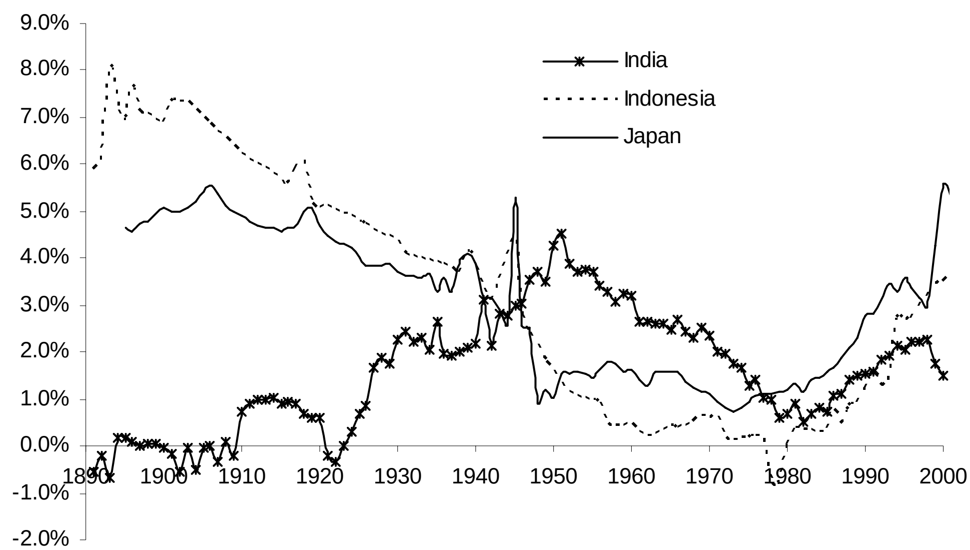
Three points may be noted from table 8.1. First, Japan was much better endowed with human capital around 1890 than India and Indonesia. Initially the per capita human capital stock in India exceeded that of Indonesia but this changed rapidly after the commencement of mass education. Second, efficiency in Japan, in the form of the human

broad range of exogenous factors (Levine and Renelt 1992; Florax, Groot, and Heijungs 2002) (for a study that identifies more exogenous variables see Sala-i-Martin (1997)).

capital coefficients, was much higher than in India and Indonesia. An exception is the second half of the twentieth century when the coefficient of $\Delta \ln hc_{t-1}$ became strongly negative which was caused by the shift to Romerian growth. Third, we mentioned in chapter 4 that Indonesia and Japan had a bottom up educational development, i.e. from primary to higher education. India, however, developed from higher to lower and then back to higher education. This had consequences for human capital accumulation.

Figure 8.1

Growth of the estimated per capita human capital stock of India, Indonesia, and Japan, 1890-2000



Source: estimated using the population data from Appendix A.2 and the human capital stock data from Appendix A. 12.

Whereas Indonesia shows a U-curve where the growth of human capital is especially strong at the start and the end of the century, India shows an inverted U-curve (see also figure 8.1).

We used these three factors to provide a simulation of the growth paths of India and Indonesia relative to Japan in tables 8.2 and 8.3. In table 8.2 we give the estimates for the pre-War period. For India and Indonesia we start by calculating how much per capita GDP growth would increase if they would have had the same human capital coefficients (efficiency) as Japan. In the second row for each country we indicate how much the per

Table 8.2: Simulation effect human capital in India and Indonesia compared with Japan, 1890-1940

	1890-1910	1920-1940
	Indonesia	
Efficiency: Increase in per capita GDP growth if Indonesia had the Japanese human capital coefficients	*8.00%*	*133.32*
Level accumulation: Increase in per capita GDP growth if Indonesia had the Japanese level of human capital accumulation	*-4.98%*	*-15.67%*
Total increase in per capita GDP growth	***3.02%***	***117.65%***
Observed Indonesian per capita GDP	713	1,075
Simulated GDP level (assuming Japanese efficiency and level of accumulation)	715	1,592
Simulated GDP level (early start: assume that per capita GDP in Indonesia was the same as in Japan in 1890)	*1,093*	*1,648*
Total simulated per capita GDP	***1,098***	***2,441***
% gap in per capita GDP with Japan explained by efficiency, the level of accumulation, and the early start	**96.03%**	**133.02%**
	India	
Efficiency: Increase in per capita GDP growth if India had the Japanese human capital coefficients	*2.53%*	*0.86%*
Level accumulation: Increase in per capita GDP growth if India had the Japanese level of human capital accumulation	*3.70%*	*0.19%*
Total increase in per capita GDP growth	***6.23%***	***1.05%***
Observed Indian per capita GDP	386	561
Simulated GDP level (assuming Japanese efficiency and level of accumulation)	389	579
Simulated GDP level (early start: assume that per capita GDP in Indonesia was the same as in Japan in 1890)	*1,113*	*1,618*
Total simulated per capita GDP	***1,120***	***1,672***
% gap in per capita GDP with Japan explained by efficiency, the level of accumulation, and the early start	**100.68%**	**72.11%**

Sources: see table 8.1

capita GDP growth would increase if India and Indonesia had the same human capital growth as Japan. The third row (in bold) gives the sum of the previous two effects.

In the fourth row, we present the per capita GDP of Indonesia and India respectively. The fifth row shows the per capita GDP under the assumption that Indonesia and India experienced Japanese efficiency (human capital coefficients) and human capital growth. Because in table 8.2 we look at the pre-War period when in all three countries Lucasian growth was present, there is no effect of the level of human capital, hence we approximate an early start in economic development by assuming that Indonesia and India had the GDP level of Japan in 1890 in row six. From this, we can in row seven calculate the total simulated per capita GDP in Indonesia and India under the assumption that their human capital forming institutions are equal to those in Japan. In the last row the difference between the simulated and the real Indonesian/Indian per capita GDP divided by the difference between the real Japanese and the real Indonesian/India per capita GDP gives the gap in per capita GDP between, on the one hand India or Indonesia and, on the other, Japan that is explained by the human capital forming institutions.

In the same way, table 8.3 reports the effect of human capital forming institutions on the gap in per capita GDP for the post-War period. In row 1 we report the actual Indonesian/Indian per capita GDP. Row 2 reports the simulated per capita GDP under the assumption that the efficiency (human capital coefficients) and human capital

Table 8.3: Simulation effect human capital in India and Indonesia compared with Japan, 1950-2000

	1950-1970	1980-2000
	Indonesia	
Observed Indonesian GDP	*982*	*2,040*
Simulated Indonesian GDP using Japanese efficiency and human capital accumulation	*1,015*	*1,555*
Simulated Indonesian GDP assuming the same GDP level as in Japan in 1890	*1,524*	*2,851*
Simulated Indonesian GDP where we added the difference between actual Japanese GDP and Japanese GDP assuming that Japan had the same level of human capital as Indonesia (The effect of Romerian growth)	1,359	4,115
Total simulated per capita GDP for Indonesia	***1,934***	***4,441***
Actual Japanese GDP	4,504	15,390
% gap in per capita GDP with Japan explained by efficiency, the level of accumulation, and the early start, and the existence of Romerian growth	**27.03%**	**17.99%**
	India	
Observed Indian GDP	*725*	*1,083*
Simulated Indian GDP using Japanese efficiency and human capital accumulation	*716*	*1,013*
Simulated Indian GDP assuming the same GDP level as in Japan in 1890	*2,077*	*3,039*
Simulated Indian GDP where we added the difference between actual Japanese GDP and Japanese GDP assuming that Japan had the same level of human capital as India (The effect of Romerian growth)	1,246	3,473
Total simulated per capita GDP for India	***2,589***	***5,359***
Actual Japanese GDP	4,504	15,390
% gap in per capita GDP with Japan explained by efficiency, the level of accumulation, and the early start, and the existence of Romerian growth	**49.33%**	**29.89%**

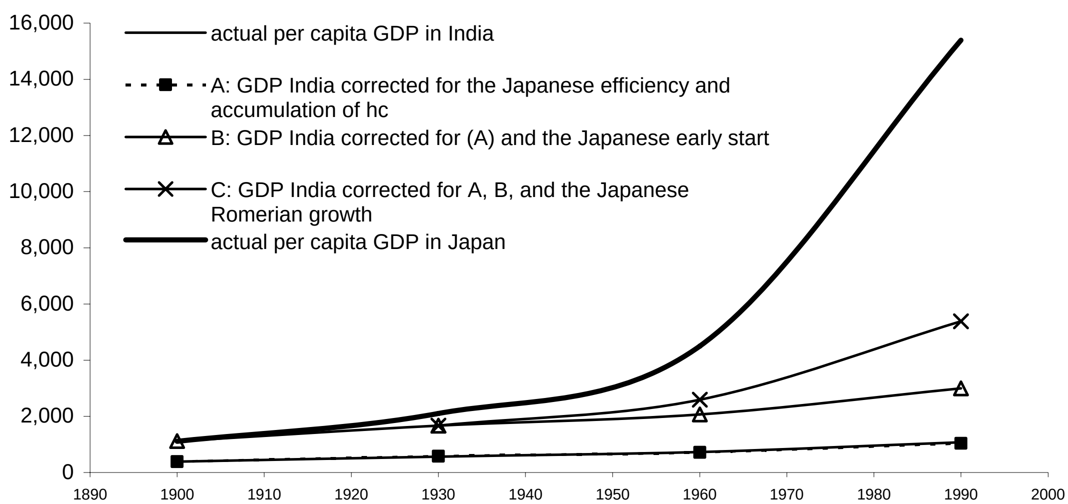
Note: All GDP figures are in 1990 Intl. USD.
Sources: see table 8.1

accumulation were equal in India/Indonesia and Japan. The third row gives the simulated per capita GDP under the assumption that the GDP level in India/Indonesia in 1890 was equal to that of Japan. The fourth row is in fact the only difference with table 8.2. Here we present the simulated Indonesian/Indian per capita GDP where we added the difference between actual Japanese GDP and Japanese GDP assuming that Japan had the same level of human capital as Indonesia (or India) (the effect of Romerian growth). The total effect of row 1-4 gives the total simulated per capita GDP in row five. Finally, just as in table 8.2, row seven reports the difference between the simulated and the real Indonesian/Indian per capita GDP divided by the difference between the real Japanese (row six) and the real Indonesian/India per capita GDP which gives the gap in per capita GDP between, on the one hand India or Indonesia and, on the other, Japan that is explained by the human capital forming institutions.

These four effects of human capital forming institutions on economic growth (an early start, efficiency, human capital accumulation, and (in the post-War period) the existence of Romerian growth) are visualized in figures 8.2-8.3. The bold line is the

Figure 8.2

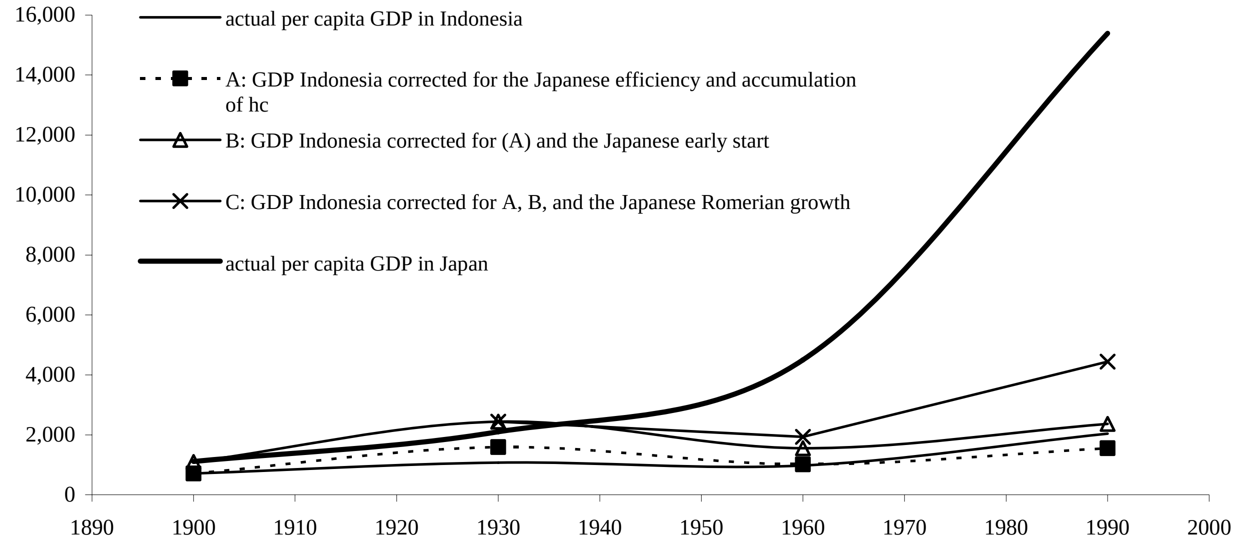
Real and simulated per capita GDP in India and its gap with Japan, 1900-1990, 1990 Intl USD



Source: Tables 8.2 and 8.3.

Figure 8.3

Real and simulated per capita GDP in Indonesia and its gap with Japan, 1900-1990, 1990 Intl. USD



Source: Tables 8.2 and 8.3.

Japanese per capita GDP. The other lines indicate the actual Indonesian and Indian per capita GDP, their GDP corrected for efficiency and the level of accumulation, a correction for an early start in modern economic growth, and for Romerian growth. The difference between actual GDP and GDP corrected for efficiency and the level of human capital accumulation gives the effect of efficiency and level of human capital accumulation on per capita GDP. The difference between the GDP corrected for efficiency and the level of human capital accumulation and the GDP corrected for both the efficiency and level of human capital accumulation and for an early start in economic growth gives the effect of an early start in economic growth on per capita GDP, and so forth.

The effect the human capital institutions had on the gap in per capita GDP was marked. Both in India and Indonesia, in the first half of the century close to 100% of the per capita GDP gap with Japan can be explained by human capital. These shares decrease in the second half when Japan starts to experience Romerian growth. However, the shares explained by human capital forming institutions are in this period with around 20% in Indonesia and 30% in India still considerable.

5. SOME SUGGESTIONS FOR FURTHER RESEARCH

5.1 Introduction

In human capital theory almost every aspect is eligible for further research. Even today, no standardized human capital stock is available, which means that there is still much to do. We need a large (historical) database of consistent human capital estimates. Once available, these data should be analyzed in a country-specific way in order to evaluate their role in economic historical development. Finally, applying the theses resulting from single country analyses in cross-section or panel analyses might also prove fruitful to test and quantify the many possible hypotheses (Temple 1999, 121). A particular important analysis in this respect is the role of institutions in economic growth. In chapter 4 we historically analysed the development of human capital forming institutions in Japan, India, and Indonesia. This resulted in two hypotheses about the relation between human capital and economic growth which we further empirically tested in chapter 7. However, this method is limited for two reasons. First, the cross-country differences are solely based on a historical analysis. A cross-section or panel approach to quantify the difference among these countries would have been fruitful. Unfortunately, due to our focus on the historical development and our small sample (only 3 countries), such an analysis has to await further research. Second, we focused on human capital forming institutions such as schools, effectiveness of human capital formation, and the later start of India and Indonesia in the formation of human capital compared to Japan. Of course many alternative institutions may also be applicable. Examples may be often used variables such as ‘constraint on the executive’, and ‘ethnolinguistic fragmentation’. Also here, the small sample and the limited research time prevented us from exploring this topic.

In addition to these more general points, there are many topics we have not explored and discussed in this thesis. To name just a few: a closer comparison with Europe (the role of colonisation), the role of firms, the role of individuals, and income distribution. Yet, in this section we will mainly focus on topics that we touched upon in this thesis, but which, in our opinion, require a more thorough research.

5.2 A fable of economic growth: some suggestions for further research

Looking at ‘natural experiments’ of economic development is an important way to advance the formation of new theories of economic growth. To this end, it is important to look at questions such as ‘**when does human capital start to grow and when does this growing human capital start to effect per capita GDP growth in a substantial way?**’ In our opinion structural explanations are far too scarce. The economic divergence literature comes up with a lot of different factors such as ‘geography’, ‘marriage patterns’, and ‘technology’ (some examples are Landes 1998; Pomeranz 2000; Mokyr 2002). Equally, some economists, like Abramovitz (1993) and Kuznets (1966), focussed on the shift from physical to human capital and between economic sectors. Still neither of these approaches can completely explain the breakthrough to ‘modern economic growth’.

But there is an alternative approach as well: the educational sociology literature that argues that factors as increased levels of per capita GDP, individualisation, and political reforms changed the perception on human capital formation. Human capital became increasingly necessary to operate machines, to transfer knowledge, to correspond with trade partners, and so on. This literature also argues that this process started around 1800 in Europe and the Western Offshoots such as the United States and only at the end of the nineteenth century in the developing countries. In the latter countries the start of this process did not so much take place because of the societal changes in the Western countries but because they wanted to imitate Western (economic) success. We focus on five consequences now.

First, it is likely that, with the rising importance of human capital for economic growth, the relationship between skilled and unskilled labour changed. If human capital is less important for economic growth, it is possible that the elasticity of substitution between skilled and unskilled labour is close to zero because ‘skilled’ jobs were preserved largely for closed groups. Yet, when human capital became more important for economic growth, the elasticity of substitution increased.

We argued that in many developing economies the education system (the way through which skills can be gained) was not based on economic development but on some “myth of progress”. This may mean that the elasticity of substitution between skilled and unskilled labour remained low compared to the developed countries. As we argued briefly in chapter 7, **the effect of technology through the Lucasian imbalance effect, has a positive effect in countries with a relatively high elasticity of substitution and an on average negative effect in countries with a low elasticity of substitution**, most notably developing countries. The reason is that a shortage of human capital is likely to be much faster corrected in countries with a high elasticity and slower in countries with a low elasticity of substitution. Assuming a downward sloping imbalance effect (a shortage of human capital decreases growth) this results in an on average positive effect for developed countries and a negative effect on balanced growth in developing countries.

The second effect of non-societal-based education systems was that an increase in educational opportunities not necessarily directly led to an increase in pupils entering schools. This is likely to increase the **elasticity of substitution between private and public expenditure on education**. This is an interesting topic, which is frequently ignored in the literature. This is largely caused by lack of data on private expenditure, especially for developing countries. The existing studies therefore focus on developed countries after the 1950s.[174] An exception is Tilak (2002) who argues that in the 1990s public and private expenditure on education in India are complements. But, in general we think that the substitution is larger in developing than in developed countries depending on the characteristics and period. If many persons that did not follow formal education entered the formal education system (around 1900 in Indonesia and in the 1930s in India), the elasticity increases because non-formal education is replaced by formal education. The same effect also may take place during periods in which compulsory education is introduced or extended.[175]

[174] See for example Pelzman (1973).
[175] However, the introduction of compulsory education can also be caused by societal pressure. Consequently, most institutional changes have already taken place before this date and the introduction of formal education is thus nothing more than a *de jure* recognition of a *de facto* situation.

The third effect of non-societal based educational development is **decreasing marginal returns in the Lucasian second sector**. We argued that decreases in the efficiency of human capital accumulation seem to coincide in developing countries with decreasing marginal returns. Because the tests for marginal returns assume a constant efficiency of human capital accumulation, when a decrease in this efficiency is present we may be falsely rejecting the presence of constant marginal returns.

The fourth effect of the education system is that **each phase with a focus on a specific level of education causes different human capital coefficients**. We found that primary education had a lower coefficient than had secondary education. In turn, after the mid-twentieth century the human capital coefficient decreased again. This corresponds with the findings of Krueger and Lindahl (2001, 1130) who argue that up to around 7.5 years of schooling the returns to human capital increase, while decreasing afterwards (an inverted U-curve). This corresponds well with Japan where we found a top of around 6.5 years of education. However, in Indonesia the top was around 2.2 years and India around 1.8 years.[176] This once again seems to suggest that developing countries follow the same educational path as the developed countries only at a less efficient level.

Indeed, a fifth important aspect is that **human capital efficiency seems to be much higher in countries with a more society-based educational development**. This might be caused by higher external effects or because of a better connection between education and the labour market.[177] There are some studies which refer to the efficiency of human capital in economic growth but only few studies have tried to estimate (in)efficiency. These are mostly frontier studies, which compare the human capital coefficient of a certain country with that of the most advanced country in the sample (that is: the country with the highest human capital coefficient).[178] But these studies suffer from many

[176] Because India has a reversed educational structure, it is actually a U-shaped development.
[177] It would be interesting to estimate, besides the external effects, the social and private returns. This might, for example, be done using the average wage as a dependent variable. See for example Venniker (2000), Moretti (2004), and Acemoglu and Angrist (1999). The differences between the social and private returns are the externalities of human capital.
[178] See for example Henderson and Russell (2005).

drawbacks: they need much data and assume a general optimum for all countries. Therefore, another option may be tried. For example, one might optimize labour, human- and physical capital in such a way that the difference between these investments and consumption becomes largest. This is an implicit form of the Solowian golden rule (Phelps 1961).

6. SOME FINAL REMARKS

In the process of writing this thesis we had to face some limitations. First, the data used in this study may be updated and improved. This is partly the result of the fact that human capital is not firmly defined in the literature as yet. Also, many data, especially of developing economies, are missing or needed to be interpolated. To give just one obvious example, some estimates of the gross fixed physical capital stock for Indonesia in the 1980s differ a factor 2 or 3 depending on the asset life assumptions (Van der Eng 2005; Yudanto, Wicaksono, and Ariantoro 2005). Up till now, there has been internationally, or nationally for that matter, no consensus on the asset life that should be used in creating the physical capital stock variable. A second limitation we faced was that we were only able to focus on a limited set of three countries. It is clear that for objective estimations and the use of more solid econometric techniques a larger sample is needed.

That being said, we think it is beyond doubt that the new growth theories, with all their limitations, are an important tool to analyze growth patterns in sets of homogenous countries. Yet, to explain why Japan was a successful developer while India and Indonesia were not, two extra ingredients were important. First, it is important to use a series on human capital that reflects all aspects that are also crucial in these theories. If one wants to test whether there are constant marginal returns to human capital accumulation, excluding the quality of human capital (which might be an important source of constant marginal returns) will bias your findings. Second, it is crucial to keep account of the institutional developments both between countries and over time. They are not only necessary for a sound economic interpretation of any regression results but also may hint which variables to include in regressions between human capital and growth.

Appendices

A.1. Craftsmen and labourers' wages and price indices in Japan, India, and Indonesia, 1870-2000[179]

In this appendix we construct series of the skilled and unskilled wages and the CPI for Japan, India, and Indonesia over the period of circa 1870-2000 which are important for estimating the human capital stock in chapter 5 and deflating some of the expenditure on education data. We have used largely published data. Furthermore, we focused on cash earnings, ignoring payments in kind. As far as possible the skilled wages are represented by carpenters, in some cases added with bricklayers. The unskilled workers are generally represented by 'unskilled labour' or 'agricultural labour'. The table at the end of this appendix gives the nominal wages in 1913 prices and the consumer price indices. This makes it possible to construct the real wages. Below sections present for each country how the data are constructed.

Japan

The Japanese wage series starts in 1870. The *skilled wage* for Japan for the period 1870-1880, the daily carpenter wages, came from the Bank of Japan (1966, table 16) and for the period 1882-1887; 1892; 1893-1939 from *Long-Term Economic Statistics (LTES)* (1967). The LTES series are identical to the series from the Bank of Japan. They only go further forward in time. There were two periods with missing data. First, the skilled wages for the year 1881 were linearly interpolated. Second, the wages for the period 1888-1891 were constructed by calculating the ratio from the wage in 1887 and 1892 with the Edo Index from Saito (2005). The resulting two ratios were linearly interpolated. Multiplying this interpolated ratio with the Edo index resulted in an estimate of the wages for the period 1888-1891. For the period 1940-1949 we used the *ILO Year Book of Labour Statistics*, wages in manufacturing. For 1950-1985 we used the carpenter wages from the *Historical Statistics of Japan* (1987). Finally for the period 1986-2000 we used the wages of carpenters from the Statistical Yearbooks of Japan.

The data for *unskilled workers* were constructed in the same way. For 1865-1880 we took the ratio of unskilled wages in Chosi (Saito (2005)) for 1865 and 1880 and interpolated these. The results were multiplied with the Chosi series for the years 1866-1879. For 1880;

[179] Pierre van der Eng kindly supplied wage data for coolies on plantations for 1949-1994.

1882-1887; 1892; 1894-1939 we used the figures of the *Bank of Japan* (1966). Just as for the skilled wage series, 1881 was linearly interpolated. The period 1888-1891 was obtained by taking the relation between the skilled and unskilled wages in 1887 and 1892 and then taking a linearly interpolation and multiplying it with the skilled wages. The year 1893 was obtained from the *Historical Statistics* (1987). Finally, 1940-2000 was obtained from the *ILO Year Book of Labour Statistics*, the male agricultural day worker.

To arrive at a *CPI* for Japan we took the Edo index for 1870-1878 (Saito, 2005). For 1879-1938; 1946-1947 and 1939-1944 (only Tokyo) the LTES (1967) was used. Only 1945 was linearly interpolated. From 1948 to 1969 we took the Historical Statistics of Japan (1987). From 1970 to 2000 we used data from the *ILO Year Book of Labour Statistics*.

India

The *skilled* and *unskilled wages* for India for 1951-1954; 1957-1958; 1967-2000 were taken from the *ILO Year Book of Labour Statistics* (1951-1958), the *International Labour Review* (1959-1961), and the *Bulletin of Labour Statistics* (1962-2001). Skilled wages were, where possible, constructed as an average of bricklayers and carpenters in construction and unskilled wages were taken from unskilled labour. For 1955-1956, and 1959-1966 we took for unskilled and skilled wages the relation with agricultural wages and manufacturing wages of the ILO respectively for 1954, 1957, 1958, and 1968. The relations were calculated with the wages in agriculture and manufacturing respectively. Next, these relations were interpolated, and finally multiplied with the agricultural and manufacturing wages. For the period 1913; 1919-1946 we took the data of Sivasubramonian (1977). For both the skilled and unskilled wages we averaged urban and rural areas. Again for the unskilled wage, we interpolated the relation with ILO agricultural wages for 1947-1950 and multiplied this interpolated relation with the agricultural wages. For the skilled wage we used the manufacturing wage in 1950, and the relation between the skilled wage from Sivasubramonian (1977) and ILO wages in manufacturing in 1946 multiplied with the ILO manufacturing wage in 1947 for the year 1947. For 1947 and 1950 we interpolated the relation between the wages in the jute textile industry (Mukerjee 1960) and the 1947 and 1950 skilled wage. Multiplying this interpolation with the jute textile industry wages gave the skilled wage for 1948 and 1949. For 1873-1912 the unskilled and skilled wages were obtained from the *Statistical Abstract of British India*, which draws from the *Prices and Wages in India* series. We only used the series mentioned in the *Statistical Abstract* that belong to present day India. The wages were for selected stations (i.e. cities) and were per State weighted by the inverse population of the city because in general there are higher wages in more populous cities while the countryside is far larger. Then the States were weighted by their population as in general central India was somewhat more populous with higher wages.

The Indian *CPI* for 1949-2000 was obtained from the *ILO Year Book of Labour Statistics*. For 1961-1968 the cities of Jamshedpur, Bombay and Delhi were averaged to obtain one series. For 1969-2000 the average of the agricultural workers, industrial workers, and urban non-manual employees' series was used. For 1900-1946 and 1948 we used the index of Sivasubramonian (2000, p. 437). We obtained the 1947 number by calculating the relation of the Sivasubramonian index with the series of Roy (1996, p. 352) for 1946 and 1948. This relation was linearly interpolated and multiplied with the 1947 figure of Roy. For 1861-1899 we used the revised series from Brahmananda (2001, p. 119, 123). This series strongly resembles the Government of India's series, but here some more consumer goods are included. To link the Sivasubramonian and the Brahmananda indices we used the index from Williamson (1998).

Indonesia

The *wages* for Indonesia for 1870- 1875 are based on the yearly wages of Indonesian writers and 'oppassers' (guards) in the Dutch colonial service. These series were available from 1870 to 1917 in the *Budgets of the Netherlands Indies* (various issues). Both nominal wage series remained constant except for two increases in 1874 and 1900 of the wage of Indonesian writers. In 1870 the yearly wage of the Indonesian writer was about fl 244 while that of the 'oppasser' remained constant over the entire period at fl 120.

From 1875-1915 we took the data for craftsmen and coolies on Java (CEI 13, table 5.4). These data are given per residency per year. For each year for both craftsmen and coolies we took the logarithmic average of all residencies as in general wages have a logarithmic distribution. For both skilled and unskilled labour, the figure for 1896 was interpolated per residency and afterwards averaged just as indicated before. From 1921 to 1940 the data were obtained for unskilled labour from the logarithmic average of workers at a sugar plantation (CEI 13, table 9.1, regular workers). For skilled labour the data were obtained from the logarithmic average of a factory foreman, canefield overseer, and fieldguard (seasonal, CEI 13, table 9.1). The years 1916-1920 were obtained by using the logarithmic average of the wages of male and female labourers in the sugar industry (CEI 13, table 9.2) to interpolate these years.

For wage data for the period 1942-1948 we entirely have to rely on sporadic accounts. An interesting source is available on the increase in prices and expenditure for Europeans outside the Japanese camps (*Rijksinstituut voor Oorlogsdocumentatie* (014614-014637)). This is a note from the Centraal Kantoor voor de Statistiek in which fifteen households were asked in August/September 1946 to give an overview (based on memory) of the costs of living during 1942-1945. Some results are given in table A.1.1. It seems that the nominal wages remained relatively constant during the War. Only after 1943 the Japanese decided to make the wages higher for the romusha (forced Indonesian labour (Sato 1994, p. 1670)). Nevertheless it is clear that as the normal wages remained more or less constant and there was

Table A.1.1: Expenditure and wages of Europeans and Indonesians in Indonesia, 1942-1945

	European*		Indonesian			
	Expenditure		Expenditure (per household)		Day Wages	
	Total per month	% on food	Total per month	% on food	Unskilled	Skilled
1942	fl 25.88	62.54%	fl 5.71	53.07%	fl 0.20**	fl 0.45
1943	fl 24.21	74.83%				
1944	fl 36.17	83.01%			fl 0.44	
1945	fl 50.71	86.18%			fl 0.45	fl 0.65

* Of those whose 1942 income was fl50-fl200.
** minimum wage
Rijksinstituut voor Oorlogsdocumentatie (Nr. 014619-014623)
Sato (1994), p. 96, 167, 169

an increasing inflation as from 1943, these wages became less important in providing for total expenditure. Agricultural labour and trade became more important as was the selling of possessions (clothes, jewellery etc.) for Europeans (*Rijksinstituut voor Oorlogsdocumentatie* (014628)). All in all the nominal unskilled wages seem to have doubled during the occupation (Sato 2000, p. 18 note 41).

The unskilled wage was taken from plantation wages supplied by Van der Eng for 1949-1994, added with Estate wages for 1995 (Wage trend of Estate Workers 1993-1995). The data for 1943 and 1944 came from Sato (1994) while the nominal unskilled wages were assumed to be constant during 1941-1943. The skilled wage for 1945 also came from Sato (1994) while the years 1941-1944 were assumed to be constant. The data on skilled wages directly after the occupation are scanty. From 1952-1957 and 1959 it are wages in mining and in 1958 we took wages in the metallurgical industry (Bank Indonesia 1954-1960). For 1960 and 1961 the wages came from metal manufacturing (Statistical pocketbook). For 1963 the skilled wage was that of bricklayers (International Labour Review 1964). For 1969, 1970, 1972, 1981-1984 the data came from the ILO Bulletin. The years 1985-1989 were farm supervisors and 1991-1992 gas supervisors (ILO bulletin). As from 1995-2000 the data were manufacturing wages from the ILO (LABORSTA). The remaining years were interpolated where 1964-1968, 1970-1971, and 1973-1978 were obtained by calculating the ratio with unskilled labour for the year before and after the gap, interpolating the ratio, and finally multiplying this ratio with the unskilled wage.

To arrive at the CPI we took the CPI from Van der Eng (2002) for 1900-1941; 1949-1983. The data for 1942-1945 were filled with Rijksinstituut voor Oorlogsdocumentatie (014623), while 1945-1948 was interpolated. As from 1984-2000 the data were obtained from LABORSTA. For the period 1870-1873 there ware data on rice and some other products as coconut oil, beef, and firewood (CEI 15, table 3A). Assuming a ratio with 10% firewood, 10% beef, 10% cooking oil, and 70% rice we calculated the index number for this period. For the years 1874-1899 we used rice prices. This constitutes no problem as rice was by far the largest consumer good. Furthermore it had a low price elasticity and therefore there is not much difference between rice index and general index.

Table A.1.2: Current daily wages for craftsmen and labourers and CPI for Japan, India, and Indonesia, 1870-2000

	Japan			India			Indonesia		
	Labourer Yen	Craftsman Yen	CPI Index 1913=100	Labourer Rupee	Craftsman Rupee	CPI Index 1913=100	Labourer Guilder/rupiah	Craftsman Guilder/rupiah	CPI Index 1913=100
1870	0.22	0.50	47.86	0.19	0.49	70.65	0.34	0.83	85.58
1871	0.20	0.50	40.14	0.19	0.49	57.91	0.34	0.83	88.33
1872	0.19	0.50	29.34	0.19	0.49	62.46	0.35	0.83	119.84
1873	0.36	0.42	29.78	0.21	0.49	64.88	0.34	0.83	118.30
1874	0.34	0.39	34.61	0.20	0.50	71.63	0.34	0.83	117.20
1875	0.31	0.42	38.20	0.21	0.50	63.06	0.34	0.83	104.30
1876	0.29	0.43	31.97	0.23	0.52	62.68	0.35	0.83	101.50
1877	0.27	0.43	32.99	0.23	0.52	80.99	0.33	0.88	105.80
1878	0.25	0.41	36.93	0.21	0.50	87.04	0.33	0.89	128.60
1879	0.22	0.41	49.23	0.21	0.49	79.69	0.35	0.87	112.90
1880	0.21	0.31	56.40	0.21	0.50	69.37	0.34	0.89	114.30
1881	0.22	0.32	62.13	0.21	0.51	62.78	0.34	0.88	112.90
1882	0.22	0.33	57.82	0.23	0.50	61.41	0.39	0.96	107.20
1883	0.19	0.28	49.68	0.22	0.51	61.96	0.38	1.01	97.20
1884	0.18	0.23	48.06	0.24	0.52	65.88	0.37	0.92	75.80
1885	0.16	0.23	48.08	0.24	0.55	65.14	0.35	0.92	70.10
1886	0.15	0.23	42.40	0.25	0.57	63.12	0.32	0.90	70.10

Continued on the next page

Table A.1.2: Current daily wages for craftsmen and labourers and CPI for Japan, India, and Indonesia, 1870-2000

	Japan			**India**			**Indonesia**		
	Labourer Yen	Craftsman Yen	CPI Index 1913=100	Labourer Rupee	Craftsman Rupee	CPI Index 1913=100	Labourer Guilder/rupiah	Craftsman Guilder/rupiah	CPI Index 1913=100
1887	0.16	0.22	45.09	0.26	0.58	64.61	0.30	0.84	67.10
1888	0.16	0.23	44.32	0.26	0.54	69.32	0.29	0.86	67.10
1889	0.17	0.24	46.93	0.26	0.56	73.53	0.32	0.78	67.10
1890	0.18	0.25	50.04	0.26	0.53	73.23	0.29	0.77	75.90
1891	0.19	0.26	47.94	0.26	0.57	74.47	0.29	0.76	77.40
1892	0.18	0.27	44.70	0.27	0.56	81.69	0.31	0.76	89.00
1893	0.21	0.31	45.24	0.27	0.55	80.85	0.30	0.76	77.40
1894	0.21	0.30	46.68	0.28	0.56	77.16	0.30	0.82	71.50
1895	0.22	0.32	51.09	0.27	0.55	75.94	0.29	0.80	64.20
1896	0.26	0.38	56.22	0.26	0.54	82.22	0.29	0.80	65.70
1897	0.29	0.44	62.64	0.28	0.56	98.37	0.29	0.80	92.00
1898	0.33	0.47	67.94	0.26	0.55	79.38	0.28	0.82	74.40
1899	0.34	0.51	64.11	0.27	0.54	70.49	0.27	0.82	70.10
1900	0.37	0.54	72.03	0.26	0.54	84.81	0.26	0.81	70.03
1901	0.39	0.59	70.46	0.25	0.56	84.45	0.28	0.83	86.87
1902	0.39	0.58	73.19	0.28	0.60	83.04	0.27	0.83	80.47
1903	0.40	0.59	76.85	0.29	0.59	79.51	0.25	0.66	84.18
1904	0.40	0.59	78.63	0.29	0.59	77.39	0.26	0.69	75.42
1905	0.41	0.60	81.66	0.28	0.66	86.22	0.26	0.71	72.73
1906	0.42	0.65	83.27	0.30	0.68	87.99	0.25	0.70	77.10
1907	0.49	0.75	91.98	0.31	0.70	92.23	0.27	0.67	87.21
1908	0.53	0.81	88.81	0.31	0.74	103.89	0.27	0.69	91.92
1909	0.52	0.80	85.36	0.31	0.74	95.41	0.27	0.69	86.20
1910	0.53	0.80	85.58	0.31	0.77	91.87	0.28	0.72	86.20
1911	0.56	0.83	91.96	0.32	0.74	88.34	0.28	0.72	94.95
1912	0.58	0.87	97.06	0.28	0.75	93.99	0.28	0.73	109.43
1913	0.59	0.88	100.00	0.33	0.73	100.00	0.30	0.74	100.00
1914	0.56	0.86	92.12	0.31	0.72	100.35	0.31	0.82	96.97
1915	0.55	0.84	86.22	0.31	0.73	106.36	0.32	0.82	94.95
1916	0.57	0.85	93.15	0.35	0.78	102.47	0.34	0.74	102.36
1917	0.70	0.96	114.27	0.37	0.79	104.59	0.33	0.72	109.43
1918	0.95	1.85	153.81	0.39	0.82	119.43	0.35	0.77	140.07
1919	1.43	1.84	204.64	0.45	1.01	165.72	0.38	0.81	140.40
1920	2.01	2.61	214.06	0.49	1.13	170.67	0.48	0.98	228.28
1921	1.98	2.65	196.17	0.52	1.24	168.20	0.52	1.05	191.58
1922	2.18	2.92	193.19	0.58	1.37	157.24	0.45	1.00	166.67
1923	2.16	2.99	191.45	0.60	1.41	142.76	0.42	0.89	149.16
1924	2.16	3.09	193.16	0.62	1.45	140.99	0.41	0.88	137.37
1925	2.13	2.97	195.50	0.65	1.57	147.70	0.41	0.88	130.98
1926	2.05	2.91	186.63	0.63	1.55	150.53	0.40	0.88	130.64
1927	1.98	2.90	183.77	0.67	1.66	145.58	0.40	0.88	126.26
1928	1.98	2.85	176.79	0.66	1.67	143.11	0.41	0.89	123.91
1929	1.93	2.78	172.74	0.68	1.67	137.81	0.42	0.89	123.23
1930	1.92	2.48	155.19	0.64	1.61	113.43	0.41	0.88	120.20
1931	1.40	2.14	137.30	0.54	1.43	98.59	0.40	0.89	107.41
1932	1.31	1.99	138.83	0.52	1.38	92.58	0.33	0.82	89.90
1933	1.27	1.87	143.07	0.48	1.35	86.57	0.28	0.79	79.46
1934	1.31	1.92	145.09	0.46	1.34	88.69	0.24	0.74	73.06

Continued on the next page

Table A.1.2: Current daily wages for craftsmen and labourers and CPI for Japan, India, and Indonesia, 1870-2000

	Japan			India			Indonesia		
	Labourer Yen	Craftsman Yen	CPI Index 1913=100	Labourer Rupee	Craftsman Rupee	CPI Index 1913=100	Labourer Guilder/rupiah	Craftsman Guilder/rupiah	CPI Index 1913=100
1935	1.32	1.93	148.68	0.41	1.67	93.64	0.23	0.63	70.03
1936	1.32	1.99	152.12	0.39	1.14	91.52	0.22	0.59	67.68
1937	1.43	2.20	163.99	0.36	1.14	93.29	0.22	0.56	72.39
1938	1.58	2.35	179.73	0.37	1.14	91.17	0.25	0.58	74.07
1939	1.97	2.67	200.97	0.37	1.12	96.47	0.25	0.58	96.30
1940	2.08	2.76	233.65	0.34	1.10	98.23	0.26	0.56	77.44
1941	2.32	3.03	236.92	0.39	1.10	111.31	0.25	0.56	85.52
1942	2.78	3.29	243.45	0.41	1.13	150.88	0.24	0.56	122.22
1943	3.72	3.74	258.16	0.61	1.36	265.72	0.25	0.56	114.35
1944	5.90	4.68	349.27	0.93	1.71	259.72	0.44	0.56	170.82
1945	17.66	6.01	3,756.89	1.12	2.01	260.42	0.45	0.65	239.45
1946	33.67	23.64	7,164.51	1.21	2.22	280.57	0.66	1.12	413.76
1947	74.26	74.26	16,143.56	1.55	1.45	330.44	0.88	1.59	588.08
1948	184.61	207.33	28,400.95	1.87	1.94	353.36	1.07	2.06	762.39
1949	235.98	374.57	37,457.27	1.71	2.55	363.96	1.31	2.53	936.70
1950	202.33	324.43	34,885.19	2.33	2.69	363.96	3.62	6.37	1,097.64
1951	209.88	349.80	41,153.28	2.53	2.72	378.09	5.12	7.50	1,830.30
1952	229.00	393.18	43,206.62	2.52	5.34	371.02	4.83	5.99	1,931.31
1953	257.81	455.78	46,038.07	2.79	3.55	381.63	5.54	5.54	2,052.19
1954	284.20	553.69	48,999.21	2.79	3.56	367.49	6.11	6.11	2,180.81
1955	300.18	561.62	48,415.62	2.40	3.90	348.15	6.64	6.06	2,887.88
1956	306.38	588.44	48,631.77	1.84	4.17	382.96	6.61	6.28	3,307.07
1957	325.94	641.85	50,144.75	1.65	4.43	402.31	6.90	6.53	3,629.97
1958	339.51	659.06	49,928.61	1.64	2.78	421.65	8.46	12.68	5,285.19
1959	347.49	689.94	50,360.90	1.50	2.82	440.99	7.67	26.84	6,389.90
1960	371.37	753.21	52,306.17	1.62	2.92	448.73	8.66	28.33	7,870.71
1961	440.93	959.02	55,116.00	1.62	3.25	477.68	9.70	42.02	10,774.41
1962	552.63	1,169.93	58,790.40	1.72	3.34	505.94	29.97	170.81	29,966.33
1963	652.29	1,329.92	63,329.37	1.74	3.37	526.47	53.60	301.52	67,003.37
1964	749.06	1,511.26	65,706.92	1.75	3.51	548.40	127.88	696.23	142,087.54
1965	840.36	1,631.69	70,029.74	1.93	3.86	584.73	805.12	3,968.08	575,084.18
1966	913.93	1,776.27	73,704.14	2.12	4.12	643.06	8.08	39.06	6,734.01
1967	1,009.98	1,966.41	76,513.98	2.27	4.47	688.14	23.20	107.07	17,845.12
1968	1,201.25	2,249.32	80,620.66	2.28	4.42	735.86	48.08	204.34	40,067.34
1969	1,333.61	2,616.26	84,943.48	2.55	4.95	772.83	65.52	257.41	46,801.35
1970	1,609.13	2,834.26	91,427.72	2.51	4.94	810.17	84.58	364.75	52,861.95
1971	1,803.77	3,219.63	96,976.80	2.55	4.44	823.09	87.81	406.13	54,882.15
1972	2,029.38	3,581.85	101,468.91	2.56	5.82	882.06	117.17	568.28	58,585.86
1973	2,408.94	4,263.70	113,095.56	3.16	7.86	1,020.21	161.21	698.59	76,767.68
1974	3,211.17	5,309.70	140,840.97	3.16	7.90	1,316.70	216.16	864.65	108,080.81
1975	3,637.98	6,142.04	157,488.21	3.25	7.91	1,412.34	257.24	926.06	128,619.53
1976	3,859.20	6,891.43	172,285.76	3.15	7.81	1,259.82	246.73	771.04	154,208.75
1977	4,446.03	7,403.85	186,026.34	2.33	7.80	1,368.08	290.77	769.70	171,043.77
1978	4,616.55	7,938.91	193,160.88	3.35	7.96	1,395.69	314.24	720.91	184,848.48
1979	4,780.74	8,661.35	200,031.17	4.41	9.27	1,470.93	400.61	756.70	222,558.92
1980	5,057.91	9,186.37	216,149.93	5.31	9.46	1,659.55	642.26	847.78	256,902.36
1981	5,327.91	9,522.22	226,719.60	5.63	11.07	1,876.71	809.46	949.02	279,124.58
1982	5,540.57	9,800.76	232,797.17	5.82	11.05	2,008.43	972.93	1,003.33	304,040.40

Continued on the next page

Table A.1.2: Current daily wages for craftsmen and labourers and CPI for Japan, India, and Indonesia, 1870-2000

	Japan			India			Indonesia		
	Labourer Yen	Craftsman Yen	CPI Index 1913=100	Labourer Rupee	Craftsman Rupee	CPI Index 1913=100	Labourer Guilder/rupiah	Craftsman Guilder/rupiah	CPI Index 1913=100
1983	5,688.60	9,860.24	237,025.04	7.36	14.73	2,231.18	1,077.44	1,043.77	336,700.34
1984	5,839.67	9,958.94	242,309.88	7.34	14.68	2,367.04	1,190.01	1,264.39	371,877.98
1985	5,979.00	10,203.84	247,066.24	10.71	16.45	2,491.68	1,323.24	1,517.83	389,187.62
1986	6,116.83	10,542.83	248,651.69	16.05	20.59	2,674.46	1,442.28	2,019.20	412,081.01
1987	6,247.79	10,802.95	248,915.93	15.94	21.73	2,897.44	1,530.17	1,980.22	450,050.53
1988	6,369.45	10,983.53	250,765.62	17.25	25.87	3,194.17	1,604.94	1,994.01	486,344.93
1989	6,536.02	11,611.06	256,314.70	21.65	30.24	3,436.01	1,759.89	2,018.69	517,613.95
1990	6,711.75	12,128.71	264,241.96	21.73	30.20	3,682.75	1,954.31	4,299.49	558,375.35
1991	6,987.83	12,692.73	272,961.95	22.90	30.11	4,241.30	2,319.16	6,530.26	610,304.26
1992	7,408.02	12,846.12	277,454.06	23.17	31.86	4,826.86	2,624.36	6,560.91	656,091.04
1993	7,675.49	12,792.48	281,153.45	23.25	32.85	5,053.97	2,953.25	6,986.95	720,304.20
1994	7,839.19	9,537.21	283,003.14	39.62	42.41	5,580.60	3,437.14	7,421.09	781,167.12
1995	7,973.24	9,613.12	282,738.90	45.54	53.54	6,153.88	4,961.50	7,869.97	855,431.04
1996	8,207.09	9,791.91	283,003.14	51.61	56.97	6,702.61		9,039.87	922,436.08
1997	8,640.71	9,908.02	288,023.74	53.61	60.76	7,148.22		10,527.27	983,857.37
1998	8,696.20	10,000.63	289,873.43	58.03	65.98	7,949.84		12,888.59	1,552,841.85
1999	8,730.24	10,031.10	289,080.71	67.85	76.23	8,377.04		14,968.93	1,871,115.80
2000	8,637.70	10,101.23	286,966.77	70.13	78.79	8,658.15		19,597.58	1,940,354.34

A.2. Basic Statistics of India, Indonesia, and Japan, 1890-2000: GDP and Gross Fixed Non-Residential Capital Stock (1990 International USD); the Gross Fixed Non-Residential Capital Stock for Indonesia in current Rupiah, population, and persons employed.

Table A.2.1: Basic Statistics of India, Indonesia, and Japan, 1890-2000: GDP and Gross Fixed Non-Residential Capital Stock (1990 International USD); the Gross Fixed Non-Residential Capital Stock for Indonesia also in current Rupiah, population, and persons employed.

	India				Indonesia					Japan			
	GDP mil. 1990 Int. USD	Physical capital stock Bill. 1990 Int. USD	population mil.	Employment mil.	GDP mil. 1990 Int. USD	Physical capital stock Bill. 1990 Int. USD	Bill. Current Rupiah	Population mil.	Employment mil.	GDP mil. 1990 Int. USD	Physical capital stock Bill. 1990 Int. USD	population mil.	Employment mil.
1890	78,624.0	59.6	224.0	78.0	24,802.1	6.5	2.51E+08	37.6	13.5	40,555.6	15.6	40.1	23.3
1891	81,209.4	65.7	226.8	78.0	25,358.4	6.7	2.58E+08	37.8	13.6	38,621.0	15.8	40.4	23.4
1892	83,941.2	66.6	228.7	78.0	26,418.7	6.9	3.09E+08	38.3	13.7	41,200.5	16.2	40.7	23.5
1893	86,846.8	68.0	231.6	79.0	27,205.0	7.1	2.75E+08	38.3	13.9	41,343.8	16.4	41.0	23.7
1894	87,655.1	69.9	232.5	79.0	27,651.6	7.4	2.85E+08	38.8	14.0	46,287.8	17.0	41.4	23.8
1895	87,533.4	72.7	233.4	80.0	28,264.8	7.6	2.43E+08	39.5	14.3	46,932.7	17.6	41.8	23.9
1896	88,345.4	74.6	234.3	80.0	28,114.9	7.7	2.47E+08	39.9	14.5	44,353.2	18.5	42.2	24.0
1897	90,572.6	75.9	235.3	81.0	28,515.2	7.8	3.50E+08	40.6	14.7	45,284.7	19.5	42.6	24.2
1898	92,814.4	77.5	236.2	81.0	28,879.9	7.9	3.03E+08	41.3	14.9	53,883.1	20.2	43.1	24.4
1899	94,359.6	79.1	237.1	82.0	30,594.2	8.0	2.57E+08	42.0	15.0	49,870.5	20.9	43.6	24.5
1900	95,676.0	79.2	238.0	82.0	31,760.3	8.3	2.67E+08	42.7	15.4	52,020.1	21.6	44.1	24.6
1901	98,752.2	80.0	239.1	82.0	31,331.1	8.8	3.94E+08	43.3	15.5	53,883.1	22.1	44.7	24.7
1902	102,039.6	79.7	241.2	82.0	30,886.1	8.9	3.42E+08	43.8	15.7	51,088.6	22.6	45.3	24.8
1903	100,016.9	80.1	242.2	82.0	32,643.1	8.7	3.93E+08	44.4	15.7	54,671.2	23.0	45.8	25.0
1904	104,313.3	81.1	244.3	83.0	33,316.5	8.9	3.44E+08	44.9	15.9	55,101.2	23.4	46.4	25.1
1905	105,770.4	82.6	245.4	83.0	33,820.0	9.6	3.69E+08	45.5	16.2	54,169.7	24.2	46.8	25.2
1906	108,962.5	76.2	246.5	84.0	34,862.7	10.4	4.02E+08	46.0	16.4	61,263.3	25.3	47.2	25.3
1907	113,134.7	78.3	248.6	84.0	35,692.3	10.8	4.87E+08	46.5	16.8	63,197.9	26.6	47.7	25.4
1908	118,887.8	77.7	249.8	84.0	35,784.6	11.4	5.12E+08	47.1	17.1	63,627.9	27.7	48.3	25.5
1909	131,236.4	79.4	251.9	85.0	37,637.2	11.4	5.11E+08	47.6	17.4	63,556.2	29.0	48.9	25.5
1910	127,260.0	80.0	252.0	85.0	40,203.8	11.6	5.24E+08	48.2	17.8	64,559.4	30.2	49.5	25.6

Continued on the next page

Table A.2.1: Basic Statistics of India, Indonesia, and Japan, 1890-2000: GDP and Gross Fixed Non-Residential Capital Stock (1990 International USD); the Gross Fixed Non-Residential Capital Stock for Indonesia also in current Rupiah, population, and persons employed.

	India				Indonesia					Japan			
	GDP	Physical capital stock	population	Employment	GDP	Physical capital stock		Population	Employment	GDP	Physical capital stock	population	Employment
	mil. 1990 Int. USD	Bill. 1990 Int. USD	mil.	mil.	mil. 1990 Int. USD	Bill. 1990 Int. USD	Bill. Current Rupiah	mil.	mil.	mil. 1990 Int. USD	Bill. 1990 Int. USD	mil.	mil.
1911	128,720.9	81.7	251.9	85.0	42,436.9	14.0	6.32E+08	48.8	18.0	68,070.4	31.6	50.2	25.7
1912	129,425.2	84.4	251.8	86.0	42,793.4	16.0	9.23E+08	49.4	18.3	70,506.6	33.3	50.9	25.9
1913	132,142.5	84.5	251.7	86.0	45,140.3	17.3	8.88E+08	49.9	18.5	71,653.0	35.0	51.7	26.1
1914	135,360.8	86.7	251.6	86.0	45,061.2	23.3	1.20E+09	50.5	18.8	69,503.4	36.8	52.4	26.3
1915	140,588.5	88.4	251.5	86.0	45,639.4	27.6	1.24E+09	51.1	19.1	75,952.2	38.3	53.1	26.5
1916	143,298.0	89.2	251.4	87.0	46,327.7	26.5	1.36E+09	51.7	19.3	87,703.3	40.0	53.8	26.7
1917	139,974.1	94.0	251.3	87.0	46,510.1	27.7	1.60E+09	52.1	19.6	90,641.0	42.5	54.4	26.9
1918	141,676.8	90.5	251.2	87.0	47,571.6	31.0	2.19E+09	52.3	19.8	91,572.5	45.9	54.9	27.1
1919	138,105.0	89.2	251.1	87.0	51,383.2	32.9	2.32E+09	53.0	20.1	100,959.1	49.9	55.3	27.1
1920	145,078.0	85.3	251.0	88.0	50,768.2	35.8	4.14E+09	53.7	20.4	94,653.6	54.4	55.8	27.3
1921	147,052.6	89.2	253.1	88.0	51,213.7	41.0	3.95E+09	54.4	20.6	105,043.3	58.2	56.5	27.4
1922	151,423.3	92.8	256.2	88.0	52,048.9	48.5	4.05E+09	55.0	20.9	104,756.7	61.5	57.2	27.6
1923	151,967.4	96.1	259.3	89.0	52,843.2	55.2	4.97E+09	55.7	21.2	104,828.3	64.0	57.9	27.8
1924	150,644.6	97.9	262.4	89.0	55,677.8	57.6	5.18E+09	56.4	21.5	107,766.1	66.4	58.7	28.1
1925	152,603.6	98.1	265.4	89.0	57,606.4	57.4	4.79E+09	57.0	21.8	112,208.6	69.0	59.5	28.3
1926	152,787.0	102.2	268.5	90.0	60,786.5	56.8	4.38E+09	57.7	22.2	113,211.7	72.5	60.5	28.6
1927	155,071.6	101.5	270.6	90.0	64,973.0	63.1	4.87E+09	58.4	22.5	114,859.8	76.2	61.4	28.8
1928	157,101.1	104.6	272.7	90.0	68,070.1	74.0	5.71E+09	59.1	22.5	124,246.3	80.0	62.4	29.1
1929	160,281.3	105.8	275.9	91.0	70,039.7	85.3	6.58E+09	59.9	23.0	128,115.6	84.0	63.2	29.3
1930	162,099.0	107.5	279.0	92.0	70,533.7	99.1	6.37E+09	60.6	23.3	118,800.7	87.9	64.2	29.6
1931	164,419.8	108.7	282.0	94.0	65,247.3	106.8	5.49E+09	61.5	23.7	119,803.8	90.8	65.2	30.0
1932	165,244.4	110.2	285.9	98.0	64,459.2	104.7	4.71E+09	62.4	24.0	129,835.2	92.1	66.2	30.2
1933	166,416.6	116.6	289.9	101.0	64,010.5	101.0	3.89E+09	63.3	24.3	142,589.5	93.0	67.2	30.7
1934	165,478.2	122.9	295.0	104.0	64,374.5	100.4	3.23E+09	64.2	24.6	142,876.1	94.6	68.1	31.1
1935	165,648.1	131.8	299.0	107.0	66,691.4	103.6	3.33E+09	65.2	25.0	146,817.0	97.8	69.2	31.6
1936	164,246.3	136.9	303.0	111.0	71,512.5	104.2	3.35E+09	66.2	25.3	157,493.3	102.5	70.2	32.1

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Table A.2.1: Basic Statistics of India, Indonesia, and Japan, 1890-2000: GDP and Gross Fixed Non-Residential Capital Stock (1990 International USD); the Gross Fixed Non-Residential Capital Stock for Indonesia also in current Rupiah, population, and persons employed.

	India				Indonesia					Japan			
	GDP mil. 1990 Int. USD	Physical capital stock Bill. 1990 Int. USD	population mil.	Employment mil.	GDP mil. 1990 Int. USD	Physical capital stock Bill. 1990 Int. USD	Bill. Current Rupiah	Population mil.	Employment mil.	GDP mil. 1990 Int. USD	Physical capital stock Bill. 1990 Int. USD	population mil.	Employment mil.
1937	161,430.5	138.3	306.9	114.0	78,482.0	102.2	4.60E+09	67.1	25.7	165,016.9	108.0	71.3	32.2
1938	161,160.4	140.8	309.9	117.0	80,053.9	110.6	4.97E+09	68.1	26.0	176,051.4	114.3	71.9	32.3
1939	162,208.4	141.7	315.0	120.0	80,830.5	124.4	5.59E+09	69.1	26.4	203,781.1	123.0	72.4	32.7
1940	163,966.0	147.9	319.0	123.0	86,666.1	130.8	6.73E+09	70.2	26.7	209,728.3	133.4	73.0	32.9
1941	166,237.1	145.0	320.9	125.0	89,287.6	130.2	7.53E+09	71.3	27.2	212,594.5	143.8	74.0	32.7
1942	168,584.6	150.5	326.7	127.0	71,633.8	122.9	1.03E+10	72.5	27.6	211,448.0	153.5	75.0	32.5
1943	172,931.0	156.9	330.7	129.0	57,817.0	111.8	8.62E+09	73.3	28.1	214,457.4	163.6	76.0	32.3
1944	174,654.5	165.8	334.6	131.0	45,543.0	95.0	1.16E+10	73.6	28.5	205,214.2	174.9	77.2	32.1
1945	177,045.8	178.7	338.5	133.0	40,150.8	76.3	1.27E+10	73.3	29.0	102,607.1	136.0	76.2	32.7
1946	180,659.4	190.9	343.5	135.0	41,735.4	69.1	2.00E+10	74.1	29.5	111,492.1	140.1	77.2	33.2
1947	185,067.1	203.0	347.2	137.0	48,320.8	71.8	2.95E+10	75.1	29.9	120,377.0	145.8	78.1	33.8
1948	191,723.8	218.7	351.1	139.0	56,608.6	76.3	4.07E+10	76.3	30.4	138,290.3	152.2	80.2	34.5
1949	199,756.9	234.4	356.1	141.0	61,890.2	77.7	5.09E+10	77.7	30.9	147,533.5	157.8	82.0	35.2
1950	212,990.0	247.7	361.0	143.0	66,396.1	71.2	5.44E+10	79.0	31.4	160,966.0	161.5	83.8	35.9
1951	227,395.0	257.4	365.0	144.6	71,264.6	66.6	8.47E+10	80.5	32.0	181,025.0	164.9	85.2	36.2
1952	233,988.0	268.6	372.0	146.6	74,667.3	70.4	9.45E+10	82.1	32.6	202,005.0	169.2	86.5	37.3
1953	249,003.0	282.0	379.0	148.6	78,427.1	64.2	9.16E+10	83.6	33.0	216,889.0	173.7	87.7	39.1
1954	259,392.0	300.5	386.0	150.5	83,321.7	51.1	7.76E+10	85.2	33.2	229,151.0	178.2	88.8	39.6
1955	265,668.0	325.5	393.0	152.4	85,591.7	47.5	9.55E+10	86.8	33.1	248,855.0	182.6	89.8	40.9
1956	281,101.0	360.2	401.0	154.6	86,686.9	49.7	1.15E+11	88.5	33.5	267,567.0	188.6	90.8	41.7
1957	278,120.0	390.1	409.0	156.8	92,647.5	52.3	1.33E+11	90.1	34.0	287,130.0	197.5	91.6	42.8
1958	299,288.0	416.8	418.0	159.4	89,250.0	54.8	2.02E+11	91.8	34.6	303,857.0	207.5	92.4	43.0
1959	305,442.0	443.4	426.0	161.6	93,097.2	57.3	2.55E+11	93.6	35.3	331,570.0	221.1	93.3	43.4
1960	326,802.0	471.2	434.0	163.7	97,063.8	58.8	3.23E+11	95.3	36.0	375,090.0	242.5	94.1	44.4
1961	336,552.0	504.2	444.0	164.9	103,492.6	59.3	4.45E+11	97.1	36.7	420,246.0	272.6	94.9	45.0
1962	344,132.0	537.6	454.0	166.2	103,286.2	58.8	1.23E+12	99.0	37.2	457,742.0	309.0	95.8	45.6

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Table A.2.1: Basic Statistics of India, Indonesia, and Japan, 1890-2000: GDP and Gross Fixed Non-Residential Capital Stock (1990 International USD); the Gross Fixed Non-Residential Capital Stock for Indonesia also in current Rupiah, population, and persons employed.

	India				Indonesia					Japan			
	GDP	Physical capital stock	population	Employment	GDP	Physical capital stock		Population	Employment	GDP	Physical capital stock	population	Employment
	mil. 1990 Int. USD	Bill. 1990 Int. USD	mil.	mil.	mil. 1990 Int. USD	Bill. 1990 Int. USD	Bill. Current Rupiah	mil.	mil.	mil. 1990 Int. USD	Bill. 1990 Int. USD	mil.	mil.
1963	361,456.0	581.0	464.0	167.6	99,392.9	55.6	2.60E+12	101.0	37.6	496,514.0	349.1	96.8	45.9
1964	389,154.0	618.4	474.0	169.1	103,031.0	53.4	5.28E+12	103.0	38.0	554,449.0	395.1	97.8	46.5
1965	373,935.0	664.5	485.0	170.6	104,042.1	53.7	2.15E+13	105.1	38.5	586,744.0	444.4	98.9	47.3
1966	377,190.0	712.3	495.0	172.1	104,088.3	52.9	2.48E+11	107.2	38.9	649,189.0	492.6	99.8	48.3
1967	408,342.0	756.2	506.0	173.7	101,689.0	44.0	5.47E+11	109.3	39.4	721,132.0	551.8	100.8	49.2
1968	419,062.0	803.6	518.0	175.2	111,643.5	35.6	9.93E+11	111.5	39.9	813,984.0	628.7	102.0	50.0
1969	447,005.0	851.6	529.0	176.7	125,369.0	34.9	1.14E+12	113.8	40.3	915,556.0	718.9	103.2	50.4
1970	469,588.0	889.8	541.0	178.3	138,556.5	36.1	1.33E+12	116.0	40.8	1,013,602.0	835.8	104.3	50.9
1971	474,224.0	927.9	554.0	183.8	146,184.5	39.7	1.52E+12	118.4	41.3	1,061,230.0	946.9	105.7	51.2
1972	472,878.0	970.4	567.0	189.5	162,760.4	44.7	1.94E+12	121.3	42.3	1,150,516.0	1,064.2	107.2	51.2
1973	494,740.0	1,012.5	580.0	195.3	186,903.6	50.9	3.05E+12	124.3	43.3	1,242,932.0	1,173.0	108.7	52.5
1974	499,899.0	1,049.6	593.0	201.3	196,355.2	58.5	5.20E+12	127.3	44.4	1,227,706.0	1,282.9	110.2	52.3
1975	544,479.0	1,090.7	607.0	207.5	196,379.9	68.8	6.50E+12	130.5	45.5	1,265,661.0	1,392.4	111.6	52.1
1976	551,180.0	1,138.5	620.0	213.9	213,673.4	82.1	8.89E+12	133.7	46.6	1,315,966.0	1,495.8	112.8	52.6
1977	594,058.0	1,191.0	634.0	220.6	230,340.7	97.4	1.20E+13	137.0	47.8	1,373,741.0	1,597.4	113.9	53.3
1978	625,968.0	1,236.6	648.0	227.4	240,828.9	115.6	1.56E+13	140.4	49.0	1,446,165.0	1,690.7	114.9	54.0
1979	594,280.0	1,275.6	664.0	234.4	254,004.7	137.2	2.78E+13	143.9	50.2	1,525,477.0	1,805.1	115.9	54.7
1980	636,902.0	1,323.1	679.0	241.5	275,806.3	159.9	4.10E+13	147.5	51.6	1,568,457.0	1,925.1	116.8	55.2
1981	676,084.0	1,379.0	692.0	248.3	294,835.7	184.9	5.27E+13	150.7	53.0	1,618,185.0	2,050.3	117.6	55.7
1982	697,380.0	1,442.9	708.0	255.2	283,934.4	214.8	6.58E+13	153.9	54.5	1,667,653.0	2,170.3	118.5	56.2
1983	754,089.0	1,503.9	723.0	262.2	295,229.1	250.3	9.04E+13	157.2	56.4	1,706,380.0	2,293.8	119.3	57.3
1984	783,340.0	1,564.8	739.0	269.3	315,716.0	288.8	1.16E+14	160.6	58.3	1,773,223.0	2,435.0	120.0	57.7
1985	814,645.0	1,634.4	755.0	276.3	323,500.7	323.0	1.36E+14	164.0	60.2	1,851,315.0	2,729.6	120.8	58.1
1986	848,871.0	1,712.5	771.0	283.9	342,467.8	351.2	1.51E+14	167.0	62.3	1,904,918.0	2,901.5	121.5	58.5
1987	886,500.0	1,803.6	788.0	291.5	359,293.3	378.4	1.94E+14	170.0	64.4	1,984,142.0	3,130.6	122.1	59.1

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Table A.2.1: Basic Statistics of India, Indonesia, and Japan, 1890-2000: GDP and Gross Fixed Non-Residential Capital Stock (1990 International USD); the Gross Fixed Non-Residential Capital Stock for Indonesia also in current Rupiah, population, and persons employed.

	India				Indonesia					Japan			
	GDP	Physical capital stock	population	Employment	GDP	Physical capital stock		Population	Employment	GDP	Physical capital stock	population	Employment
	mil. 1990 Int. USD	Bill. 1990 Int. USD	mil.	mil.	mil. 1990 Int. USD	Bill. 1990 Int. USD	Bill. Current Rupiah	mil.	mil.	mil. 1990 Int. USD	Bill. 1990 Int. USD	mil.	mil.
1988	978,880.0	1,907.8	805.0	299.3	379,905.8	408.5	2.20E+14	173.0	66.6	2,107,060.0	3,313.5	122.6	60.1
1989	1,043,940.0	2,030.6	822.0	307.2	414,173.1	444.5	2.60E+14	176.1	68.9	2,208,858.0	3,547.7	123.1	61.3
1990	1,098,251.0	2,165.5	839.0	315.2	450,988.0	488.6	3.14E+14	179.2	71.6	2,321,153.0	3,805.8	123.5	62.5
1991	1,111,944.0	2,279.9	856.0	315.4	473,597.6	539.8	3.65E+14	182.2	74.0	2,393,300.0	4,086.1	123.9	63.7
1992	1,169,352.0	2,399.4	872.0	320.2	524,468.2	593.8	4.22E+14	185.3	76.3	2,415,691.0	4,290.4	124.3	64.4
1993	1,236,102.0	2,530.0	889.3	325.1	560,556.4	649.0	4.78E+14	188.4	78.6	2,425,642.0	4,458.1	124.7	64.5
1994	1,324,948.4	2,691.9	905.6	329.7	602,534.5	709.9	5.51E+14	191.5	82.0	2,450,521.0	4,610.3	125.0	64.5
1995	1,418,154.4	2,893.4	922.1	334.4	652,039.7	783.2	6.78E+14	194.8	80.1	2,487,838.0	4,768.6	125.3	64.6
1996	1,529,548.0	3,091.2	938.4	342.0	704,176.9	870.8	8.13E+14	198.0	85.7	2,574,912.0	4,943.9	125.6	64.9
1997	1,602,783.5	3,289.9	954.6	349.8	735,934.3	968.8	9.85E+14	201.4	87.1	2,619,694.0	5,112.7	126.0	65.6
1998	1,708,520.0	3,515.2	970.8	357.8	639,536.3	1,034.7	2.12E+15	204.4	87.7	2,592,327.0		126.2	65.1
1999	1,816,678.5	3,768.0	986.8	366.1	644,481.9	1,053.6	2.39E+15	207.4	88.8	2,609,742.0		126.5	64.2
2000	1,915,172.3	4,026.5	1,002.7	374.8	675,432.6			210.9	89.8	2,669,450.0		126.7	64.5

Sources:

GDP was obtained from Maddison (2003) for Japan, Indonesia, and India. However, for Indonesia, we interpolated the years 1942-1948 with data from Van der Eng (1992). For India, we linked the constant GDP estimates for the pre-1951 years from Roy (1996) with the estimates of Sivisubramonian (2002) for the period after 1950. The latter were also used by Madison (2003) to create a GDP series for India in 1990 Intl. USD which allowed us to convert the Roy (1996) data into constant 1990 Intl USD.

Stock of gross non-residential fixed capital was obtained from Pilat (2002) for Japan. For India, we used the gross fixed capital formation figures from Roy (1996) and the UN National Accounts Statistics, corrected it for residential structures, and assumed average asset life of 15 years. For Indonesia, we used data as estimated in appendix A.4, where we subtracted the residential structure by assuming a share in residential buildings in gross fixed capital formation of 20% and assuming that this percentage remained the same over time. Further, we used an an average asset life of 15 years.

Population was obtained from Maddison (2003). For India prior to 1946 we took, however, data from Roy (1996).

Persons employed was obtained from Pilat (2002) for Japan, Roy (1996) for India, and Van der Eng (2002) for Indonesia. The 1942-1948 years in Indonesia were again interpolated using Van der Eng (1996). All figures were updated with ILO (LABORSTA).

A.3. Purchasing Power Parities 1913-1990[180]

Comparing expenditure over time and across borders is complicated. Using simple exchange rates creates biases because they are based on the prices of tradable items. Non-exportables however, which make up an important part of expenditure, are much cheaper in developing countries. As a consequence, the exchange rate generally underestimates the purchasing power of developing countries. Using expenditure expressed in kilogrammes of grain or rice, on the other hand, could overstate the purchasing power in land-abundant countries (Van der Eng and Bassino 2002) and is, due to the changing consumption basket, in any case hardly suited for a comparison between 1880 and 2000. That is the reason that several authors prefer to use purchasing power parities (PPPs) (Maddison 1995; Van der Eng and Bassino 2002).

The estimation of PPPs is based on matching the products in the two countries concerned, weighting for their share in the total consumption basket. This is done using the data supplied by Van der Eng and Bassino (2002) for Indonesia and Japan (1913, 1922, 1930, 1952, 1958, 1969), added with he data for 1990 from the ILO Bulletin of Labour Statistics. Further we added price data for India. For 1913 -1938 the data came from the *Labour Gazette* (Bombay). For 1913 we used the data of July 1914. The Data for 1952, 1958, 1969, and 1990 came from the ILO Statistical Yearbook, the ILO International labour Review, and the ILO Bulletin of Labour Statistics. The quantities consumed are taken from *Report on an Enquiry into the Family Budgets of Middle Class Employees of the Central* Government (1949, table XXII).

It is clear from table A.3.1 below that the number of product matches is relatively low (between 6 and 18). However, because they are largely food and fuel items they do comprise a large share in total expenditure. Yet, the matches are not always entirely uniform. Furthermore, because the data for India from 1952 onwards are obtained from the ILO they are October prices instead of year averages. Nevertheless the PPPs seem to behave conform expectations. There was a convergence between PPP and exchange rate after the 1930s and a divergence after 1952. Nevertheless both the guilder/rupiah as the rupees were undervalued compared to the yen, except the rupiah for a short period around 1952.

[180] Data on Japan and Indonesia was kindly supplied by Pierre van der Eng and Jean-Pascal Bassino.

Table A.3.1: Exchange rates and PPPs of India and Indonesia per 100 Japanese Yen, 1913-1990

		1913	1922	1930	1938	1952	1958	1969	1990
Indonesia (guilder/rupiah									
Exchange rate		124,13	129,75	123,25	51,19	3,16	10,00	91,25	1270,90
PPP	PPP	69,65	73,14	52,71	31,73	3,49	7,02	28,54	167,30
	Matches	11	16	13	18	13	14	13	6
India (rupee)									
Exchange rate		151,75	165,50	136,32	77,74	1,32	1,32	2,11	12,06
PPP	PPP	74,78	59,39	75,58	45,57	1,07	0,88	1,09	2,07
	Matches	9	10	10	9	9	10	14	8

Source: Indonesia (Van der Eng and Bassino), India and Indonesia 1990 (calculated in this appendix)

A.4. A method of estimating the national income of Indonesia using the expenditure approach, 1890-2002.[181]

A.4.1 Introduction

It is important to make some estimates of the Indonesia GDP using the expenditure approach, even though these estimates are rough compared to some alternative estimates. Indeed, the GDP estimates of Van der Eng using the production approach (2002) are fairly consistent. In this appendix we thus do not aim at making significantly different GDP estimates but turn to the expenditure approach of estimating GDP for two reasons. First, it is difficult inserting human capital in the national accounts when they are created using the production approach. As human capital is generally calculated using the income or expenditure approach, it is far easier to include human capital in the national accounts using either of these two methods of calculating national income. Second, estimates of household consumption are important as they are the basis of our later estimates of private expenditure on education. As our estimates are only intended to offer a background for the estimates of human capital formation, we will only present GDP in current prices. In the next section we will start with a brief overview of the estimates of the GDP for Indonesia already available. Next, we estimate the GDP for Indonesia using the expenditure approach. This is done by treating in each of the following sections a part of GDP, i.e. household consumption expenditure, government consumption expenditure, capital investment, exports, and imports.

A.4.2 Estimates of the GDP for Indonesia using the expenditure approach: an overview

Some GDP estimations are already performed for Indonesia. Since the 1950s the Indonesian Bureau of Statistics (BPS) provides data on GDP using the production approach and since 1960 also on the basis of the expenditure approach. Also before independence some estimates have been produced of which the most important are those of Polak (1943) and the Statistical Office (published in 1948). Recently, Van der Eng (1992; 2002) has made a series of the Indonesian GDP using the production approach which is standardized for the period 1880-2000.

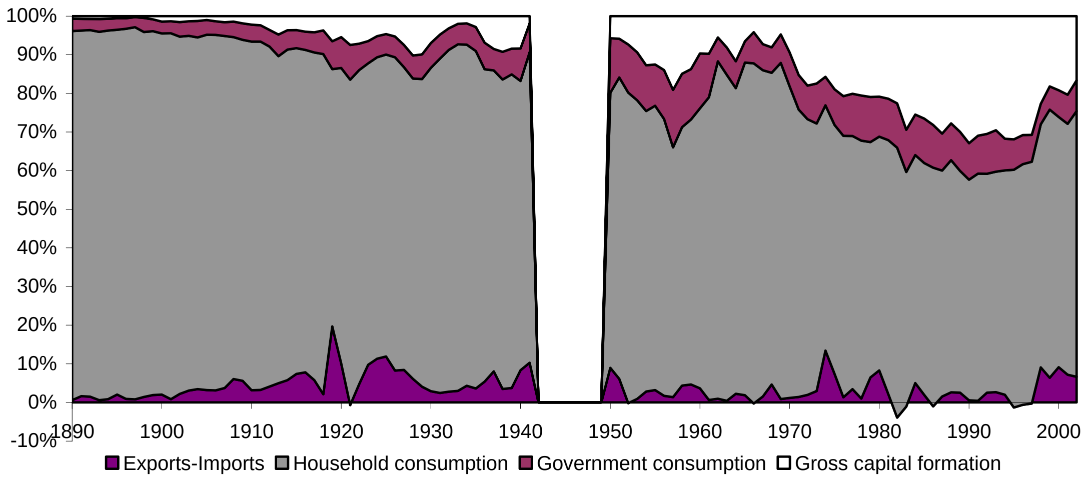
The results from our exercise in the next sections are presented in figure A.4.1. Although, as mentioned, these are crude estimaties, the figure does give an indication of the

[181] From 1960 onwards we used the data of the BPS and the input-output tables. We are aware that much criticisms can be levied against these data. However, currently a large project is underway for revising these data and this appendix is not the place nor the time to undertake a large revision of the estimates of the BPS after 1960.

division of the several expenditure shares in GDP. Not surprisingly, the percentage household consumption expenditure declines over time. We do see a strong increase in the percentage

Figure A.4.1

Percentage division of GDP in Indonesia 1890-2000 in current prices in expenditure shares



Note: We included exports minus imports. In years when the value of the imports were larger than the value of the exports the other parts of GDP first have to make up this negative difference. Hence, for some years there is a negative value.

household consumption in times of economic turmoil and crisis, i.e. the 1930s and 1960s. The main reason is a decline in exports, government consumption and gross capital formation. Also we see a strong peak in exports during and just after World War I. A final finding is that the share of gross capital formation increases strongly since the 1970s. This can be attributed the booming economy and the oil crises which made it possible to increase investments significantly.

The results thus do seem to give an indication of Indonesian economic development. In the next section, we very briefly outline the estimation of each of the components of the GDP.

A.4.3 Household consumption expenditure

We start with the by far largest component of GDP, namely household expenditure. The best data available are for the period after independence. Some important sources are available. First, the input-output tables provide data on private expenditure for 1969, 1971, 1975, 1980, 1985, 1990, 1995, and 2000. These data are relatively reliable as they provide information on all streams of income, production and expenditure in the Indonesian society. As such, we will use these figures to provide benchmarks. Further, we have data on private expenditure from the Indonesian household surveys (SUSENAS) which are available since the 1960s. Finally, we have the national accounts statistics which provide data on household consumption expenditure since 1960.[182]

The period prior to 1960 is more difficult to estimate. In this instance, a commodity flow method might underestimate household consumption expenditure as it might ignore in

Table A.4.1: Overview of the main household expenditure surveys in Java/Indonesia, 1885-1960

Source	Sample size	Region	Year
Arminius (1889)	3 farm households	Kutoarjo (Bagelen)	1886-8
Boeke (1927)	29 rural households	Java (various parts)	1924-25
CKS (1928)	314 urban households	Indonesia	1925
Rohrman (1932)	18 rural households	Kraksaän (Probolinggo)	1932
CKS (1939)	95 labourers' households	Jakarta	1937
Huizenga (1958)	1,945 rural labourers' hh	Java	1939-40
Sato (1994: 96)	421 farm households	Tasikmadu (Malang, E.Java)	1942
Sato (1994: 102-3)	345 farm households	Tumut (Bantul, C.Java)	1942
ILO (1967) = Ministry of Labour	2,639 urban households	Jakarta	1957
ILO (1967) = Ministry of Labour	2,180 urban households	Surabaya	1958
Sukamto (1962)	503 households	DI Yogyakarta	1958-9

Source: Van der Eng (2001) and this appendix.

some cases home consumption of certain crops of which rice is of main importance. Therefore we opted to use household expenditure data from several surveys in the period 1880-1960. An overview of these surveys is given in table A.4.1 of this appendix. In an interesting paper in which he estimated the GDP by the expenditure approach, Van der Eng (2001) constructed private consumption using a part of these data. He, however, only used the expenditure on the 6 most important food crops combining it with the expenditure data from Japan to calibrate the results. We do not, however, follow this approach as 1) it does not make use of all available data, 2) home consumption is probably underreported, and 3) it is doubtful whether Japan knew the same developments in this long period as did Indonesia. Therefore, we opted instead on focusing on the difference between households. Following the Social Accounting Matrices, we divided the households in 10 classes (see table A.4.2). For each household class we estimated their share in total consumption. In addition, as we also had the

[182] The total private consumption expenditure statistics were obtained from Badan Pusat Statistik, *Statistik Indonesia (Statistical Yearbook of Indonesia)*, Jakarta: BPS 1976-2003. Further they were obtained from Pusat Penelitian dan Perkembangan Statistik, Biro Pusat Statistik, *Pendapatan Nasional Indonesia 1960-1968 (National Income of Indonesia 1960-1968)*, Djakarta: Pusat Penelitian dan Perkembangan Statistik, Biro Pusat Statistik 1970. Finally, of course, the input-output tables were used.

Table A.4.2: Total household consumption expenditure per household category (%)							
	household category	1975	1980	1985	1990	1993	1999
Agriculture	Agricultural employee household	5%	5%	4%	4%	4%	6%
	Operator, land owner 0,0-0,5 ha agriculture household	11%	13%	13%	18%	17%	9%
	Operator, land owner 0,5-1 ha agriculture household	8%	7%	6%	5%	5%	5%
	Operator, land owner >1 ha agriculture household	13%	14%	13%	8%	7%	5%
non-agriculture	Non agricultural lower level rural household	10%	14%	9%	7%	6%	12%
	Non labour force rural household	2%	3%	4%	2%	2%	5%
	Non agricultural higher level rural household	5%	6%	10%	16%	19%	13%
	Non agricultural lower level urban household	12%	16%	16%	12%	10%	19%
	Non labour force urban household	2%	3%	5%	3%	3%	5%
	Non agricultural higher level urban household	14%	14%	17%	25%	28%	21%
Total		**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
Total consumption (accounts) (billion)		8.744,5	27.502,9	56.857,9	106.312,3	158.342,7	838.097,2
Source: National accounts statistics; Social Accounting Matrix.							

number of persons in each class, we used the shares of each household class in the population and extrapolated them backwards to 1960 (see table A.4.3). We found only a minor shift from the share of the population in agricultural occupations versus the share of the households in the towns.[183] On average, however, the shares remained fairly constant, especially for the period before 1980, allowing the assumption that the changes would not have been very large in the period prior to 1960. This looks like a big assumption but there are three reasons to follow it. First, looking at table A.4.3, we do not see a strong change of rural to urban from 1960 to 1975. As these processes are generally initially slowly changing and later rapidly changing, we expect that the change from rural to urban was even less strong in the period prior to 1960. Second, in 1960 about 67% of the households resided in rural areas. Yet in 1920 circa 76% of the labour force was employed in agriculture. These figures correspond rather good, especially considering the situation that some urban households also were employed in agriculture and given the situation that the average household size is likely to be larger in rural areas. Third, even if this assumption would not entirely be warranted, still this would not considerably bias our estimates as it is likely that household consumption expenditure was more equal between urban and rural areas in the 1920s than in the 1960s.

[183] However, be aware, a decrease of 8% in the urban households from 1975 back to 1960 means a decrease of 19% in the total urban households.

We therefore assume that from 1960 backwards, the shares of each household class in agriculture and non-agriculture remained constant. Now we have to estimate on the basis of

Table A.4.3: Share of household category in total population

(non-)-agriculture	household category	1960	1975	1980	1985	1990	1993	1999
Agriculture	Agricultural employee household	14%	12%	11%	7%	9%	10%	14%
	Operator, land owner 0,0-0,5 ha agriculture household	25%	22%	21%	24%	28%	26%	18%
	Operator, land owner 0,5-1 ha agriculture household	14%	12%	11%	8%	6%	6%	6%
	Operator, land owner >1 ha agriculture household	14%	14%	15%	10%	7%	6%	5%
Non-agricultural	Non agricultural lower level rural household	17%	17%	15%	14%	9%	9%	14%
	Non labour force rural household	2%	3%	4%	5%	2%	2%	5%
	Non agricultural higher level rural household	2%	3%	4%	8%	13%	12%	6%
	Non agricultural lower level urban household	8%	11%	12%	13%	13%	12%	14%
	Non labour force urban household	1%	2%	3%	4%	3%	3%	5%
	Non agricultural higher level urban household	3%	5%	6%	9%	12%	11%	8%
Total		**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
Total population (‘000s)		95,254	130,485	147,490	164,047	179,248	188,359	207,429

Source: National accounts statistics; Sistem neraca social ekonomi Indonesia (Social Accounting Matrix), various issues.

the household surveys (table A.4.1) the per capita expenditure for the available years and household classes between 1890 and 1960. Before doing this, we first, as far as possible, corrected for the consumption of goods produced by the household itself.[184] Using these corrected expenditure data from the surveys mentioned in table A.4.1 we estimate the total per capita expenditure per household category. This can then be multiplied with the total population in that category to obtain the total household expenditure for that household class. In this way we obtained for several years and household categories the total expenditure.

Obviously, we have these data only for a limited number of years and household categories. Therefore, our next step was to estimate the relation between the expenditure in the several household categories. For example, if we had in 1930 the total expenditure of non labour force rural households and non labour force urban households while we had in 1931 the total expenditure of non labour force urban households and agricutural employee households, we calculated the relationship between the latter two (for example the total expenditure of the non labour force urban households was 50% of that of the agricultural

[184] This was only possible for the largest crop, rice. First we estimated on the basis of more complete data the average rice consumption of a person (both adult and child). Next, we calculated for each survey the ‘average’ consumption of adults and children of rice. Then, we added the money value of the amount of rice between what a certain household consumed according to the survey and what was their expected average consumption to the household expenditure.

employee households) and used that figure to heighten the total expenditure in 1930 up. In this way we constructed total household expenditure for each year for which we had at least 1 observation for a household category.

However, not for all years prior to 1960 data were available. Therefore, the next step was to impute the missing years. We used data on craftsmen and labourers' wages, government expenditure and population to impute the missing years. However, it is clear that the results from the surveys are of doubtful quality. This caused unlikely fluctuations in the series (imputation does not smooth a series). Therefore, we ran a regression with total household expenditure as a dependent variable and population, craftsmen and labourers' wages, and government expenditure as the independent variables. The resulting coefficients were used to smooth the household expenditure series.

A.4.4 Government Consumption

A second part in GDP is government consumption. Government consumption is defined as all government spending minus spending on transfers, subsidies, government enterprises and capital investments. Again, for the period after 1960, these data can be obtained from the Indonesian national accounts and the input-output tables. For 1950-1959 we filled in government consumption by taking the ratio between government consumption and total central government expenditure in 1960 (74%). This figure was multiplied by central government spending for 1950-1959.

For the period prior to independence no really reliable data exist on government consumption. Only for 1938 there is an estimate that government consumption is about 12% of the GDP, however this is probably an overestimation due to an underestimation of the GDP. We therefore took the total central government expenditure for the ordinary service and deducted utilities (CEI 2).[185] This was done because the extraordinary service mainly existed of capital investments. However, especially in the 1920s, the share of 'other service' in the extraordinary expenditure increased. Therefore, we included the post 'other services;' from the extraordinary services with the central government spending on the ordinary service. Furthermore we deducted interest and transfers (pensions). The transfers to state enterprises were already deducted from these figures.

[185] For data on central and regional government expenditure in indonesia one may, besides the *Indische Verslagen* and *Jaarcijfers Koloniën*, look at P. Creutzberg, *Changing Economy in Indonesia*, Vol. 2: Public Finance 1816-1939, The Hague: Martinus Nijhoff 1976.

However, these figures excluded native states and municipalities whose finances became increasingly important during the twentieth century. We therefore estimated the total expenditure from these lower governments based on CEI 2. Next we estimated the percentage central government consumption on total central government expenditure. This percentage was also applied to the expenditure of the lower governments.

A.4.5 Gross Capital Formation

The Gross Capital Formation is available since 1953 by Keuning and Van der Eng (Van der Eng 2002, 174-175). However, their estimates were somewhat high. Therefore, we preferred to use the capital formation figures from the national accounts. We arrived at the stock around 1950 by using the data of Keuning and Van der Eng (2002) and of Nehru and Dhareshwar (1993).

The period 1890-1950 is far more difficult. Fortunately there is a figure available for the stock of capital for 1940 from Sitsen (1943, 12). This figure is divided into Buildings, communications, commercial capital, government enterprise and others not included, totalling 10,150 million guilders. Of a total of 5,400 million, 900 million was Indonesian capital. Furthermore 4,889 million was the capital value of all non-Indonesian private enterprises (CEI vol. 3, 1977, 25). This thus includes government enterprises, Western commercial capital and communications.

Starting with the Indonesian commercial capital, the Indonesian stock was calculated from the ratio with the Indonesian part of GDP from Polak (1943). The differences between those years were calculated as the net capital formation. Equally the fixed capital formation (1910-1939) from CEI 3 was used to calculate the ratio with the government and non-government capital stock. Because these series knew strong fluctuations, we used a moving average to smooth some of the more unlikely fluctuations. The period before 1910 was calculated by using the ratio from the stock of government and non-government capital with GDP of Van der Eng (2002) and calculating it back to 1890. Here also, the difference between year t and year t-1 was assumed to be the net capital formation. Finally, the other, not yet included, part of the physical capital stock was calculated by estimating the ratio between this post in the Sitzen figure and the total GDP and calculating it back to 1890. Also here, we used the difference from year t to year t-1 to calculate the net capital formation.

The sum of the three series of net capital formation gave the total capital formation. As we had the stock around 1940 from Sitzen, we could bring the stock of physical capital back to 1890. To obtain constant 1990 rupiah the time series were divided by the national income and multiplied by the constant series. This gave the physical capital stock in 1990 rupiah. However, to arrive at the gross capital formation, we took the difference of this stock to arrive at the net capital formation in 1990 rupiah. Adding subtracting 5% depreciation of the GDP of Van der Eng (2002) gave the gross capital formation.

A.4.6 Export and Import

A final step in calculating the Indonesian GDP is to estimate the total value of import and export. This is relatively straightforward. Between 1950 and 2002 we used the data as supplied in the Indonesian national accounts. For 1948-1949 we used the IMF *International Financial Statistics* data. However, partly they were in USD. These we converted into rupiah using the black market rate in order to avoid the over- and undervaluing of the currency. The period 1890-1941 was obtained from the CEI 12a (table 1A and 2B) and the *Indische Verslag*. Although the latter only include exports and imports of goods, we do not think this to be a problem because the exports and imports of services was relatively small.

Table A.4.4: Indonesian GDP (expenditure approach) in billion current rupiah, 1890-2002

	Household consumption	Government consumption	Gross capital formation	Exports	Imports	GDP
1890	2.67	0.09	0.02	0.18	0.16	2.79
1891	2.69	0.09	0.02	0.22	0.18	2.85
1892	2.83	0.08	0.02	0.21	0.17	2.98
1893	2.52	0.09	0.02	0.19	0.18	2.65
1894	2.81	0.09	0.02	0.20	0.18	2.94
1895	2.95	0.09	0.02	0.23	0.16	3.12
1896	3.20	0.09	0.02	0.20	0.17	3.35
1897	3.53	0.10	0.01	0.21	0.18	3.66
1898	2.55	0.10	0.01	0.22	0.18	2.70
1899	2.94	0.10	0.03	0.25	0.19	3.12
1900	2.93	0.10	0.04	0.26	0.20	3.13
1901	3.03	0.10	0.04	0.26	0.23	3.20
1902	2.61	0.11	0.04	0.27	0.20	2.82
1903	2.62	0.11	0.04	0.27	0.19	2.85
1904	2.34	0.11	0.03	0.30	0.21	2.57
1905	2.64	0.11	0.03	0.31	0.22	2.87
1906	2.80	0.11	0.04	0.33	0.24	3.04
1907	2.85	0.11	0.05	0.36	0.25	3.13
1908	2.77	0.12	0.05	0.47	0.28	3.13
1909	2.74	0.13	0.06	0.46	0.28	3.11
1910	3.07	0.15	0.08	0.45	0.35	3.40
1911	3.38	0.16	0.09	0.52	0.40	3.75
1912	3.45	0.17	0.14	0.60	0.43	3.92
1913	3.23	0.21	0.18	0.68	0.49	3.82
1914	3.79	0.22	0.16	0.68	0.43	4.43

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Table A.4.4: Indonesian GDP (expenditure approach) in billion current rupiah, 1890-2002

	Household consumption	Government consumption	Gross capital formation	Exports	Imports	GDP
1915	4.23	0.23	0.18	0.77	0.40	5.01
1916	4.53	0.26	0.22	0.87	0.45	5.42
1917	4.37	0.27	0.22	0.79	0.50	5.15
1918	4.71	0.33	0.20	0.68	0.57	5.34
1919	4.64	0.50	0.46	2.17	0.79	6.98
1920	7.04	0.73	0.50	2.24	1.31	9.20
1921	5.84	0.62	0.52	1.20	1.24	6.93
1922	6.27	0.53	0.55	1.15	0.78	7.72
1923	5.91	0.44	0.49	1.39	0.65	7.57
1924	5.88	0.41	0.39	1.56	0.70	7.53
1925	6.23	0.42	0.37	1.81	0.86	7.98
1926	6.64	0.44	0.43	1.60	0.92	8.19
1927	6.79	0.50	0.65	1.66	0.93	8.66
1928	7.09	0.55	0.93	1.59	1.03	9.13
1929	7.44	0.59	0.93	1.49	1.11	9.34
1930	7.71	0.59	0.64	1.19	0.92	9.22
1931	7.34	0.53	0.40	0.82	0.61	8.48
1932	6.42	0.41	0.23	0.61	0.41	7.26
1933	5.80	0.35	0.13	0.52	0.33	6.47
1934	5.30	0.33	0.11	0.55	0.29	6.00
1935	4.87	0.35	0.16	0.48	0.28	5.58
1936	4.31	0.37	0.37	0.58	0.29	5.34
1937	4.42	0.31	0.48	0.97	0.52	5.68
1938	4.29	0.38	0.50	0.69	0.50	5.36
1939	5.00	0.41	0.52	0.76	0.53	6.15
1940	4.00	0.45	0.45	0.88	0.44	5.34
1941	4.79	0.44	0.11	1.09	0.48	5.96
1942	5.23					6.45
1943	3.91					4.79
1944	5.60					6.81
1945	6.22					7.50
1946	8.30					9.94
1947	11.48					13.63
1948	16.89			4.51	5.31	20.25
1949	24.37			6.03	6.63	29.93
1950	32.80	6.50	2.64	9.18	5.05	46.06
1951	61.39	7.91	4.59	14.83	10.02	78.70
1952	72.40	11.19	6.63	10.72	10.88	90.07
1953	72.68	11.66	8.81	9.64	8.77	94.02
1954	69.99	11.46	12.27	9.95	7.22	96.45
1955	83.78	12.15	14.25	10.86	7.23	113.81
1956	84.20	14.91	16.42	10.81	8.77	117.56
1957	83.06	19.08	24.56	10.22	8.45	128.48
1958	127.07	26.31	28.36	20.73	12.44	190.02
1959	174.29	33.04	34.91	29.77	18.03	253.98
1960	230.63	45.10	30.70	35.73	24.14	318.01
1961	385.60	55.40	48.10	27.66	24.56	492.20
1962	1,180.00	83.30	74.80	39.36	26.22	1,351.24
1963	2,726.50	228.30	263.00	132.10	118.67	3,231.23
1964	5,821.30	508.20	862.00	543.22	378.12	7,356.60

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Table A.4.4: Indonesian GDP (expenditure approach) in billion current rupiah, 1890-2002

	Household consumption	Government consumption	Gross capital formation	Exports	Imports	GDP
1965	20,902.50	1,329.80	1,586.70	1,297.07	845.84	24,270.22
1966	303.30	27.80	14.30	65.11	66.05	344.46
1967	786.00	62.50	67.90	145.82	131.18	931.04
1968	1,771.20	143.50	177.90	387.12	285.83	2,193.88
1969	2,359.90	198.50	129.11	278.40	254.51	2,711.41
1970	2,692.80	293.00	313.13	402.02	363.37	3,337.57
1971	2,832.60	341.00	580.00	494.83	442.22	3,806.21
1972	3,401.60	414.00	857.00	763.22	670.75	4,765.07
1973	4,790.70	716.00	1,208.00	1,361.46	1,157.14	6,919.03
1974	7,258.60	841.00	1,797.00	3,182.04	1,646.25	11,432.39
1975	8,744.50	1,253.70	2,571.70	3,060.96	2,055.78	13,575.08
1976	10,463.80	1,590.50	3,204.90	3,429.60	3,222.10	15,466.70
1977	12,458.40	2,077.30	3,826.40	4,465.80	3,817.20	19,010.70
1978	15,184.50	2,658.90	4,670.70	4,973.90	4,742.00	22,746.00
1979	19,513.70	3,733.40	6,704.30	9,628.70	7,554.70	32,025.40
1980	27,502.90	4,688.20	9,485.20	13,849.20	10,079.80	45,445.70
1981	35,560.00	5,787.90	11,553.40	14,927.90	13,802.20	54,027.00
1982	41,670.30	6,831.70	13,467.10	13,345.20	15,681.70	59,632.60
1983	44,739.30	8,077.30	21,668.40	20,447.70	21,235.10	73,697.60
1984	51,398.90	9,121.50	22,176.70	22,984.90	18,627.20	87,054.80
1985	56,857.90	10,893.10	25,136.20	21,671.10	19,837.50	94,720.80
1986	63,355.30	11,328.70	28,888.20	20,009.90	21,036.20	102,545.90
1987	71,988.90	11,765.50	37,491.02	29,874.30	27,955.80	123,163.92
1988	81,045.30	12,755.80	37,453.52	34,665.60	31,171.40	134,748.82
1989	88,752.30	15,687.60	46,318.96	42,505.00	38,601.00	154,662.86
1990	106,312.30	17,572.60	61,255.39	51,953.10	50,945.70	186,147.69
1991	125,035.80	20,784.60	65,880.06	62,263.80	61,375.70	212,588.56
1992	135,880.30	24,731.30	73,129.89	76,384.40	70,336.60	239,789.29
1993	158,342.70	29,756.70	82,003.36	85,454.30	78,064.70	277,492.36
1994	219,565.00	31,014.00	120,034.84	99,437.50	91,873.80	378,177.54
1995	279,876.40	35,584.20	145,056.33	119,592.90	125,656.90	454,452.93
1996	332,094.40	40,299.20	164,181.80	137,533.30	140,812.00	533,296.70
1997	387,170.70	42,952.00	190,189.36	174,871.30	176,599.80	618,583.56
1998	647,823.60	54,415.90	233,981.93	506,244.80	413,058.10	1,029,408.13
1999	838,097.20	72,631.30	219,788.69	390,560.10	313,720.20	1,207,357.09
2000	850,818.70	90,779.70	251,980.00	542,992.40	423,317.90	1,313,252.90
2001	975,730.80	113,416.10	305,674.46	612,482.20	505,127.70	1,502,175.86
2002	1,137,762.50	132,218.70	275,027.22	569,941.90	459,631.10	1,655,319.22

Note: the GDP estimates for the period 1942-1949 were interpolated by calculating ratios with household consumption data.

A.5. Estimates of the Gross Enrolment Ratio per Ethnicity in Indonesia, 1890-1940.

A.5.1 Population

To obtain estmates of the gross erolment ratio, we need data on enrolments per level of education and estimates on the size of the population in the relevant age classes. In this section we start with population, more specific with the indigenous, Indonesian, population which was the least educated, the least registered, and the least enumerated. It was necessary to obtain the population figures for the ages 5-10, 5-12, 12-17, and 17-21, to estimate the enrolment ratio before independence. Contrary to the European and Chinese population, it was necessary to include the age class 5-10 for the Indonesian population prior to independence, as the Village School, the most important form of education for the Indonesian population, was of a rather short duration. We took the numbers of Chinese, Europeans, and Indonesians from Changing Economy in Indonesia Vol. 11. These figures were corrected to match the total population as estimated by from Van der Eng (1996; 2002). Next, we took population surveys which contained data on the ages of the population to calculate the ratio with the total Indonesian population. The different ratios were then linearly interpolated and the result multiplied with the total Indoensian population to obtain the figures for each age class for all years. The same method was applied for Chinese and Europeans.

Three points have to be noticed. First, the figure for males in the 1930 survey has been obtained by dividing the number “other children” by 13.5 (assuming that between age 1.5 and age 15 boys fell under ‘other children’) and multiplying it by 10 as we wanted to estimate 10 years (between age 5 and age 15). The others (until age 1.5) were assumed to be “children not yet able to walk”. For women this is obtained by dividing the number of ‘other children’ by 12.5 and multiplying it with 10, as girls were supposed to reach adulthood sooner. Second, only for Indonesians, for Java we used instead of interpolation the number of births on Java (CEI 11, table 9a.2) added with the net births from the census of 1920 and the difference of net deaths (CEI 11) and population growth (Van der Eng (2002) figures) and linear interpolation for 1895-1905. The births in year *t-15* till year *t-5* were added to obtain the number of children for age 5-15 for Java. For 1880-1894 the ratio between the cohort 5-15 of Java and the Indigenous population on Java has been used of 1895. The figures for Java have been corrected for the downward bias with the linear interpolation of the coefficients mentioned in CEI 11 and Van der Eng (1996). For the Outer Provinces the years 1890-1940 were calculated as the interpolated ratio of the total population to the number of Indonesians in the Outer Provinces. Third, to obtain the figures for the post-1930 period, we took the age classes from the 1961 census. These figures were corrected for the absence of Irian Jaya by adding the population of Irian which was at that time ca. 700,000. We assumed that the age classes in Irian had the same share in total population as in Indonesia.

A.5.2 Enrolments

Now we have the necessary population figures for Chinese (and other Asians), Indonesians, and Europeans. By dividing the number of Indonesians, Chinese, and Europeans enrolled by the relevant age classes in the population, we arrive at their respective gross enrolment ratios as reported in table A.5.1. Unfortunately, the enrolment of Indonesians poses a problem because in primary education there are two enrolment figures for the same level. This is because we have two forms of primary education which have a different duration and thus a different relevant age group as we have seen in section A.5.1. As the (short) indigenous primary education was unknown for Chinese and Europeans, we cannot add the enrolments of the three ethnicities together. This problem is solved by adding the cohort 5-10 to that of 5-12 together by weighing it with the number of Indonesian pupils in respectively the Indonesian and European schools. For Chinese and Europeans we simply divided the enrolment rates by the relevant population from section A.5.1.

There are two points of warning. First, for the colonial period and the first years thereafter no fixed entrance age is available and the cohorts are therefore necessarily crude. Second, as a consequence of the marginal supply of higher education, the gross enrolment ratio in higher education is in all cases very low. In the case of Indonesians, it is so small, that it cannot be reported. This does not mean, however, that in Indonesia no-one had followed higher education. It were especially Europeans and a few Indonesians who came to the Netherlands to follow higher education.

Table A.5.1: Gross Enrolment Ratio per Ethnicity and Level of Education in Indonesia, 1890-1940

	Europeans			Chinese		Indonesians	
	Primary	Secondary	Tertiary	Primary	Secondary	Primary	Secondary
1890	146.29	11.98	0.00	1.91	0.01	1.41	0.02
1891	147.30	13.57	0.00	1.96	0.01	1.47	0.02
1892	148.93	13.56	0.00	2.06	0.01	1.56	0.02
1893	151.13	15.15	0.00	2.15	0.01	1.65	0.03
1894	151.46	13.61	0.00	2.24	0.05	1.72	0.02
1895	148.02	13.49	0.00	2.34	0.07	1.79	0.02
1896	141.59	12.52	0.00	2.48	0.07	1.90	0.02
1897	140.94	12.44	0.00	2.38	0.07	1.84	0.02
1898	140.48	11.91	0.00	2.50	0.07	1.90	0.02

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Table A.5.1: Gross Enrolment Ratio per Ethnicity and Level of Education in Indonesia, 1890-1940

	Europeans			Chinese		Indonesians	
	Primary	Secondary	Tertiary	Primary	Secondary	Primary	Secondary
1899	138.68	12.19	0.00	2.70	0.07	2.31	0.02
1900	137.14	12.90	0.00	2.65	0.07	2.13	0.02
1901	138.18	13.88	0.00	2.80	0.09	2.31	0.03
1902	140.35	13.76	0.00	2.93	0.09	2.49	0.03
1903	142.50	14.89	0.00	3.13	0.10	2.66	0.04
1904	148.87	17.23	0.00	3.46	0.16	2.98	0.06
1905	145.32	16.91	0.00	3.67	0.17	3.14	0.06
1906	142.62	16.60	0.00	3.87	0.17	3.35	0.05
1907	133.12	17.16	0.00	3.52	0.21	3.47	0.06
1908	130.53	18.17	0.00	4.62	0.25	3.84	0.07
1909	125.83	18.81	0.00	5.83	0.28	4.69	0.08
1910	120.52	19.60	0.00	7.20	0.34	5.91	0.10
1911	114.66	18.60	0.00	8.32	0.36	7.15	0.09
1912	108.93	16.90	0.00	9.14	0.37	8.10	0.10
1913	107.60	16.18	0.00	9.56	0.38	8.71	0.10
1914	108.68	16.41	0.00	10.08	0.41	8.30	0.11
1915	112.44	18.47	0.00	10.85	0.43	9.09	0.12
1916	115.59	19.27	0.00	11.65	0.45	9.96	0.13
1917	117.73	23.05	0.00	12.41	0.56	10.42	0.17
1918	117.45	26.14	0.00	13.17	0.65	10.53	0.19
1919	114.52	27.68	0.00	13.12	0.73	9.04	0.22
1920	111.59	28.98	0.17	14.12	0.80	9.67	0.24
1921	111.05	28.06	0.32	14.63	0.74	10.91	0.26
1922	112.00	28.56	0.49	13.96	0.76	11.00	0.29
1923	109.79	30.47	0.43	13.51	0.78	11.25	0.34
1924	111.69	30.34	0.54	13.50	0.79	11.56	0.38
1925	110.12	31.10	0.56	14.30	0.78	11.31	0.43
1926	109.76	31.09	0.50	14.80	0.78	12.07	0.46
1927	110.34	32.28	0.49	16.03	0.82	13.25	0.48
1928	112.06	34.36	0.60	17.69	0.91	14.66	0.48
1929	106.81	36.68	0.64	15.27	1.06	13.89	0.53
1930	109.17	37.71	0.85	16.64	1.24	14.55	0.54
1931	111.47	38.96	1.04	17.86	1.42	15.33	0.52
1932	110.42	39.81	1.09	18.32	1.57	15.37	0.48
1933	106.40	39.86	1.17	18.13	1.60	15.00	0.44
1934	103.72	37.20	1.25	17.74	1.66	14.74	0.42
1935	101.49	37.80	1.22	17.47	1.81	14.83	0.38
1936	101.42	35.61	1.21	17.87	1.83	15.45	0.56
1937	99.80	41.05	1.02	17.81	1.94	15.91	0.57
1938	100.61	42.24	1.02	18.12	2.16	16.61	0.64
1939	103.58	51.19	1.18	18.46	2.30	17.02	0.78
1940	94.54	42.24	0.99	16.71	2.19	16.73	0.75

A.6. Enrolments per level of education and sex in Indonesia, India, and Japan 1880-2000

The construction and sources of the following data on enrolment and the gross enrolment ratio is given in chapter 3.

Table A.6.1: Enrolments per level of education and sex in Indonesia, 1880-2000

	Primary education ('000s)				Secondary Education				Higher Education			
	Boys	Girls	Total	% of relevant	Boys	Girls	Total	% of relevant	Boys	Girls	Total	% of relevant
1880	64.6	12.2	76.8	1.26	473	20	493	0.06	0	0	0	0.00
1881	65.1	11.9	76.9	1.24	448	32	480	0.05	0	0	0	0.00
1882	72.3	14.4	86.7	1.39	467	44	511	0.06	0	0	0	0.00
1883	75.1	16.0	91.1	1.47	441	56	497	0.05	0	0	0	0.00
1884	78.9	17.3	96.3	1.50	467	50	517	0.05	0	0	0	0.00
1885	81.0	18.2	99.2	1.60	442	46	488	0.06	0	0	0	0.00
1886	82.8	19.0	101.8	1.50	448	51	499	0.06	0	0	0	0.00
1887	84.9	20.2	105.1	1.65	392	58	450	0.06	0	0	0	0.00
1888	90.3	22.0	112.3	1.58	364	58	422	0.05	0	0	0	0.00
1889	92.6	22.6	115.3	1.79	392	63	455	0.06	0	0	0	0.00
1890	93.6	22.4	115.9	1.61	389	77	466	0.04	0	0	0	0.00
1891	96.4	23.6	120.0	1.67	460	86	546	0.05	0	0	0	0.00
1892	104.3	23.6	127.9	1.77	471	85	556	0.04	0	0	0	0.00
1893	110.7	24.5	135.2	1.86	527	70	597	0.06	0	0	0	0.00
1894	108.4	33.6	142.0	1.94	515	68	583	0.05	0	0	0	0.00
1895	115.0	34.5	149.5	2.00	515	71	586	0.05	0	0	0	0.00
1896	118.3	34.9	153.2	2.13	514	74	588	0.05	0	0	0	0.00
1897	119.3	34.4	153.7	2.07	514	91	605	0.05	0	0	0	0.00
1898	124.4	35.7	160.1	2.14	488	109	597	0.05	0	0	0	0.00
1899	146.3	44.3	190.6	2.54	494	137	631	0.05	0	0	0	0.00
1900	140.1	40.5	180.6	2.36	533	153	686	0.05	0	0	0	0.00
1901	150.9	44.1	195.1	2.55	576	151	727	0.06	0	0	0	0.00
1902	159.7	47.2	206.8	2.73	582	132	714	0.06	0	0	0	0.00
1903	171.4	51.5	222.9	2.90	627	155	782	0.07	0	0	0	0.00
1904	195.1	56.3	251.4	3.23	636	203	839	0.09	0	0	0	0.00
1905	211.1	59.4	270.5	3.38	624	209	833	0.09	0	0	0	0.00
1906	219.9	63.3	283.2	3.60	663	230	893	0.09	0	0	0	0.00
1907	229.1	66.0	295.0	3.72	742	262	1,004	0.10	0	0	0	0.00
1908	255.2	71.7	326.9	4.11	815	295	1,110	0.12	0	0	0	0.00
1909	318.2	76.1	394.3	4.96	861	393	1,254	0.13	0	0	0	0.00
1910	402.4	85.4	487.7	6.19	899	425	1,324	0.16	0	0	0	0.00
1911	486.1	94.1	580.2	7.43	802	549	1,351	0.15	0	0	0	0.00
1912	557.5	106.2	663.8	8.37	774	491	1,265	0.16	0	0	0	0.00
1913	610.5	111.4	721.9	8.99	779	482	1,261	0.16	0	0	0	0.00
1914	594.8	108.7	703.5	8.59	813	495	1,308	0.17	0	0	0	0.00
1915	662.8	118.3	781.2	9.40	850	546	1,396	0.19	0	0	0	0.00
1916	737.9	128.7	866.6	10.29	977	633	1,610	0.21	0	0	0	0.00
1917	783.9	134.2	918.0	10.76	1,087	743	1,830	0.26	0	0	0	0.00
1918	819.6	146.8	966.4	10.87	1,309	896	2,205	0.30	0	0	0	0.00
1919	724.9	146.6	871.5	9.40	1,745	982	2,727	0.33	0	0	0	0.00
1920	823.1	160.0	983.1	10.01	1,841	1,054	2,895	0.37	26	2	28	0.00

Continued on the next page

Table A.6.1: Enrolments per level of education and sex in Indonesia, 1880-2000

	Primary education ('000s)				Secondary Education				Higher Education			
	Boys	Girls	Total	% of relevant	Boys	Girls	Total	% of relevant	Boys	Girls	Total	% of relevant
1921	939.5	176.4	1,115.9	11.25	1,770	1,067	2,837	0.39	54	1	55	0.00
1922	903.6	238.4	1,141.9	11.35	1,865	1,030	2,895	0.42	93	0	93	0.00
1923	980.1	209.7	1,189.8	11.59	1,890	1,177	3,067	0.48	92	0	92	0.00
1924	990.0	213.5	1,203.5	11.91	1,767	1,161	2,928	0.52	133	4	137	0.00
1925	1,067.6	235.4	1,303.0	11.65	1,691	1,182	2,873	0.58	153	9	163	0.01
1926	1,137.8	252.0	1,389.8	12.42	1,726	1,168	2,894	0.61	168	8	176	0.01
1927	1,244.9	297.1	1,542.0	13.61	2,147	1,428	3,575	0.64	204	11	215	0.01
1928	1,347.6	343.9	1,691.5	15.04	2,474	1,458	3,932	0.65	203	13	259	0.01
1929	1,297.7	347.7	1,645.4	14.22	2,718	1,653	4,371	0.71	341	13	354	0.01
1930	1,423.6	414.1	1,837.7	14.88	3,116	1,870	4,986	0.73	462	24	486	0.01
1931	1,488.8	473.4	1,962.2	15.67	3,702	2,080	5,782	0.72	582	36	618	0.02
1932	1,485.0	506.5	1,991.6	15.72	3,921	2,296	6,217	0.69	694	46	740	0.02
1933	1,441.0	526.0	1,967.0	15.34	3,984	2,401	6,385	0.65	807	55	862	0.02
1934	1,429.8	527.3	1,957.1	15.08	3,758	2,500	6,258	0.63	919	65	984	0.03
1935	1,441.1	548.0	1,989.0	15.15	3,816	2,581	6,397	0.59	951	69	1,020	0.03
1936	1,510.9	590.9	2,101.8	15.77	4,054	2,424	6,478	0.76	968	70	1,038	0.03
1937	1,561.7	621.3	2,183.0	16.21	4,167	3,027	7,194	0.80	1,002	85	1,087	0.03
1938	1,652.0	671.1	2,323.2	16.90	4,662	3,133	7,795	0.87	1,010	91	1,092	0.03
1939	1,706.1	706.6	2,412.6	17.33	5,228	3,456	8,684	1.06	1,140	106	1,096	0.03
1940	1,659.4	693.2	2,352.6	16.98			7,795	0.98			1,101	0.03
1941	1,644.2	686.8	2,331.0	17.08			8,684	1.13			1,246	0.04
1942	837.8	409.0	1,246.8	9.01				0.60				0.01
1943	947.6	486.2	1,433.8	10.26				0.71				0.00
1944	975.3	500.3	1,475.6	10.54				0.77				0.01
1945	1,667.8	855.6	2,523.4	21.89				1.67				0.02
1946	1,911.8	980.8	2,892.6	25.08			111,746	2.00			1,600	0.03
1947	2,155.7	1,106.0	3,261.7	28.19				2.35				0.04
1948	2,399.7	1,231.1	3,630.9	31.24				2.71				0.06
1949	2,643.7	1,356.3	4,000.0	34.17	132,344	29,341	161,685	3.10				0.08
1950	3,259.6	1,717.7	4,977.3	42.22	136,780	30,325	167,105	3.15	5,096	903	5,999	0.11
1951	3,450.5	1,867.5	5,318.0	44.76	144,236	32,340	176,576	3.27	20,218	3,582	23,799	0.42
1952	3,505.1	1,947.8	5,452.9	45.53	153,660	34,787	188,447	3.43	35,339	6,261	41,600	0.70
1953	4,189.1	2,434.9	6,624.0	54.88	186,617	42,400	229,017	4.10	50,460	8,939	59,400	0.97
1954	4,375.2	2,658.8	7,034.0	57.84	291,811	65,869	357,680	6.28	65,582	11,618	77,200	1.22
1955	4,350.4	2,762.6	7,113.0	58.06	320,427	72,529	392,956	6.78	74,841	13,259	88,100	1.35
1956	4,223.6	2,801.4	7,025.0	56.91	574,827	128,563	703,390	11.93	92,681	16,419	109,100	1.62
1957	4,322.5	2,993.5	7,316.0	58.85	474,059	106,873	580,932	9.68	91,662	16,238	107,900	1.56
1958	4,284.0	3,096.7	7,380.7	58.96	271,494	62,216	333,710	5.46	101,516	17,984	119,500	1.67
1959	4,685.7	3,534.8	8,221.1	65.21	387,798	89,158	476,957	7.67	112,050	19,850	131,900	1.79
1960	5,104.4	3,850.7	9,062.1	70.62	404,273	29,289	597,803	6.85	111,907	46,193	158,100	2.08
1961	5,400.0	4,242.9	9,642.9	75.52	577,565	38,807	820,069	9.56	95,678	73,322	169,000	2.17
1962	5,898.2	4,677.8	10,576.0	80.15	798,420	67,480	865,900	12.40	106,103	75,097	181,200	2.27
1963	6,143.3	4,917.7	11,061.0	81.12	947,407	119,693	1,067,100	14.15	112,767	73,633	186,400	2.29
1964	6,350.7	5,131.3	11,482.0	81.51	932,905	166,895	1,099,800	13.55	132,370	79,630	212,000	2.55
1965	6,437.4	5,250.0	11,687.4	80.33	923,697	215,788	1,139,485	13.08	292,512	161,837	454,349	5.34
1966	6,966.1	5,505.9	12,472.0	83.00	991,048	282,793	1,273,841	13.65	207,918	105,580	313,498	3.61
1967	7,121.0	5,454.0	12,575.0	81.04	936,807	322,870	1,259,677	12.63	260,767	121,233	382,000	4.30

Continued on the next page

Table A.6.1: Enrolments per level of education and sex in Indonesia, 1880-2000

	Primary education ('000s)				Secondary Education				Higher Education			
	Boys	Girls	Total	% of relevant	Boys	Girls	Total	% of relevant	Boys	Girls	Total	% of relevant
1967	7,121.0	5,454.0	12,575.0	81.04	936,807	322,870	1,259,677	12.63	260,767	121,233	382,000	4.30
1968	7,022.7	5,211.3	12,234.0	76.37	907,490	369,510	1,277,000	12.01	319,434	135,566	455,000	5.01
1969	7,487.2	5,382.4	12,869.6	77.82	1,093,242	520,270	1,613,512	14.26	396,530	153,085	549,615	5.93
1970	8,766.2	6,104.0	14,870.2	81.26	979,420	529,700	1,509,120	12.55	477,300	166,930	644,230	6.80
1971	7,401.3	6,073.4	13,474.7	78.92	1,040,464	605,999	1,646,463	13.68	561,041	149,100	710,141	8.02
1972	8,753.6	7,279.2	16,032.8	94.82	1,076,374	619,927	1,696,301	13.78	473,584	207,596	681,180	7.42
1973	9,334.9	7,279.2	16,614.1	95.72	1,101,452	655,869	1,757,321	13.97	495,685	219,588	715,273	7.52
1974	9,388.7	7,806.7	17,195.3	96.50	783,080	1,014,573	1,797,653	13.98	555,267	234,491	789,758	8.02
1975	9,688.4	8,088.3	17,776.6	97.17	1,756,566	1,081,614	2,838,180	21.58	582,841	277,313	860,154	8.43
1976	10,100.7	8,679.2	18,779.9	99.98	2,027,792	1,184,902	3,212,694	23.90	643,139	308,491	951,630	9.01
1977	10,643.4	9,139.9	19,783.3	102.58	1,823,021	1,081,514	2,904,535	21.13	596,084	298,906	894,991	8.18
1978	10,350.2	8,882.7	19,232.9	97.13	2,059,542	1,252,203	3,311,745	23.56	550,141	288,211	838,351	7.39
1979	11,370.8	9,752.6	21,123.5	103.89	2,465,820	1,541,679	4,007,499	27.89	505,308	276,404	781,712	6.66
1980	13,750.6	11,786.5	25,537.1	122.31	3,294,092	2,128,444	5,422,536	36.90	536,311	306,143	842,454	6.93
1981	14,374.2	12,652.3	27,026.5	128.18	3,630,279	2,410,321	6,040,600	39.65	520,129	324,785	844,914	6.63
1982	14,558.8	13,431.5	27,990.3	131.47	4,075,190	2,869,435	6,944,625	43.99	539,453	354,252	837,571	6.69
1983	15,110.7	13,997.9	29,108.6	135.42	4,352,617	2,990,398	7,343,015	44.88	547,272	387,255	901,048	6.69
1984	15,503.5	14,405.7	29,909.2	137.84	5,060,391	3,593,049	8,653,440	51.06	568,788	435,135	1,003,923	6.87
1985	15,576.2	14,320.9	29,897.1	136.51	5,572,664	4,016,614	9,589,278	54.62	631,445	490,298	1,121,743	7.34
1986	15,511.3	14,371.2	29,882.6	135.69	6,145,495	4,572,739	10,718,23	59.16	740,826	583,823	1,324,649	8.32
1987	15,599.9	14,400.1	30,000.0	135.49	6,514,082	4,938,516	11,452,59	61.28	853,042	643,151	1,447,269	9.03
1988	15,578.5	14,552.1	30,130.6	135.37	6,432,944	5,131,615	11,738,80	59.98	846,557	623,681	1,414,773	8.53
1989	15,475.5	14,458.3	29,933.8	133.80	6,456,346	5,074,287	11,530,63	57.99	837,336	648,813	1,410,072	8.29
1990	15,274.3	14,479.3	29,753.6	132.34	6,280,951	5,025,268	11,306,21	55.14	827,875	566,092	1,393,967	7.48
1991	15,115.9	14,461.8	29,577.7	131.53	6,434,680	5,115,582	11,550,26	54.89	787,456	561,528	1,348,984	7.15
1992	15,244.7	14,354.1	29,598.8	131.93	6,644,480	5,124,094	11,768,57	54.90	782,980	582,094	1,365,074	7.10
1993	15,411.6	14,464.6	29,876.2	133.64	6,862,065	5,360,884	12,222,94	56.04	792,006	613,701	1,405,707	7.17
1994	15,357.9	14,364.0	29,721.9	133.50	7,126,249	5,735,547	12,861,79	58.12	893,098	677,760	1,517,135	7.87
1995	15,215.7	14,232.3	29,448.0	132.80	7,609,228	6,230,500	13,839,72	61.91	917,042	724,809	1,641,851	8.05
1996	15,106.3	14,129.9	29,236.3	132.16	8,717,204	6,314,007	15,031,21	66.93	996,026	770,541	1,766,567	8.44
1997	14,482.8	13,546.3	28,029.1	126.87	8,160,751	6,401,143	14,561,89	64.80	1,203,178	791,041	1,994,219	9.35
1998	13,859.3	12,962.6	26,822.0	121.44	7,598,611	6,493,969	14,092,58	62.86	1,410,329	811,542	2,221,871	10.24
1999	13,235.8	12,379.0	25,614.8	115.81	7,030,781	6,592,483	13,623,26	61.03	1,617,481	832,042	2,449,523	11.12
2000				110.18				59.20	1,724,798	1,293,089	3,017,887	

Sources: see chapter 3.

Table A.6.2: Enrolments per level of education and sex in India, 1880-2000												
	Primary education ('000s)				Secondary Education ('000s)				Higher Education ('000s)			
	Boys	Girls	Total	% of relevant	Boys	Girls	Total	% of relevant	Boys	Girls	Total	% of relevant
1880	1,179.1	90.8	1,270.0	3.16	190.5	2.2	192.7	0.84	6.4	0.0	6.4	0.04
1881	1,346.8	88.5	1,435.3	3.55	198.6	13.5	212.1	0.92	6.7	0.0	6.7	0.04
1882	1,537.6	109.5	1,647.1	4.02	215.7	7.5	223.2	0.96	7.1	0.0	7.1	0.04
1883	1,772.8	131.8	1,904.6	4.60	201.1	7.8	208.9	0.89	7.9	0.0	7.9	0.04
1884	1,949.5	156.4	2,105.9	5.02	295.9	14.9	310.8	1.30	7.9	0.0	7.9	0.04
1885	2,081.5	143.9	2,225.4	5.26	323.3	17.7	341.0	1.41	8.6	0.0	8.7	0.05
1886	1,964.9	158.7	2,123.6	4.97	333.1	19.4	352.6	1.45	9.7	0.0	9.8	0.05
1887	1,984.9	169.9	2,154.8	5.00	349.4	20.2	369.6	1.51	10.7	0.0	10.7	0.06
1888	2,025.8	224.7	2,250.5	5.17	358.0	23.0	381.0	1.54	12.2	0.0	12.2	0.06
1889	2,071.9	226.3	2,298.2	5.21	363.8	24.1	387.9	1.55	13.0	0.0	13.1	0.07
1890	2,128.1	238.8	2,366.9	5.49	365.8	28.9	394.7	1.61	14.4	0.1	14.5	0.08
1891	2,220.1	258.1	2,478.2	5.73	371.4	28.6	399.9	1.63	14.8	0.0	14.9	0.08
1892	2,256.7	276.6	2,533.4	5.79	378.5	21.5	400.0	1.64	15.2	0.1	15.3	0.08
1893	2,304.8	286.9	2,591.7	5.93	389.6	30.7	420.3	1.73	16.7	0.1	16.7	0.09
1894	2,371.7	300.3	2,672.0	6.12	401.5	31.2	432.8	1.81	16.6	0.1	16.7	0.08
1895	2,440.9	302.7	2,743.6	6.29	407.3	32.0	439.3	1.86	17.5	0.1	17.6	0.09
1896	2,479.2	304.9	2,784.2	6.39	411.4	32.6	443.9	1.90	17.1	0.1	17.1	0.09
1897	2,408.6	301.7	2,710.2	6.23	415.5	32.1	447.6	1.94	17.5	0.1	17.6	0.09
1898	2,440.3	302.6	2,742.9	6.31	424.4	33.4	457.8	2.01	19.1	0.1	19.2	0.09
1899	2,474.9	319.1	2,793.9	6.43	441.9	34.7	476.6	2.12	18.2	0.1	18.3	0.09
1900	2,431.5	318.5	2,750.0	6.34	436.4	33.9	470.3	2.12	19.4	0.1	19.6	0.09
1901	2,521.9	334.1	2,856.0	6.58	417.2	31.8	449.0	2.05	20.7	0.2	20.9	0.10
1902	2,616.1	355.4	2,971.5	6.79	421.1	32.0	453.2	2.06	21.3	0.1	21.5	0.10
1903	2,862.9	421.1	3,284.0	7.47	450.0	35.9	485.9	2.21	22.0	0.2	22.2	0.10
1904	2,931.5	457.0	3,388.5	7.70	477.9	39.4	517.3	2.34	23.4	0.2	23.6	0.11
1905	2,825.5	450.4	3,276.0	7.42	502.7	42.1	544.9	2.46	22.4	0.2	22.5	0.10
1906	2,899.9	459.5	3,359.4	7.59	531.1	45.0	576.1	2.59	22.7	0.2	22.9	0.11
1907	3,022.6	524.1	3,546.7	7.98	572.7	54.1	626.8	2.81	23.0	0.2	23.2	0.11
1908	3,371.4	632.2	4,003.6	9.00	626.6	62.7	689.4	3.08	22.5	0.2	22.8	0.10
1909	3,222.8	616.8	3,839.6	8.66	665.4	63.5	728.9	3.24	26.2	0.2	26.4	0.12
1910	3,269.9	640.3	3,910.2	8.84	713.7	74.1	787.8	3.51	27.7	0.2	27.9	0.13
1911	3,507.6	731.6	4,239.2	9.58	744.2	61.7	805.9	3.61	32.3	0.2	32.5	0.15
1912	3,917.2	828.5	4,745.7	10.65	804.4	66.1	870.5	3.90	36.9	0.3	37.2	0.17
1913	3,807.2	835.0	4,642.2	10.35	850.4	73.6	924.0	4.13	42.0	0.3	42.3	0.19
1914	3,964.6	913.5	4,878.1	10.80	870.2	83.0	953.2	4.26	45.4	0.3	45.8	0.21
1915	3,531.3	833.3	4,364.5	9.60	826.9	73.5	900.4	4.02	49.2	0.4	49.6	0.23
1916	3,632.8	868.1	4,500.9	9.83	845.7	70.2	915.9	4.09	51.6	0.7	52.3	0.24
1917	3,694.8	908.4	4,603.2	9.99	834.4	65.4	899.8	4.01	55.4	0.7	56.1	0.26
1918	4,173.6	1,086.1	5,259.7	11.34	866.3	70.5	936.8	4.17	56.8	0.7	57.5	0.27
1919	3,787.9	1,003.5	4,791.3	10.26	887.1	74.3	961.4	4.28	57.9	0.8	58.7	0.28
1920	3,922.5	1,035.3	4,957.8	10.55	868.3	77.1	945.4	4.21	54.0	0.9	54.9	0.26
1921	3,928.0	1,026.0	4,954.0	10.38	849.6	80.6	930.3	4.10	52.2	1.0	53.2	0.25
1922	4,205.6	1,093.0	5,298.6	11.06	926.2	80.4	1,006.6	4.35	59.3	0.8	60.1	0.28
1923	4,321.9	1,117.6	5,439.5	11.30	1,015.1	85.0	1,100.1	4.66	65.4	0.9	66.2	0.30
1924	4,551.0	1,171.0	5,722.0	11.84	1,114.2	90.1	1,204.3	5.01	73.0	0.9	74.0	0.33
1925	4,849.9	1,241.6	6,091.5	12.57	1,252.1	97.2	1,349.4	5.51	76.9	0.9	77.8	0.34
1926	5,178.4	1,319.1	6,497.5	13.36	1,373.8	111.4	1,485.2	5.95	78.1	1.4	79.5	0.33

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Table A.6.2: Enrolments per level of education and sex in India, 1880-2000												
	Primary education ('000s)				Secondary Education ('000s)				Higher Education ('000s)			
	Boys	Girls	Total	% of relevant	Boys	Girls	Total	% of relevant	Boys	Girls	Total	% of relevant
1927	5,424.0	1,429.7	6,853.7	14.09	1,484.2	121.6	1,605.7	6.34	78.7	2.2	80.9	0.33
1928	5,561.1	1,529.7	7,090.8	14.59	1,520.6	130.8	1,651.4	6.42	81.8	1.7	83.5	0.34
1929	5,895.7	1,272.5	7,168.2	14.70	1,595.9	148.1	1,744.0	6.66	83.8	2.0	85.7	0.34
1930	6,263.9	1,013.8	7,277.7	14.88	1,590.5	161.4	1,752.0	6.57	79.1	2.0	81.1	0.31
1931	6,301.6	1,063.0	7,364.6	15.03	1,551.4	173.6	1,725.0	6.35	85.6	2.2	87.7	0.33
1932	6,320.4	1,108.1	7,428.6	15.08	1,530.0	187.6	1,717.6	6.21	88.8	2.5	91.2	0.34
1933	6,488.1	1,162.9	7,651.0	15.45	1,530.5	204.6	1,735.1	6.15	92.4	3.0	95.4	0.35
1934	6,660.9	1,190.1	7,851.0	15.73	1,647.9	275.9	1,923.8	6.67	96.2	3.7	99.9	0.37
1935	6,833.7	1,217.4	8,051.1	16.05	1,592.0	233.9	1,825.9	6.21	97.2	3.9	101.1	0.37
1936	6,991.7	1,232.8	8,224.5	16.33	1,634.8	247.4	1,882.2	6.29	99.6	4.4	104.0	0.37
1937	7,186.6	1,378.4	8,565.0	16.95	1,771.8	261.1	2,032.9	6.67	107.2	5.0	112.3	0.40
1938	7,375.1	1,531.4	8,906.5	17.61	1,899.1	285.5	2,184.6	7.06	114.8	5.8	120.6	0.43
1939	7,557.2	1,691.8	9,249.1	18.17	2,024.3	312.0	2,336.3	7.40	122.3	6.5	128.8	0.46
1940	7,697.4	1,851.1	9,548.5	18.69	2,091.6	331.2	2,422.8	7.54	128.5	7.3	135.8	0.48
1941	7,747.2	1,994.9	9,742.0	19.14	2,106.0	342.4	2,448.4	7.53	133.3	8.0	141.3	0.50
1942	7,382.6	2,029.8	9,412.4	18.34	2,030.0	337.0	2,367.0	7.12	123.9	7.9	131.8	0.46
1943	6,997.1	2,048.8	9,045.9	17.58	2,123.6	357.3	2,480.9	7.34	136.3	9.1	145.4	0.50
1944	7,084.8	2,204.3	9,289.2	18.02	2,317.0	393.9	2,710.9	7.88	157.8	11.1	168.8	0.58
1945	7,418.2	2,447.5	9,865.6	19.11	2,541.8	439.6	2,981.3	8.53	176.4	13.0	189.3	0.65
1946	7,928.3	2,768.6	10,696.9	20.62	2,608.9	446.3	3,055.3	8.57	163.5	12.6	176.1	0.60
1947	8,422.6	3,107.9	11,530.5	22.21	2,509.0	416.3	3,387.3	9.35	161.5	22.7	229.6	0.77
1948	9,451.3	3,543.3	12,994.6	25.01	3,031.2	492.8	3,917.2	10.65	191.6	24.0	272.0	0.91
1949	12,607.1	5,008.0	17,615.1	33.78	5,153.3	963.7	6,117.0	16.32	268.5	32.5	300.9	1.00
1950	13,442.1	5,264.2	18,706.3	35.75	5,290.3	1,053.8	6,344.1	16.61	286.0	40.2	326.2	1.08
1951	13,791.5	5,507.1	19,298.6	36.87	5,600.9	1,133.4	6,734.3	17.36	324.2	45.3	369.5	1.22
1952	14,069.8	5,731.7	19,801.5	34.83	5,928.8	1,210.6	7,139.4	18.11	361.4	53.7	415.1	1.34
1953	15,006.3	6,199.9	21,206.2	36.60	6,013.5	1,263.4	7,276.9	18.18	411.6	61.4	473.0	1.50
1954	15,881.5	6,740.4	22,621.9	38.31	6,510.6	1,399.3	7,909.9	19.46	457.5	72.1	529.6	1.65
1955	17,024.6	7,486.7	24,511.3	40.75	6,997.0	1,621.4	8,618.4	20.89	491.2	84.1	575.2	1.75
1956	17,884.1	8,080.7	25,964.8	42.29	7,435.7	1,807.1	9,242.8	22.02	688.7	110.0	798.7	2.38
1957	18,844.3	8,559.4	27,403.6	43.74	7,735.0	1,983.3	9,718.2	22.77	724.7	124.9	849.6	2.48
1958	17,920.1	8,309.5	26,229.5	40.94	8,304.2	2,104.2	10,408.3	23.94	688.9	134.7	823.5	2.35
1959	21,895.5	10,363.1	32,258.7	49.39	8,799.8	2,421.1	11,220.9	25.41	647.8	137.7	785.5	2.20
1960	22,687.3	10,944.1	33,631.4	50.52	10,182.6	2,958.2	13,140.8	29.30	657.8	149.9	807.6	2.22
1961	24,967.2	12,610.9	37,578.1	52.59	11,275.9	4,007.8	15,283.7	33.41	704.7	160.6	865.3	2.32
1962	26,727.0	13,754.3	40,481.3	57.55	11,949.5	4,366.5	16,316.0	34.63	755.2	171.3	926.5	2.03
1963	27,957.8	14,826.9	42,784.7	58.96	12,714.2	4,831.4	17,545.5	36.18	805.7	225.4	1,031.1	2.68
1964	30,654.1	16,903.2	47,557.3	63.56	12,747.4	5,204.6	17,952.0	35.98	875.9	259.8	1,135.7	2.91
1965	30,608.8	17,085.7	47,694.5	64.94	13,991.3	5,355.3	19,346.6	31.62	946.3	296.0	1,242.3	3.14
1966	31,726.9	18,179.9	49,906.8	66.33	14,938.7	5,926.4	20,865.1	33.09	895.3	328.0	1,223.3	3.05
1967	35,344.0	18,982.0	54,326.0	70.36	14,713.4	6,180.9	20,894.3	32.11	1,091.1	311.3	1,402.5	3.45
1968	34,156.9	20,211.8	54,368.7	68.53	15,120.2	6,343.7	21,463.9	31.91	1,235.8	361.8	1,597.6	3.87
1969	34,769.1	20,715.9	55,485.0	68.22	15,544.8	6,710.9	22,255.7	32.09	1,380.4	412.3	1,792.7	4.28
1970	35,739.2	21,306.2	57,045.4	71.35	15,263.7	6,195.5	21,459.1	25.28	1,814.0	614.0	2,428.0	6.86
1971	37,017.7	22,268.0	59,235.7	72.23	15,934.5	5,538.0	21,472.5	24.47	2,166.9	684.1	2,850.9	7.87
1972	38,296.2	23,229.8	61,426.0	73.82	16,585.2	6,559.6	23,144.8	25.96	2,519.8	754.1	3,273.9	8.77
1973	37,816.4	22,825.6	60,642.0	71.86	16,665.8	7,020.1	23,685.9	25.91	2,374.4	802.5	3,176.9	8.26

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Table A.6.2: Enrolments per level of education and sex in India, 1880-2000

	Primary education ('000s)				Secondary Education ('000s)				Higher Education ('000s)			
	Boys	Girls	Total	% of relevant	Boys	Girls	Total	% of relevant	Boys	Girls	Total	% of relevant
1974	40,266.5	24,589.1	64,855.6	75.82	16,997.7	7,480.7	24,478.5	26.12	2,229.0	850.8	3,079.8	7.77
1975	40,649.0	25,011.0	65,660.0	75.65	17,370.3	7,639.2	25,009.5	26.01	2,240.2	872.9	3,113.1	7.62
1976	42,689.9	26,370.8	69,060.7	78.59	19,226.4	8,306.4	27,532.7	27.96	2,961.3	1,056.0	4,017.3	9.56
1977	41,899.3	25,461.7	67,361.0	75.64	18,849.7	8,503.5	27,353.2	27.10	3,180.4	1,143.6	4,324.0	9.99
1978	42,657.4	26,093.0	68,750.4	76.21	19,865.5	9,144.3	29,009.8	28.05	3,330.5	1,125.7	4,456.2	10.01
1979	44,218.8	27,339.3	71,558.1	78.12	20,040.1	9,467.0	29,507.1	27.77	3,949.1	1,396.5	5,345.6	11.64
1980	45,657.4	28,537.3	74,194.7	79.94	23,014.5	10,856.1	33,870.5	31.09	2,611.9	933.4	3,545.3	7.49
1981	44,478.0	29,395.0	73,873.0	80.88	26,268.0	12,642.8	38,910.8	36.38	2,463.0	948.1	3,411.1	8.23
1982	45,171.0	30,935.0	76,106.0	82.15	27,853.3	14,785.5	42,638.7	39.06	2,829.1	1,087.2	3,916.3	9.24
1983	47,276.0	32,231.0	79,507.0	84.77	29,789.7	14,796.6	44,586.3	40.09	3,040.3	1,170.8	4,211.2	9.75
1984	49,397.0	33,193.0	82,590.0	86.90	31,759.3	16,194.1	47,953.3	42.29	3,021.4	1,250.2	4,271.6	9.68
1985	52,247.0	35,194.0	87,441.0	90.85	32,953.6	17,082.8	50,036.4	43.29	3,134.6	1,336.2	4,470.8	9.93
1986	51,683.0	35,446.0	87,129.0	89.44	33,655.7	16,736.7	50,392.4	42.80	3,375.5	1,430.7	4,806.2	10.47
1987	53,508.0	36,952.0	90,460.0	91.67	34,103.8	17,302.5	51,406.3	42.82	2,930.7	1,345.2	4,275.9	9.12
1988	57,143.0	38,597.0	95,740.0	95.84	49,034.3	17,930.3	52,545.9	42.95	3,091.2	1,437.8	4,529.0	9.47
1989	57,731.0	39,587.0	97,318.0	96.28	47,560.6	19,609.8	56,356.3	53.90	3,228.8	1,551.3	4,780.2	9.80
1990	58,094.0	41,024.0	99,118.0	96.96	46,086.8	21,289.4	60,166.8	53.10	3,313.4	1,637.6	4,951.0	9.96
1991	59,218.0	42,359.0	101,577.0	98.30	44,613.0	22,968.9	63,977.3	52.34	3,234.1	1,698.5	4,932.7	9.74
1992	60,454.0	44,916.0	105,370.0	100.51	43,139.3	24,648.4	67,787.7	51.59	3,642.7	2,053.1	5,695.8	11.01
1993	61,805.0	46,396.0	108,201.0	101.83	43,935.6	25,715.6	69,651.2	52.11	3,861.9	2,198.6	6,060.4	11.47
1994	62,257.0	46,787.0	109,044.0	101.34	44,720.9	26,113.8	70,834.7	52.11	4,081.0	2,344.0	6,425.1	11.92
1995	62,360.0	47,374.0	109,734.0	100.84	45,555.5	26,776.2	72,331.7	52.34	4,300.2	2,489.5	6,789.7	12.35
1996	62,498.0	47,892.0	110,390.0	100.60	46,428.4	28,102.3	74,530.7	48.50	4,452.0	2,303.0	6,755.0	12.06
1997	61,329.0	47,453.0	108,782.0	98.80					4,632.0	2,446.0	7,078.0	12.39
1998	62,700.0	48,200.0	110,900.0						4,844.0	2,574.0	7,418.0	12.75
1999	64,100.0	49,500.0	113,600.0						4,993.0	2,741.0	7,734.0	13.05
2000	64,000.0	49,800.0	113,800.0									

Sources: see chapter 3.

Table A.6.3: Enrolments per level of education and sex in Japan, 1880-2000

	Primary education (‘000s)				Secondary Education (‘000s)				Higher Education (‘000s)			
	Boys	Girls	Total	% of relevant age group	Boys	Girls	Total	% of relevant age group	Boys	Girls	Total	% of relevant
1880	1,759.2	586.4	2,345.6	42.36	72.2	18.5	90.7	2.26	7.1	0.0	7.1	0.22
1881	1,927.3	680.0	2,607.3	46.70	73.6	17.1	90.8	2.24	8.5	0.0	8.5	0.26
1882	2,188.3	816.0	3,004.3	53.38	63.7	12.7	76.4	1.87	8.9	0.0	8.9	0.27
1883	2,323.4	914.3	3,237.7	56.99	68.7	12.3	81.0	1.96	9.0	0.1	9.1	0.27
1884	2,285.4	948.0	3,233.4	56.36	70.7	11.3	82.0	1.97	10.0	0.1	10.1	0.30
1885	2,155.8	941.6	3,097.4	53.58	76.6	11.0	87.6	2.09	11.7	0.1	11.8	0.35
1886	1,955.2	847.6	2,802.8	48.24	75.4	12.1	87.5	2.07	12.0	0.1	12.1	0.35
1887	1,897.3	816.3	2,713.6	46.41	86.5	16.4	102.8	2.42	14.0	0.1	14.1	0.41
1888	2,051.9	876.1	2,928.0	49.59	94.3	18.3	112.7	2.63	13.2	0.1	13.3	0.38
1889	2,129.7	902.4	3,032.1	50.79	89.0	18.5	107.5	2.48	14.4	0.1	14.5	0.41
1890	2,179.9	916.5	3,096.4	51.36	92.0	19.6	111.6	2.65	15.9	0.1	16.0	0.45
1891	2,194.4	959.4	3,153.8	51.92	93.8	20.6	114.3	2.70	17.3	0.1	17.4	0.48
1892	2,176.5	988.9	3,165.4	51.72	88.5	19.8	108.2	2.53	16.4	0.1	16.5	0.46
1893	2,267.5	1,070.0	3,337.6	54.11	87.1	19.8	107.0	2.49	14.6	0.1	14.6	0.40
1894	2,349.9	1,151.2	3,501.1	56.55	90.1	19.9	110.0	2.55	14.8	0.1	14.9	0.40
1895	2,433.4	1,236.9	3,670.3	58.97	99.0	21.4	120.4	2.79	15.6	0.1	15.7	0.41
1896	2,518.4	1,359.6	3,878.0	61.98	115.6	25.6	141.2	3.27	15.9	0.1	16.0	0.40
1897	2,539.9	1,454.9	3,994.8	63.49	130.2	29.9	160.1	3.70	18.0	0.2	18.2	0.45
1898	2,527.6	1,534.8	4,062.4	64.12	137.7	31.7	169.4	3.90	20.1	0.2	20.3	0.48
1899	2,618.6	1,684.0	4,302.6	67.16	156.9	36.9	193.8	4.44	21.7	0.2	22.0	0.52
1900	2,786.7	1,896.9	4,683.6	72.32	173.0	45.9	219.0	5.00	23.5	0.3	23.8	0.57
1901	2,925.6	2,055.0	4,980.6	75.94	199.9	61.3	261.1	5.93	27.2	0.5	27.6	0.66
1902	2,977.6	2,157.9	5,135.5	77.27	228.9	78.1	307.0	6.93	31.0	0.7	31.7	0.75
1903	2,909.1	2,175.0	5,084.1	75.52	255.0	97.6	352.5	7.90	31.2	0.8	32.1	0.76
1904	2,910.0	2,244.1	5,154.1	74.54	275.7	112.6	388.3	8.64	36.9	1.2	38.1	0.90
1905	2,979.0	2,369.3	5,348.2	75.48	319.5	138.3	457.8	10.14	38.8	1.4	40.2	0.94
1906	3,050.8	2,464.0	5,514.7	76.06	373.5	157.8	531.3	11.72	40.3	1.4	41.8	0.98
1907	3,139.1	2,574.6	5,713.7	76.93	404.0	170.9	574.9	12.62	42.7	1.4	44.1	1.03
1908	3,271.5	2,724.6	5,996.1	78.66	412.9	177.0	589.9	12.85	45.1	1.4	46.5	1.08
1909	3,507.4	2,966.2	6,473.6	83.98	447.5	188.3	635.8	13.01	45.7	1.3	47.1	1.08
1910	3,691.6	3,170.1	6,861.7	87.98	489.7	197.5	687.3	13.24	45.3	1.2	46.5	1.07
1911	3,774.5	3,249.1	7,023.7	88.93	529.3	214.3	743.6	13.49	47.2	1.3	48.6	1.11
1912	3,777.7	3,259.7	7,037.4	87.96	575.2	238.3	813.4	13.93	48.1	1.3	49.5	1.12
1913	3,804.7	3,291.0	7,095.8	87.57	615.8	259.3	875.1	14.17	51.7	1.5	53.2	1.20
1914	3,890.5	3,373.3	7,263.7	87.65	677.7	286.6	964.3	15.86	52.2	1.6	53.8	1.18
1915	3,988.2	3,466.4	7,454.7	87.97	730.4	307.1	1,037.5	17.34	53.0	1.7	54.6	1.17
1916	4,087.3	3,566.8	7,654.0	88.41	814.1	335.2	1,149.3	19.56	56.4	2.0	58.5	1.23
1917	4,202.5	3,682.1	7,884.5	89.29	914.0	365.6	1,279.6	22.23	59.5	2.5	62.0	1.27
1918	4,329.1	3,808.3	8,137.3	90.64	1,039.9	401.3	1,441.2	25.67	62.3	2.9	65.2	1.31
1919	4,440.7	3,922.2	8,363.0	91.65	1,144.0	436.6	1,580.6	28.40	67.1	3.4	70.5	1.42
1920	4,575.4	4,057.4	8,632.9	92.76	1,242.6	478.0	1,720.6	31.07	76.4	3.4	79.8	1.59
1921	4,695.1	4,176.9	8,872.0	95.18	1,253.4	534.2	1,787.6	31.41	84.1	4.6	88.7	1.76
1922	4,766.5	4,254.1	9,020.6	96.58	1,281.8	596.0	1,877.8	32.08	92.8	5.4	98.1	1.93
1923	4,820.8	4,316.4	9,137.2	97.63	1,305.7	652.2	1,958.0	32.54	100.0	6.7	106.7	2.08
1924	4,840.4	4,347.9	9,188.3	97.98	1,342.1	730.3	2,072.4	33.50	109.5	8.5	118.0	2.28
1925	4,833.2	4,355.4	9,188.6	97.66	1,376.3	795.5	2,171.8	34.11	120.0	10.8	130.8	2.51
1926	4,874.2	4,413.5	9,287.7	96.91	2,358.6	852.9	3,211.5	49.92	131.0	13.2	144.2	2.68

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Table A.6.3: Enrolments per level of education and sex in Japan, 1880-2000

	Primary education ('000s)				Secondary Education ('000s)				Higher Education ('000s)			
	Boys	Girls	Total	% of relevant age group	Boys	Girls	Total	% of relevant age group	Boys	Girls	Total	% of relevant
1927	4,973.1	4,524.8	9,498.0	97.35	2,406.7	889.6	3,296.3	50.75	137.5	15.1	152.6	2.76
1928	5,057.2	4,623.5	9,680.7	97.51	2,390.3	914.3	3,304.6	50.42	147.8	18.1	165.9	2.91
1929	5,139.5	4,721.4	9,860.9	97.71	2,395.1	945.1	3,340.2	50.55	154.8	20.2	175.0	2.98
1930	5,258.4	4,853.9	10,112.2	98.47	2,407.2	962.8	3,369.9	50.54	157.7	22.5	180.2	2.98
1931	5,394.1	4,987.2	10,381.3	98.76	2,387.5	941.4	3,328.9	49.36	158.5	22.2	180.7	2.97
1932	5,562.8	5,151.4	10,714.2	99.63	2,430.2	942.5	3,372.7	49.47	158.7	21.9	180.6	2.95
1933	5,725.1	5,310.2	11,035.3	100.32	2,427.0	956.8	3,383.8	49.10	159.7	21.7	181.5	2.94
1934	5,822.7	5,409.4	11,232.1	99.98	2,465.3	991.8	3,457.1	49.70	161.9	22.4	184.3	2.96
1935	5,918.5	5,507.2	11,425.6	99.25	2,123.5	1,194.0	3,317.4	47.10	163.7	22.7	186.4	2.97
1936	5,987.0	5,579.9	11,566.9	99.21	2,211.6	1,252.8	3,464.4	47.86	164.4	23.2	187.6	3.01
1937	6,099.2	5,693.5	11,792.7	99.65	2,307.6	1,314.1	3,621.8	48.59	166.1	23.6	189.7	3.05
1938	6,190.6	5,788.1	11,978.7	100.44	2,514.0	1,453.8	3,967.8	52.07	171.4	25.3	196.7	3.19
1939	6,314.0	5,913.0	12,227.0	101.91	2,800.9	1,604.0	4,404.9	56.66	186.3	28.7	215.0	3.53
1940	6,364.9	5,970.2	12,335.1	102.03	2,969.1	1,714.7	4,683.8	58.97	209.7	34.2	243.9	4.05
1941	6,404.9	6,046.3	12,451.1	102.09	3,110.7	1,892.4	5,003.1	62.09	207.3	36.3	243.6	3.88
1942	6,497.5	6,173.2	12,670.7	103.03	3,216.4	2,030.2	5,246.6	64.21	226.4	40.8	267.2	4.09
1943	6,568.0	6,280.2	12,848.2	103.69	3,369.1	2,152.0	5,521.1	66.68	271.7	52.7	324.5	4.78
1944	6,605.1	6,356.2	12,961.3	103.58	3,288.2	2,202.4	5,490.6	80.63	277.9	55.8	333.7	3.85
1945	6,511.5	6,306.4	12,817.9	104.29	3,004.0	2,156.5	5,160.4	76.79	271.4	62.8	334.2	3.82
1946	6,247.6	6,060.6	12,308.2	99.42	2,942.6	2,177.8	5,120.4	75.29	307.1	66.6	373.7	4.13
1947	5,345.6	5,193.8	10,539.4	85.20	4,245.9	3,412.3	7,658.2	75.57	326.9	65.5	392.4	5.30
1948	5,460.6	5,314.1	10,774.7	86.25	3,053.6	3,031.4	6,085.0	59.00	325.6	61.3	386.9	5.09
1949	5,566.3	5,425.6	10,991.9	87.42	3,299.4	3,562.3	6,861.7	65.60	315.9	46.1	362.0	4.65
1950	5,662.8	5,528.6	11,191.4	88.71	3,519.7	3,778.9	7,298.6	69.51	350.4	40.8	391.2	4.95
1951	5,786.9	5,636.1	11,423.0	89.14	3,451.7	3,893.1	7,344.7	69.38	374.8	45.4	420.3	5.22
1952	5,654.4	5,493.9	11,148.3	86.05	3,408.3	4,034.0	7,442.3	69.83	438.5	63.8	502.3	6.13
1953	5,700.3	5,525.2	11,225.5	85.87	3,495.2	4,245.1	7,740.3	72.29	457.2	78.9	536.1	6.45
1954	5,974.2	5,776.8	11,750.9	88.97	3,644.3	4,591.9	8,236.2	76.48	471.6	93.8	565.5	6.70
1955	6,243.9	6,023.1	12,267.0	90.96	3,730.8	4,773.3	8,504.1	78.75	494.3	107.0	601.2	7.03
1956	6,424.2	6,192.1	12,616.3	94.04	3,780.7	4,914.0	8,694.7	79.95	511.4	113.0	624.4	7.29
1957	6,599.9	6,356.4	12,956.3	97.25	3,724.3	4,923.1	8,647.4	79.09	521.2	116.4	637.6	7.45
1958	6,875.6	6,616.5	13,492.1	101.94	3,501.1	4,798.5	8,299.6	75.47	528.9	120.4	649.3	7.59
1959	6,818.4	6,556.3	13,374.7	101.67	3,533.8	4,897.4	8,431.2	76.20	544.0	129.4	673.4	7.87
1960	6,421.2	6,169.4	12,590.7	96.38	3,861.3	5,313.9	9,175.2	82.48	567.7	142.2	709.9	8.30
1961	6,025.9	5,785.0	11,810.9	95.00	4,311.8	5,768.9	10,080.7	87.55	604.0	159.5	763.6	8.90
1962	5,643.4	5,413.5	11,056.9	93.64	4,559.0	6,089.5	10,648.5	89.35	655.4	182.8	838.2	9.75
1963	5,346.7	5,124.7	10,471.4	93.61	4,636.8	6,264.4	10,901.2	88.37	716.3	208.7	925.0	10.72
1964	5,123.8	4,907.2	10,031.0	94.95	4,761.1	6,391.8	11,152.9	87.36	768.0	227.8	995.9	11.50
1965	4,995.3	4,780.2	9,775.5	98.32	4,718.8	6,356.0	11,074.8	83.83	844.8	262.5	1,107.3	12.73
1966	4,897.5	4,686.6	9,584.1	97.39	4,427.8	6,171.7	10,599.5	84.03	945.9	322.2	1,268.1	13.83
1967	4,830.0	4,622.1	9,452.1	96.91	4,167.9	5,932.0	10,099.9	84.01	1,049.4	379.8	1,429.2	14.79
1968	4,794.8	4,588.4	9,383.2	96.96	3,895.1	5,719.2	9,614.3	84.11	1,140.8	423.0	1,563.8	15.37
1969	4,805.0	4,598.2	9,403.2	97.97	3,747.4	5,505.7	9,253.2	85.52	1,206.6	453.2	1,659.8	15.52
1970	4,851.2	4,642.3	9,493.5	99.5	3,658.2	5,341.0	8,999.2	88.36	1,242.5	471.5	1,714.1	15.28
1971	4,905.0	4,690.0	9,595.0	98.79	3,663.6	5,261.2	8,924.8	88.78	1,286.5	504.0	1,790.5	16.68
1972	4,958.6	4,737.5	9,696.1	98.02	3,693.0	5,204.6	8,897.6	89.61	1,327.3	537.7	1,865.0	22.99
1973	5,022.1	4,794.4	9,816.5	97.49	3,789.8	5,249.6	9,039.3	92.26	1,373.8	581.6	1,955.4	25.47

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Table A.6.3: Enrolments per level of education and sex in Japan, 1880-2000

	Primary education ('000s)				Secondary Education ('000s)				Higher Education ('000s)			
	Boys	Girls	Total	% of relevant age group	Boys	Girls	Total	% of relevant age group	Boys	Girls	Total	% of relevant
1974	5,163.4	4,925.3	10,088.8	98.42	3,838.3	5,229.8	9,068.0	93.88	1,413.7	624.3	2,038.1	28.19
1975	5,306.8	5,058.0	10,364.8	99.47	3,900.1	5,258.9	9,159.1	96.40	1,462.5	673.3	2,135.8	31.61
1976	5,434.4	5,175.6	10,610.0	99.06	4,061.8	5,224.0	9,285.8	96.54	1,503.3	700.4	2,203.7	32.97
1977	5,544.0	5,275.7	10,819.7	98.43	4,284.0	5,141.9	9,425.9	96.94	1,536.2	724.2	2,260.4	34.26
1978	5,713.9	5,433.0	11,146.9	98.91	4,409.1	5,125.9	9,535.0	97.07	1,549.3	739.9	2,289.2	35.19
1979	5,963.4	5,665.7	11,629.1	100.74	4,435.5	5,105.1	9,540.7	96.22	1,530.2	736.4	2,266.6	35.38
1980	6,067.0	5,759.5	11,826.6	100.10	4,613.0	5,195.1	9,808.1	98.03	1,516.0	736.8	2,252.8	35.75
1981	6,115.0	5,809.7	11,924.7	102.01	4,789.0	5,287.2	10,076.2	97.72	1,500.1	740.9	2,241.0	35.28
1982	6,100.7	5,800.8	11,901.5	102.99	4,935.9	5,383.5	10,319.4	97.20	1,491.4	747.4	2,238.8	34.99
1983	6,015.3	5,724.2	11,739.5	102.79	5,052.1	5,465.2	10,517.3	96.26	1,499.4	761.7	2,261.2	35.08
1984	5,872.0	5,592.2	11,464.2	101.65	5,221.5	5,594.1	10,815.7	96.28	1,500.7	771.9	2,272.6	35.01
1985	5,680.8	5,414.5	11,095.4	99.69	5,477.1	5,786.2	11,263.3	97.59	1,498.7	769.4	2,268.1	34.71
1986	5,462.6	5,202.8	10,665.4	99.80	5,708.6	5,541.7	11,250.3	96.13	1,544.6	865.1	2,409.7	36.97
1987	5,237.6	4,988.7	10,226.3	100.01	5,750.5	5,589.3	11,339.8	97.71	1,577.6	932.6	2,510.2	38.65
1988	5,056.4	4,816.1	9,872.5	101.23	5,731.5	5,578.5	11,310.0	98.30	1,609.7	978.8	2,588.5	40.03
1989	4,919.1	4,687.5	9,606.6	103.57	5,642.9	5,501.0	11,143.9	97.67	1,649.1	1,033.9	2,683.0	41.69
1990	4,798.2	4,575.1	9,373.3	106.67	5,607.1	5,418.7	11,025.7	97.48			2,664.9	41.63
1991	4,686.1	4,471.4	9,157.4	106.84	5,428.8	5,248.0	10,676.9	98.94	1,725.3	1,173.8	2,899.1	44.94
1992	4,578.0	4,369.2	8,947.2	107.09	5,201.3	5,054.0	10,255.3	99.65	1,712.7	1,160.1	3,872.8	51.83
1993	4,504.1	4,294.0	8,798.1	108.16	5,189.4	5,013.1	10,202.5	104.07	2,160.3	1,680.8	3,841.1	58.64
1994	4,409.5	4,202.6	8,612.1	108.90	5,026.4	4,852.2	9,878.6	105.91	2,192.5	1,725.2	3,917.7	59.39
1995	4,282.6	4,087.7	8,370.2	108.69			9,191.9	103.4			3,102.2	46.59
1996	4,148.2	3,057.4	8,105.6	105.01			8,972.4	100.70			3,126.4	46.84
1997	4,020.2	3,835.1	7,855.4	101.4			8,754.2	98.17			3,137.3	46.97
1998			7,664.0	98.70			8,650.0	96.78	1,380.7	1,760.5	3,141.2	46.92
1999			7,500.0	96.40			8,467.0	94.55	1,348.4	1,787.1	3,135.4	46.74
2000			7,366.0	94.52			8,279.9	92.31	1,342.7	1,782.0	3,124.7	46.51

Sources: see chapter 3.

A.7. Attainment and average years of education in Indonesia, India, and Japan, 1890-2000

The construction and sources of the following data on attainment and average years of education is given in chapter 3.

Table A.7.1: Attainment (%) and per capita Average Years of Education in the population of 15 years and older

years	Indonesia				India				Japan			
	Primary	Secondary	higher	Average years of education	Primary	Secondary	Higher	Average years of education	Primary	Secondary	Higher	Average years of education
1890					3.56	0.70	0.07	0.30	24.17	4.06	0.47	1.71
1891					3.54	0.79	0.07	0.31	24.39	4.18	0.51	1.74
1892					3.72	0.66	0.08	0.31	24.13	4.56	0.55	1.77
1893	4.23	0.16	0.03	0.19	3.82	0.68	0.09	0.31	24.63	4.82	0.59	1.83
1894	4.42	0.19	0.03	0.20	3.91	0.72	0.09	0.32	24.68	5.25	0.64	1.89
1895	4.62	0.15	0.01	0.20	4.02	0.77	0.09	0.34	25.64	5.35	0.63	1.94
1896	4.82	0.17	0.02	0.21	4.13	0.79	0.09	0.35	25.90	5.51	0.66	1.98
1897	4.99	0.19	0.03	0.22	4.23	0.82	0.10	0.36	25.36	6.02	0.69	2.01
1898	5.22	0.21	0.03	0.24	4.34	0.85	0.10	0.37	25.77	6.34	0.74	2.07
1899	5.52	0.25	0.04	0.25	4.45	0.89	0.11	0.38	25.65	6.90	0.79	2.13
1900	5.44	0.20	0.02	0.24	4.57	0.96	0.11	0.39	26.61	7.01	0.78	2.19
1901	5.67	0.22	0.02	0.25	4.70	0.98	0.12	0.40	26.84	7.22	0.82	2.23
1902	5.90	0.25	0.03	0.27	4.83	1.03	0.12	0.42	26.14	7.86	0.87	2.27
1903	6.11	0.26	0.03	0.28	4.97	1.06	0.13	0.43	26.46	8.27	0.92	2.34
1904	6.32	0.28	0.04	0.29	5.11	1.11	0.13	0.44	25.95	8.95	0.99	2.40
1905	6.54	0.29	0.04	0.30	5.25	1.19	0.13	0.46	26.83	9.04	0.97	2.45
1906	6.76	0.31	0.04	0.31	5.40	1.22	0.14	0.47	26.95	9.25	1.02	2.48
1907	7.01	0.32	0.04	0.32	5.56	1.27	0.15	0.49	26.22	10.05	1.07	2.54
1908	7.25	0.34	0.04	0.33	5.73	1.31	0.15	0.51	26.66	10.49	1.14	2.64
1909	7.49	0.36	0.04	0.34	5.89	1.37	0.16	0.52	25.90	11.32	1.22	2.73
1910	7.76	0.38	0.04	0.36	6.04	1.46	0.17	0.54	26.89	11.37	1.18	2.81
1911	8.02	0.40	0.05	0.37	6.20	1.49	0.17	0.56	26.91	11.62	1.24	2.87
1912	8.30	0.42	0.05	0.38	6.37	1.55	0.18	0.57	25.92	12.65	1.30	2.96
1913	8.58	0.44	0.05	0.40	6.53	1.58	0.19	0.59	25.98	13.21	1.38	3.06
1914	8.86	0.46	0.06	0.41	6.67	1.65	0.20	0.61	24.78	14.27	1.48	3.15
1915	9.16	0.49	0.06	0.43	6.83	1.77	0.20	0.63	26.08	14.32	1.43	3.24
1916	9.47	0.51	0.06	0.44	6.99	1.80	0.21	0.64	26.47	14.64	1.49	3.34
1917	9.79	0.54	0.06	0.46	7.17	1.87	0.22	0.66	25.51	15.90	1.57	3.45
1918	10.11	0.57	0.07	0.47	7.37	1.91	0.23	0.68	25.79	16.54	1.67	3.55
1919	10.44	0.59	0.07	0.49	7.57	1.99	0.23	0.70	24.20	17.82	1.79	3.61
1920	10.78	0.63	0.07	0.51	7.75	2.15	0.24	0.73	25.73	17.71	1.74	3.68
1921	11.14	0.66	0.07	0.53	7.99	2.19	0.25	0.75	26.09	17.90	1.81	3.74
1922	11.52	0.70	0.08	0.55	8.24	2.27	0.26	0.77	24.75	19.38	1.91	3.83
1923	11.87	0.73	0.09	0.57	8.51	2.31	0.26	0.79	24.97	20.03	2.04	3.93
1924	12.21	0.77	0.09	0.58	8.77	2.41	0.27	0.82	24.74	21.69	2.20	4.11
1925	12.55	0.81	0.10	0.60	9.03	2.59	0.28	0.86	26.39	21.48	2.12	4.18
1926	12.90	0.85	0.10	0.62	9.30	2.62	0.29	0.88	26.55	21.66	2.21	4.22
1927	13.27	0.91	0.10	0.64	9.56	2.70	0.30	0.90	24.69	23.53	2.33	4.32

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Table A.7.1: Attainment (%) and per capita Average Years of Education in the population of 15 years and older												
years	Indonesia				India				Japan			
	Primary	Secondary	higher	Average years of education	Primary	Secondary	Higher	Average years of education	Primary	Secondary	Higher	Average years of education
1928	13.64	0.95	0.11	0.66	9.82	2.72	0.31	0.92	24.83	24.31	2.48	4.44
1929	14.00	0.99	0.11	0.68	10.06	2.83	0.32	0.95	24.36	25.18	2.66	4.53
1930	14.37	1.05	0.12	0.70	10.29	3.05	0.33	0.99	26.46	24.73	2.54	4.59
1931	14.74	1.10	0.12	0.72	10.54	3.08	0.34	1.01	26.50	24.92	2.64	4.63
1932	15.17	1.16	0.13	0.75	10.82	3.18	0.36	1.04	24.19	27.31	2.77	4.76
1933	15.58	1.21	0.14	0.77	11.10	3.21	0.36	1.06	23.94	28.26	2.93	4.87
1934	15.98	1.27	0.14	0.80	11.38	3.33	0.38	1.09	23.29	29.43	3.14	4.99
1935	16.40	1.33	0.15	0.82	11.65	3.63	0.39	1.14	25.93	28.70	2.97	5.04
1936	16.83	1.40	0.16	0.85	11.96	3.66	0.41	1.17	26.24	28.86	3.08	5.10
1937	17.30	1.47	0.17	0.87	12.26	3.77	0.42	1.20	23.82	31.90	3.22	5.29
1938	17.75	1.54	0.17	0.90	12.57	3.78	0.43	1.22	23.80	33.32	3.43	5.48
1939	18.20	1.62	0.18	0.93	12.87	3.92	0.44	1.25	23.50	34.68	3.69	5.64
1940	18.63	1.70	0.19	0.95	13.16	4.29	0.45	1.31	27.07	33.49	3.47	5.70
1941	19.04	1.79	0.20	0.98	13.48	4.31	0.47	1.34	27.72	33.20	3.60	5.73
1942	19.53	1.89	0.22	1.01	13.81	4.42	0.48	1.37	26.71	36.64	3.78	6.05
1943	19.98	1.98	0.22	1.06	14.19	4.42	0.50	1.40	25.81	38.16	4.05	6.20
1944	20.42	2.07	0.23	1.12	14.73	4.58	0.51	1.45	25.10	39.39	4.38	6.34
1945	20.88	2.16	0.24	1.17	15.29	5.03	0.52	1.53	29.66	37.30	4.08	6.35
1946	21.38	2.27	0.26	1.23	15.93	5.03	0.54	1.57	27.49	36.46	4.23	6.15
1947	21.93	2.39	0.27	1.29	16.57	5.14	0.55	1.62	27.14	38.88	4.40	6.41
1948	22.43	2.50	0.28	1.35	17.19	5.04	0.56	1.65	26.64	41.21	4.66	6.67
1949	22.91	2.63	0.29	1.42	17.81	5.05	0.57	1.69	25.55	42.85	5.09	6.85
1950	23.41	2.76	0.30	1.48	18.40	5.45	0.58	1.77	32.12	39.69	4.69	6.85
1951	23.95	2.87	0.32	1.55	18.84	5.36	0.60	1.79	32.26	41.00	4.85	7.02
1952	24.56	3.00	0.34	1.63	19.25	5.25	0.61	1.80	32.36	42.97	5.11	7.27
1953	25.16	3.11	0.35	1.70	19.68	4.92	0.61	1.79	31.93	45.29	5.37	7.53
1954	26.01	3.20	0.37	1.78	20.23	4.84	0.60	1.82	30.57	47.43	5.72	7.73
1955	26.87	3.30	0.37	1.87	20.84	5.24	0.60	1.90	38.46	42.90	5.23	7.65
1956	27.76	3.42	0.39	1.96	21.58	5.00	0.60	1.92	38.55	44.08	5.48	7.82
1957	28.39	3.57	0.39	2.05	22.27	4.72	0.59	1.93	38.83	45.85	5.76	8.07
1958	28.88	3.69	0.38	2.12	23.00	4.10	0.56	1.90	38.85	48.41	6.03	8.38
1959	29.32	3.79	0.35	2.18	23.72	3.78	0.53	1.91	37.71	50.86	6.30	8.61
1960	29.77	3.86	0.33	2.24	24.40	5.70	0.49	2.14	47.20	44.80	5.60	8.43
1961	29.86	3.82	0.29	2.24	24.66	4.91	0.43	2.06	46.34	45.58	5.76	8.49
1962	29.88	3.64	0.26	2.22	24.83	4.13	0.38	1.98	45.48	46.36	5.92	8.54
1963	30.52	3.76	0.34	2.28	25.21	4.29	0.40	2.03	44.62	47.14	6.08	8.60
1964	31.00	4.15	0.40	2.36	25.23	5.31	0.58	2.16	43.76	47.92	6.24	8.66
1965	31.49	4.60	0.53	2.46	25.30	5.97	0.79	2.27	42.90	48.70	6.40	8.71
1966	32.18	5.00	0.61	2.55	25.68	4.21	1.01	2.14	40.01	52.76	6.89	9.04
1967	33.03	5.42	0.71	2.66	26.14	5.34	1.23	2.33	39.25	53.43	7.08	9.10
1968	34.25	5.84	0.84	2.80	26.55	5.97	1.44	2.45	38.32	54.24	7.44	9.18
1969	35.45	6.30	0.98	2.95	27.13	6.77	1.64	2.60	37.25	54.44	8.31	9.28
1970	36.71	6.73	1.15	3.09	27.66	7.41	1.83	2.73	36.24	54.96	8.8	9.35
1971	37.83	7.19	1.32	3.24	28.11	7.51	1.98	2.79	32.97	57.74	9.29	9.53
1972	39.00	7.66	1.48	3.38	28.61	8.44	2.15	2.95	32.12	58.22	9.67	9.59
1973	40.01	8.15	1.66	3.52	29.11	9.11	2.37	3.08	31.25	58.8	9.95	9.64

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Table A.7.1: Attainment (%) and per capita Average Years of Education in the population of 15 years and older

years	Indonesia				India				Japan			
	Primary	Secondary	higher	Average years of education	Primary	Secondary	Higher	Average years of education	Primary	Secondary	Higher	Average years of education
1974	40.87	8.59	1.84	3.65	29.66	9.94	2.58	3.24	30.73	58.64	10.63	9.70
1975	41.48	9.32	2.04	3.79	30.18	10.54	2.79	3.36	30.05	58.94	11.01	9.75
1976	42.11	10.11	2.22	3.94	30.65	10.74	3.04	3.45	27.28	61.38	11.34	9.90
1977	42.69	10.78	2.37	4.07	30.96	11.62	3.18	3.59	26.6	61.78	11.62	9.94
1978	43.68	11.51	2.5	4.23	31.23	12.25	3.33	3.69	25.81	62.45	11.74	9.98
1979	44.61	12.35	2.63	4.39	31.38	13.44	3.5	3.85	25.55	62.25	12.2	10.02
1980	45.26	13.47	2.74	4.57	31.5	14.24	3.67	3.97	25.01	62.54	12.45	10.06
1981	45.8	14.68	2.85	4.75	31.59	14.52	3.83	4.03	22.76	64.54	12.7	10.17
1982	46.24	16.08	2.95	4.93	31.79	15.83	4.04	4.22	22.27	64.84	12.89	10.21
1983	46.61	17.51	3.06	5.12	31.97	16.69	4.2	4.34	21.55	65.37	13.08	10.25
1984	46.59	19.13	3.17	5.31	32.21	17.75	4.34	4.49	21.46	65.01	13.53	10.28
1985	46.76	20.82	3.3	5.52	32.22	18.58	4.49	4.60	21.13	65.08	13.78	10.31
1986	47.44	22.68	3.46	5.78	32.26	19.19	4.63	4.69	19.3	66.64	14.06	10.40
1987	48.25	24.61	3.6	6.06	32.48	20.57	4.78	4.87	19.05	66.74	14.21	10.42
1988	48.96	26.2	3.74	6.29	32.62	21.3	4.97	4.99	18.43	67.02	14.55	10.47
1989	49.99	27.6	3.85	6.51	32.84	22.58	5.15	5.17	18.12	66.61	15.28	10.53
1990	51.2	28.78	3.93	6.72	33.26	23.61	5.33	5.33	17.75	66.44	15.81	10.57
1991	51.46	29.42	3.95	6.81	33.62	24.14	5.52	5.44	16.01	67.79	16.19	10.67
1992	51.64	30.01	3.97	6.88	34.11	25.3	5.72	5.62	16.21	68.03	15.76	10.64
1993	51.66	30.66	4.00	6.96	34.63	25.8	5.91	5.73	16.13	67.77	16.1	10.66
1994	51.67	31.28	4.04	7.03	35.25	26.77	6.09	5.90	16.23	67.02	16.75	10.69
1995	51.51	31.94	4.09	7.10	35.93	27.6	6.28	6.06	16.13	66.67	17.2	10.72
1996	51.23	32.76	4.17	7.18	36.52	27.84	6.39	6.14	14.72	67.74	17.54	10.80
1997	50.94	33.48	4.28	7.26	36.99	28.65	6.53	6.27	15.07	67.81	17.12	10.76
1998	50.63	34.13	4.4	7.33	37.42	29.12	6.65	6.37	16.18	68.61	15.21	10.61
1999	49.93	34.79	4.39	7.35	37.82	36.97	6.37	7.17	20.61	63.51	15.87	10.44
2000	51.01	34.48	4.76	7.44	38.78	37.38	6.6	7.31	20.23	63.41	16.36	10.49

Source: see chapter 3.

A.8. Public and private expenditure on education (current prices) per level of education in Japan, Indonesia, and India, 1880-2000, in national currencies.

The construction and sources of the following data on public and private expenditure on education is given in chapter 3. The only point to note is that the sum of public expenditure per level of education equals that of total public expenditure. We divided capital expenditure between the levels of education according to the share of of each level of education in total current expenditure on education.

Table A.8.1: Public and private expenditure on education in Japan, current Yen

	Government expenditure					Private expenditure	
	Primary	Secondary	Higher	Total	Average per student	Total	Average per student
	Yen (‘000)	Yen (‘000)	Yen (‘000)	Yen (‘000)	Yen	Yen (‘000)	Yen
1886	6,990	916	349	8,256	2.8	1,118	0.4
1887	6,176	1,008	279	7,462	2.6	2,366	0.9
1888	6,875	1,119	171	8,165	2.7	3,454	1.2
1889	7,077	1,144	136	8,357	2.7	3,919	1.3
1890	7,392	1,151	132	8,675	2.7	4,019	1.3
1891	7,675	1,124	139	8,939	2.7	4,296	1.4
1892	8,304	1,127	173	9,604	2.9	4,390	1.4
1893	9,120	1,344	218	10,683	3.1	4,974	1.5
1894	9,805	1,346	226	11,377	3.1	5,582	1.6
1895	10,670	1,911	93	12,674	3.3	6,477	1.8
1896	12,590	2,818	118	15,526	3.9	5,445	1.4
1897	15,148	3,378	142	18,669	4.5	8,766	2.2
1898	17,585	4,992	149	22,727	5.4	10,462	2.6
1899	20,502	7,263	140	27,905	6.2	12,207	2.8
1900	25,571	9,664	165	35,400	7.2	14,547	3.1
1901	30,507	11,843	234	42,584	8.1	12,576	2.5
1902	32,199	12,086	202	44,487	8.1	14,130	2.7
1903	32,520	11,647	262	44,430	8.1	14,864	2.9
1904	24,912	10,059	285	35,256	6.3	16,191	3.1
1905	27,154	9,940	343	37,437	6.4	18,494	3.5
1906	33,514	10,953	389	44,856	7.4	21,447	3.9
1907	41,845	13,282	506	55,634	8.8	23,792	4.2
1908	54,520	15,582	645	70,747	10.7	23,552	3.9
1909	58,721	17,043	888	76,651	10.7	31,240	4.8
1910	58,070	17,673	893	76,636	10.1	33,893	4.9
1911	60,181	18,620	892	79,693	10.2	37,693	5.4
1912	60,518	19,529	820	80,868	10.2	39,300	5.6
1913	58,434	18,600	927	77,960	9.7	42,587	6.0
1914	57,499	18,387	809	76,695	9.3	45,230	6.2
1915	60,735	19,103	806	80,644	9.4	48,405	6.5
1916	65,196	19,536	895	85,627	9.7	50,150	6.5
1917	72,097	22,703	1,114	95,914	10.4	57,272	7.3
1918	98,110	30,117	1,386	129,613	13.4	67,670	8.3

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Table A.8.1: Public and private expenditure on education in Japan, current Yen

	Government expenditure					Private expenditure	
	Primary	Secondary	Higher	Total	Average per student	Total	Average per student
	Yen (‘000)	Yen (‘000)	Yen (‘000)	Yen (‘000)	Yen	Yen (‘000)	Yen
1919	146,809	43,513	1,865	192,187	19.2	85,807	10.2
1920	203,006	63,258	2,717	268,981	25.8	110,070	12.7
1921	223,113	76,789	3,198	303,100	28.2	130,680	14.7
1922	239,807	99,929	4,362	344,097	31.3	144,470	16.0
1923	254,007	96,373	4,924	355,304	31.8	169,484	18.5
1924	265,708	102,070	5,461	373,239	32.8	187,540	20.3
1925	276,883	107,069	4,751	388,703	33.9	195,510	21.2
1926	313,181	122,713	5,382	441,276	35.0	219,826	23.5
1927	326,921	127,746	5,067	459,733	35.6	250,826	26.3
1928	338,440	127,054	5,828	471,322	35.9	255,238	26.2
1929	314,592	127,199	5,378	447,168	33.5	270,527	27.2
1930	280,996	119,773	5,578	406,347	29.8	276,621	27.2
1931	267,593	111,558	3,194	382,345	27.6	284,503	27.2
1932	276,304	105,607	2,990	384,901	27.0	296,709	27.5
1933	294,718	107,171	3,436	405,326	27.8	312,038	28.1
1934	306,161	113,383	3,454	422,998	28.5	339,033	30.0
1935	330,809	119,786	2,682	453,277	30.4	356,697	31.0
1936	349,086	127,920	2,773	479,779	31.6	371,909	32.0
1937	348,034	136,443	2,592	487,069	31.2	406,942	34.3
1938	346,415	142,126	2,823	491,364	30.5	437,999	36.3
1939	352,671	158,100	2,992	513,763	30.5	475,304	38.6
1940	268,771	321,572	5,643	595,986	34.6	554,289	44.6
1941	212,126	253,801	4,445	470,372	26.6	569,681	45.5
1942	155,897	186,526	3,268	345,691	19.0	598,984	46.9
1943	100,041	120,574	0	220,615	11.8	647,691	50.0
1944	45,645	55,355	0	101,000	5.4	696,625	53.3
1945	1,663,051	2,027,310	0	3,690,361	201.8	5,392,158	417.5
1946	5,231,388	6,405,922	366,167	12,003,478	675.4	6,162,913	496.1
1947	16,198,961	19,913,592	2,123,873	38,236,426	2,511.6	4,646,921	435.5
1948	38,456,793	47,437,540	1,059,200	86,953,532	5,114.8	7,922,951	734.5
1949	56,940,675	70,451,242	13,251,080	140,642,996	7,837.6	12,612,108	1,134.3
1950	74,100,058	85,818,489	23,661,450	183,579,997	9,817.7	14,239,664	1,247.3
1951	94,870,741	103,111,380	31,808,885	229,791,006	12,033.9	15,441,399	1,315.7
1952	122,527,478	129,660,216	33,248,305	285,435,998	15,006.8	20,666,228	1,789.6
1953	150,833,298	151,537,500	40,875,208	343,246,007	17,645.9	31,995,211	2,741.1
1954	172,868,276	170,786,694	46,910,027	390,564,996	19,028.0	39,379,133	3,216.5
1955	178,075,730	175,839,771	51,877,492	405,792,993	19,012.1	43,883,384	3,431.1
1956	190,715,482	188,934,950	58,625,568	438,276,000	20,007.5	47,449,304	3,604.7
1957	213,645,494	211,837,695	64,729,819	490,213,007	22,072.0	51,780,181	3,829.7
1958	234,826,131	231,460,003	73,483,863	539,769,997	24,087.8	55,842,574	3,968.9
1959	251,472,868	254,974,120	82,967,018	589,414,006	26,260.9	62,024,409	4,439.1
1960	278,104,980	321,013,310	99,945,716	699,064,005	31,152.7	66,348,808	5,020.0
1961	308,511,704	408,764,407	124,344,890	841,621,001	37,210.1	68,385,550	5,479.2
1962	360,525,862	502,416,897	155,434,243	1,018,377,002	45,251.2	74,532,699	6,324.9
1963	419,781,427	609,551,499	199,770,063	1,229,102,989	55,223.2	159,107,870	14,123.4
1964	493,077,346	694,005,753	261,382,907	1,448,466,006	65,431.9	183,642,318	16,873.5

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Table A.8.1: Public and private expenditure on education in Japan, current Yen							
	Government expenditure					Private expenditure	
	Primary	Secondary	Higher	Total	Average per student	Total	Average per student
	Yen (‘000)	Yen (‘000)	Yen (‘000)	Yen (‘000)	Yen	Yen (‘000)	Yen
1965	568,564,032	769,524,236	340,883,735	1,678,972,003	76,618.7	214,565,196	20,028.2
1966	652,541,904	845,339,302	434,682,795	1,932,564,002	90,284.4	229,572,579	21,600.1
1967	742,882,013	926,199,837	498,002,140	2,167,083,990	103,526.2	244,334,162	23,023.2
1968	854,996,208	1,033,008,001	565,448,803	2,453,453,012	119,610.5	257,101,234	24,133.2
1969	1,007,873,477	1,182,920,692	625,464,836	2,816,259,005	138,964.7	268,831,712	24,989.1
1970	1,232,923,281	1,388,862,139	702,063,577	3,323,848,998	164,906.7	287,033,648	26,333.4
1971	1,526,729,288	1,671,441,621	686,697,085	3,884,867,994	191,768.5	319,443,408	28,873.4
1972	1,818,098,597	1,926,892,821	813,760,578	4,558,751,997	223,421.9	352,183,671	31,374.0
1973	2,230,341,660	2,365,521,216	1,020,888,137	5,616,751,013	270,650.9	411,901,212	36,088.1
1974	3,060,505,073	3,251,815,715	1,323,677,191	7,635,997,979	361,321.8	532,746,312	45,347.1
1975	3,554,089,167	3,761,263,232	1,544,313,580	8,859,665,979	410,242.3	667,630,268	55,180.7
1976	3,948,265,464	4,186,061,548	1,822,486,967	9,956,813,979	451,887.5	865,751,690	69,809.0
1977	4,518,158,356	4,724,789,526	2,089,774,145	11,332,722,026	505,062.3	1,029,469,761	81,323.3
1978	5,114,599,558	5,306,404,383	2,330,170,036	12,751,173,978	556,837.8	1,157,173,043	88,951.0
1979	5,529,125,736	5,749,220,008	2,536,297,273	13,814,643,017	591,697.0	1,308,137,676	97,075.4
1980	5,963,906,109	6,266,129,756	2,881,193,126	15,111,228,991	635,040.4	1,499,804,683	109,780.5
1981	6,180,098,943	6,756,403,972	3,198,325,103	16,134,828,018	668,170.9	1,616,527,758	117,593.2
1982	6,176,366,270	7,083,054,710	3,284,492,989	16,543,913,969	679,007.0	1,794,467,518	130,800.3
1983	6,256,495,858	7,462,213,200	3,472,684,927	17,191,393,986	703,886.7	1,799,164,940	132,545.2
1984	6,166,372,135	7,891,353,387	3,709,397,448	17,767,122,970	726,447.4	1,980,973,114	148,863.0
1985	6,367,829,343	8,351,492,469	4,008,678,166	18,727,999,977	763,432.2	1,971,676,634	152,322.7
1986	6,523,522,025	8,524,660,150	4,311,817,795	19,359,999,970	794,908.8	2,036,119,849	162,305.6
1987	6,640,515,181	8,719,974,332	4,587,510,493	19,948,000,006	827,580.9	2,118,024,859	174,179.6
1988	6,894,283,041	8,985,874,957	4,794,841,978	20,674,999,976	868,770.6	2,223,611,390	187,362.0
1989	7,154,149,595	9,216,434,213	5,015,416,209	21,386,000,016	911,944.5	2,350,955,039	201,383.6
1990	7,558,039,897	9,771,897,617	5,480,062,485	22,810,000,000	990,447.0	2,561,590,000	222,631.0
1991	7,840,803,512	10,258,132,447	5,863,064,090	23,962,000,049	1,061,957.1	2,468,564,280	217,246.1
1992	8,067,529,392	10,530,299,726	6,056,170,849	24,653,999,968	1,116,829.4	2,714,085,170	241,466.4
1993	8,018,669,474	10,463,114,144	6,624,216,404	25,106,000,022	1,162,099.8	2,717,523,076	243,527.3
1994	7,962,150,731	10,441,367,859	6,686,481,362	25,089,999,951	1,184,272.2	2,836,253,267	256,326.7
1995	8,186,782,023	10,611,974,410	6,926,243,527	25,724,999,961	1,238,744.4	2,837,989,918	259,960.8
1996	8,205,267,610	10,750,054,875	6,934,677,520	25,890,000,004	1,274,992.3	2,840,736,473	265,415.2
1997	8,102,410,429	10,772,840,443	7,010,749,176	25,886,000,048	1,304,475.0	2,864,436,106	273,089.7
1998	8,086,140,379	10,629,628,992	7,189,230,599	25,904,999,971	1,332,287.9	2,771,657,162	268,259.3
1999	8,009,564,558	10,392,136,122	7,458,299,295	25,859,999,975	1,354,564.6	2,549,747,561	249,950.6
2000	7,991,218,963	10,324,057,438	7,237,723,586	25,552,999,987	1,362,100.3	2,711,015,480	268,258.3

Source: see chapter 3

Table A.8.2: Public and private expenditure on education in Indonesia, current Rupiah							
	Government expenditure					Private expenditure	
	primary	secondary	higher	Total	Average per student	Total	average per student
	Rupiah ('000)	Rupiah ('000)	Rupiah ('000)	Rupiah ('000)	Rupiah	Rupiah ('000)	Rupiah
1880	2,665	385	0	3,050	39.5	2,097	27.1
1881	2,628	448	0	3,076	39.7	2,011	26.0
1882	2,817	465	0	3,282	37.6	3,008	34.5
1883	2,897	537	0	3,434	37.5	3,565	38.9
1884	2,896	498	0	3,395	35.1	4,468	46.2
1885	2,932	529	0	3,461	34.7	4,414	44.3
1886	2,895	481	0	3,376	33.0	3,678	36.0
1887	2,973	471	0	3,444	32.6	3,427	32.5
1888	3,024	473	0	3,497	31.0	3,523	31.3
1889	3,151	467	0	3,617	31.3	3,537	30.6
1890	3,235	751	0	3,986	34.2	2,603	22.4
1891	3,282	754	0	4,036	33.5	2,661	22.1
1892	3,393	725	0	4,118	32.0	2,379	18.5
1893	3,583	819	0	4,402	32.4	3,231	23.8
1894	3,636	786	0	4,422	31.0	3,707	26.0
1895	3,840	823	0	4,663	31.1	4,030	26.9
1896	3,927	789	0	4,716	30.7	3,837	25.0
1897	3,976	804	0	4,781	31.0	2,317	15.0
1898	4,075	828	0	4,903	30.5	2,876	17.9
1899	4,189	845	0	5,034	26.3	3,473	18.2
1900	3,323	842	10	4,175	23.0	2,444	13.5
1901	3,431	713	7	4,151	21.2	2,059	10.5
1902	3,590	893	6	4,489	21.6	2,388	11.5
1903	3,771	913	6	4,691	21.0	1,883	8.4
1904	3,974	966	6	4,947	19.6	2,528	10.0
1905	4,133	1,018	6	5,157	19.0	2,885	10.6
1906	4,181	1,060	6	5,247	18.5	2,648	9.3
1907	5,067	1,183	7	6,257	21.1	2,587	8.7
1908	5,449	1,221	6	6,675	20.3	2,737	8.3
1909	6,233	1,422	6	7,661	19.4	3,846	9.7
1910	6,891	1,562	6	8,459	17.3	5,252	10.7
1911	7,606	1,984	3	9,593	16.5	6,082	10.5
1912	8,527	2,012	3	10,542	15.9	6,121	9.2
1913	9,471	2,278	3	11,751	16.3	8,040	11.1
1914	9,716	3,409	6	13,131	18.6	9,259	13.1
1915	11,012	3,845	4	14,861	19.0	11,313	14.5
1916	12,808	3,205	14	16,027	18.5	11,055	12.7
1917	14,387	3,509	5	17,902	19.5	11,176	12.1
1918	15,248	4,233	7	19,488	20.1	10,287	10.6
1919	23,690	6,992	34	30,716	35.1	13,119	15.0
1920	30,126	8,374	16	38,516	39.1	12,563	12.7
1921	32,575	9,784	146	42,506	38.0	20,296	18.1
1922	28,727	10,234	178	39,139	34.2	19,095	16.7
1923	25,983	9,739	170	35,892	30.1	17,610	14.8
1924	27,706	8,829	237	36,772	30.5	18,467	15.3
1925	30,456	9,306	485	40,247	30.8	21,335	16.3

Continued on the next page

Table A.8.2: Public and private expenditure on education in Indonesia, current Rupiah							
	Government expenditure					Private expenditure	
	primary	secondary	higher	Total	Average per student	Total	average per student
	Rupiah (‘000)	Rupiah (‘000)	Rupiah (‘000)	Rupiah (‘000)	Rupiah	Rupiah (‘000)	Rupiah
1926	33,209	10,457	534	44,200	31.7	23,172	16.6
1927	35,801	9,613	802	46,216	29.9	26,658	17.2
1928	37,363	9,427	840	47,630	28.1	29,664	17.5
1929	42,407	11,062	946	54,415	33.0	26,581	16.1
1930	43,756	10,711	1,233	55,700	30.2	23,350	12.7
1931	43,119	12,364	1,163	56,646	28.8	20,221	10.3
1932	39,265	11,378	1,085	51,728	25.9	17,464	8.7
1933	36,573	9,742	1,062	47,377	24.0	16,760	8.5
1934	31,107	9,297	1,234	41,638	21.2	16,142	8.2
1935	23,380	6,665	894	30,939	15.5	14,106	7.1
1936	22,243	4,886	586	27,715	13.1	13,275	6.3
1937	17,100	4,607	637	22,344	10.2	13,330	6.1
1938	17,956	5,098	947	24,001	10.3	12,141	5.2
1939	22,008	6,821	912	29,741	12.3	16,601	6.9
1940	21,233	6,581	880	28,694	12.2	11,967	5.1
1941						14,216	6.1
1942						27,557	22.1
1943						21,495	15.0
1944						15,822	10.7
1945						13,892	5.5
1946						23,755	7.9
1947						33,080	9.8
1948						44,017	11.6
1949						56,059	13.5
1950						49,693	9.6
1951	353,087	96,284	42,317	491,689	89.1	81,636	14.8
1952	605,253	169,012	72,913	847,178	149.1	86,373	15.2
1953	565,845	161,752	68,518	796,115	115.2	81,760	11.8
1954	561,999	164,411	68,406	794,816	106.4	92,075	12.3
1955	636,788	190,593	77,915	905,295	119.2	132,205	17.4
1956	739,288	226,319	90,932	1,056,538	134.8	174,565	22.3
1957	910,526	285,023	112,585	1,308,134	163.4	209,760	26.2
1958	1,119,773	358,332	139,194	1,617,298	206.4	466,052	59.5
1959	1,344,644	439,768	168,039	1,952,450	221.1	1,087,304	123.1
1960	1,656,092	553,424	208,071	2,417,587	246.2	2,980,247	303.6
1961	2,020,417	689,719	255,215	2,965,351	278.9	3,690,379	347.1
1962	7,032,379	2,451,860	893,135	10,377,373	892.8	11,293,147	971.6
1963	19,977,871	7,112,334	2,551,096	29,641,300	2,407.0	26,093,949	2,118.9
1964	51,174,795	18,599,427	6,570,667	76,344,888	5,967.2	55,712,531	4,354.7
1965	192,311,638	71,341,733	24,828,344	288,481,715	21,721.1	200,047,290	15,062.6
1966	2,846,184	1,089,495	370,624	4,306,302	306.3	2,902,723	206.5
1967	8,386,316	3,311,077	1,101,548	12,798,942	900.3	7,522,383	529.1
1968	22,554,717	9,181,071	2,988,572	34,724,360	2,486.4	16,951,228	1,213.8
1969	40,382,463	16,940,972	5,398,171	62,721,607	4,172.3	22,270,514	1,481.5
1970	54,766,037	23,669,386	7,386,295	85,821,718	5,041.3	23,000,034	1,351.0
1971	64,596,565	28,751,757	8,790,649	102,138,971	6,451.7	27,109,283	1,712.4

Continued on the next page

Table A.8.2: Public and private expenditure on education in Indonesia, current Rupiah

	Government expenditure					Private expenditure	
	primary	secondary	higher	Total	Average per student	Total	average per student
	Rupiah ('000)	Rupiah ('000)	Rupiah ('000)	Rupiah ('000)	Rupiah	Rupiah ('000)	Rupiah
1972	85,133,041	39,631,994	13,231,425	137,996,461	7,495.6	39,056,691	2,121.4
1973	132,083,275	63,908,739	22,204,727	218,196,741	11,431.9	64,163,098	3,361.6
1974	220,096,590	110,684,015	39,903,000	370,683,605	18,737.7	111,090,453	5,615.5
1975	297,895,841	155,704,877	58,092,196	511,692,914	23,827.5	150,546,085	7,010.4
1976	393,976,640	214,039,521	82,449,753	690,465,914	30,093.3	228,735,862	9,969.3
1977	451,092,130	254,745,551	101,105,196	806,942,877	34,217.3	285,753,730	12,117.0
1978	543,685,372	319,191,818	130,278,682	993,155,873	42,473.3	364,633,696	15,594.0
1979	811,033,621	495,066,502	207,444,668	1,513,544,792	58,409.5	403,161,120	15,558.3
1980	1,151,160,979	730,722,331	313,862,488	2,195,745,798	69,044.2	475,999,804	14,967.6
1981	1,337,269,248	882,899,787	388,184,358	2,608,353,392	76,915.1	635,327,887	18,734.8
1982	1,348,213,199	926,031,813	416,232,734	2,690,477,745	75,210.8	767,794,163	21,463.5
1983	1,679,905,609	1,200,715,027	551,092,806	3,431,713,441	91,873.1	849,355,660	22,739.1
1984	1,911,994,855	1,422,516,904	665,961,064	4,000,472,823	101,107.5	1,004,522,464	25,387.9
1985	2,051,077,041	1,588,955,940	758,016,818	4,398,049,799	108,304.7	1,142,999,848	28,147.0
1986	2,088,839,519	1,685,597,817	818,650,331	4,593,087,667	109,553.9	1,326,752,789	31,645.4
1987	2,440,632,401	2,052,330,291	1,013,912,994	5,506,875,686	128,366.0	1,567,931,943	36,548.9
1988	2,610,451,598	2,339,453,830	1,232,839,298	6,182,744,726	142,840.5	1,833,156,248	42,351.5
1989	3,020,805,653	2,749,933,682	1,388,986,887	7,159,726,223	166,992.6	2,081,917,784	48,558.1
1990	3,820,245,241	3,612,335,473	1,834,976,286	9,267,557,000	218,298.0	2,583,000,000	60,843.0
1991	3,922,117,455	3,853,563,104	1,968,280,041	9,743,960,600	229,394.5	3,382,719,156	79,637.1
1992	4,282,132,562	4,373,298,051	2,245,615,499	10,901,046,112	255,099.6	4,050,819,573	94,795.5
1993	4,934,048,506	5,240,064,986	2,704,511,181	12,878,624,673	296,027.9	5,157,116,839	118,540.7
1994	5,428,202,491	5,780,725,486	2,802,231,994	14,011,159,971	317,707.3	7,756,573,683	175,882.3
1995	5,815,517,230	6,209,810,426	2,820,755,870	14,846,083,526	330,429.4	10,659,000,351	237,237.9
1996	7,311,577,799	7,827,742,052	3,323,265,333	18,462,585,184	401,064.3	12,038,399,907	261,509.9
1997	9,600,929,370	10,304,972,059	4,077,112,341	23,983,013,770	537,913.9	13,324,554,157	298,856.3
1998	16,348,196,184	17,590,785,789	6,464,567,995	40,403,549,968	936,646.4	21,106,385,617	489,294.7
1999	15,916,549,964	18,365,249,958	6,121,749,986	40,403,549,908	969,196.3	25,767,896,544	618,118.8
2000						24,597,999,459	

Source: See chapter 3.

Table A.8.3: Public and private expenditure on education in India, current Rupee							
	Government expenditure					Private expenditure	
	Primary	Secondary	Higher	Total	Average per student	Total	Average per student
	Rupee (‘000)	Rupee (‘000)	Rupee (‘000)	Rupee (‘000)	Rupee	Rupee (‘000)	Rupee
1880	4,016	3,309	1,095	8,420	5.7	5,594	3.8
1881	4,670	3,058	1,033	8,762	5.3	6,495	3.9
1882	4,816	3,170	1,118	9,105	4.9	7,220	3.9
1883	5,232	3,481	1,112	9,825	4.6	8,345	3.9
1884	4,626	4,146	1,156	9,928	4.1	8,712	3.6
1885	4,553	5,035	1,379	10,966	4.3	9,569	3.7
1886	4,610	5,272	1,515	11,398	4.6	9,872	4.0
1887	4,451	5,225	1,570	11,246	4.4	11,368	4.5
1888	4,531	5,396	1,612	11,538	4.4	11,934	4.5
1889	4,495	5,564	1,701	11,760	4.4	12,179	4.5
1890	4,800	5,804	1,763	12,368	4.5	12,627	4.6
1891	5,227	6,228	1,851	13,306	4.6	13,103	4.5
1892	5,226	6,343	1,851	13,420	4.5	13,975	4.7
1893	5,377	6,367	1,846	13,589	4.5	14,314	4.7
1894	5,455	6,373	1,937	13,765	4.4	14,813	4.8
1895	5,717	6,788	1,723	14,228	4.4	15,960	5.0
1896	5,744	6,735	1,698	14,177	4.4	16,208	5.0
1897	5,238	6,879	1,746	13,863	4.4	16,775	5.3
1898	5,383	6,290	1,648	13,321	4.1	17,136	5.3
1899	5,725	6,860	1,752	14,336	4.4	17,839	5.4
1900	5,728	6,885	1,781	14,393	4.4	18,884	5.8
1901	6,181	6,811	1,890	14,882	4.5	19,858	6.0
1902	7,463	7,831	2,181	17,475	5.1	20,812	6.0
1903	7,888	8,804	2,826	19,517	5.1	20,748	5.5
1904	8,214	9,759	3,062	21,035	5.4	21,098	5.4
1905	9,160	10,446	3,361	22,967	6.0	22,077	5.7
1906	9,807	11,237	3,757	24,800	6.3	22,650	5.7
1907	10,675	12,100	4,172	26,947	6.4	24,067	5.7
1908	12,410	15,043	4,509	31,962	6.8	26,038	5.5
1909	11,828	13,920	4,796	30,545	6.7	27,980	6.1
1910	11,819	14,517	5,021	31,357	6.6	29,885	6.3
1911	13,049	15,652	5,578	34,278	6.7	32,719	6.5
1912	16,687	20,486	7,822	44,995	8.0	35,092	6.2
1913	17,826	21,280	7,543	46,650	8.3	38,775	6.9
1914	21,329	27,605	9,188	58,121	9.9	39,729	6.8
1915	18,953	23,651	9,150	51,754	9.7	40,895	7.7
1916	18,165	23,098	8,375	49,639	9.1	41,903	7.7
1917	16,566	21,004	7,728	45,298	8.2	41,833	7.5
1918	6,236	7,953	2,025	16,215	2.6	42,191	6.7
1919	18,994	23,834	9,191	52,019	9.0	39,914	6.9
1920	34,597	38,471	11,555	84,622	14.2	56,539	9.5
1921	40,298	42,641	13,522	96,460	16.3	58,232	9.8
1922	40,103	45,027	12,517	97,647	15.3	60,885	9.6
1923	40,151	44,827	12,631	97,609	14.8	63,496	9.6
1924	40,418	46,549	13,796	100,763	14.4	67,801	9.7

Continued on the next page

Table A.8.3: Public and private expenditure on education in India, current Rupee							
	Government expenditure					Private expenditure	
	Primary	Secondary	Higher	Total	Average per student	Total	Average per student
	Rupee (‘000)	Rupee (‘000)	Rupee (‘000)	Rupee (‘000)	Rupee	Rupee (‘000)	Rupee
1925	45,047	50,164	14,960	110,171	14.6	71,188	9.5
1926	49,853	55,041	16,298	121,192	15.0	74,514	9.2
1927	52,217	57,856	16,701	126,773	14.8	77,677	9.1
1928	49,847	56,210	15,962	122,019	13.8	82,577	9.4
1929	54,878	63,559	17,661	136,098	15.1	82,175	9.1
1930	56,743	65,271	18,096	140,111	15.4	85,563	9.4
1931	53,070	60,144	16,517	129,731	14.1	86,255	9.4
1932	47,738	56,864	15,814	120,415	13.0	87,257	9.5
1933	52,226	53,618	16,955	122,800	13.0	88,527	9.3
1934	51,559	56,971	16,965	125,494	12.7	96,065	9.7
1935	50,979	60,200	16,971	128,150	12.8	93,646	9.4
1936	52,078	61,591	17,520	131,188	12.8	95,875	9.4
1937	51,461	60,904	20,195	132,560	12.4	100,592	9.4
1938	53,367	63,228	23,722	140,317	12.5	101,475	9.1
1939	56,332	66,787	27,817	150,936	12.9	108,369	9.2
1940	54,792	65,801	32,244	152,836	12.6	115,281	9.5
1941	59,602	70,276	30,857	160,735	13.0	114,189	9.2
1942	62,597	72,687	31,788	167,073	14.0	114,591	9.6
1943	67,990	77,084	34,298	179,371	15.4	127,710	11.0
1944	77,152	88,054	38,324	203,530	16.7	144,432	11.8
1945	88,537	102,771	45,582	236,890	18.2	172,612	13.2
1946	99,616	94,762	46,214	240,592	17.3	162,122	11.7
1947	377,928	338,448	160,431	876,807	57.9	208,973	13.8
1948	286,289	273,029	124,038	683,356	39.7	253,596	14.8
1949	418,601	425,339	178,438	1,022,379	42.5	283,736	11.8
1950	492,879	495,141	165,801	1,153,821	45.5	366,258	14.4
1951	490,871	501,064	253,702	1,245,636	47.2	355,735	13.4
1952	534,909	587,016	254,458	1,376,383	50.3	395,224	14.4
1953	573,962	613,090	290,350	1,477,401	51.0	432,018	14.9
1954	651,343	668,896	326,244	1,646,483	53.0	461,215	14.9
1955	705,042	801,793	389,733	1,896,568	56.2	561,067	16.6
1956	821,248	945,370	296,286	2,062,904	57.3	526,905	14.7
1957	957,486	1,108,635	337,853	2,403,974	63.4	587,065	15.5
1958	906,073	1,360,908	393,384	2,660,365	71.0	642,994	17.2
1959	1,001,531	1,534,520	460,442	2,996,493	67.7	778,940	17.6
1960	984,978	1,695,607	762,917	3,443,502	72.4	878,025	18.4
1961	1,214,225	2,118,130	631,115	3,963,470	73.8	983,442	18.3
1962	1,267,704	2,256,633	870,070	4,394,407	76.4	1,094,927	19.0
1963	1,295,161	2,439,786	1,106,104	4,841,051	78.9	1,206,546	19.7
1964	1,376,816	2,524,887	1,408,146	5,309,849	79.7	1,290,458	19.4
1965	1,531,953	2,762,503	1,568,801	5,863,257	85.9	1,199,707	17.6
1966	1,711,140	3,148,762	1,949,000	6,808,901	94.6	1,617,625	22.5
1967	2,053,243	3,832,450	2,132,439	8,018,132	104.6	1,766,340	23.0
1968	2,095,137	3,897,232	2,810,576	8,802,946	113.7	1,971,951	25.4
1969	2,274,958	4,406,993	3,402,455	10,084,406	126.8	2,089,280	26.2

Continued on the next page

Table A.8.3: Public and private expenditure on education in India, current Rupee

	Government expenditure					Private expenditure	
	Primary	Secondary	Higher	Total	Average per student	Total	Average per student
	Rupee ('000)	Rupee ('000)	Rupee ('000)	Rupee ('000)	Rupee	Rupee ('000)	Rupee
1970	2,736,111	5,392,926	3,034,820	11,163,858	137.9	2,207,605	27.3
1971	2,436,290	4,810,732	2,930,440	10,177,462	121.8	2,418,033	28.8
1972	3,125,779	4,847,222	2,885,720	10,858,721	123.6	2,628,396	29.9
1973	4,810,578	6,003,718	3,543,579	14,357,875	164.0	2,838,665	32.4
1974	4,293,602	8,612,720	5,047,133	17,953,456	194.1	3,049,031	32.9
1975	8,931,771	6,388,846	5,419,909	20,740,526	221.3	3,259,379	34.9
1976	10,395,652	5,918,505	6,291,962	22,606,119	224.8	3,469,786	34.6
1977	11,415,425	6,564,531	6,995,607	24,975,563	252.2	3,599,673	36.4
1978	15,003,285	6,325,783	7,051,635	28,380,704	277.8	4,322,271	42.4
1979	13,891,037	7,957,630	8,917,145	30,765,813	289.2	3,739,284	35.1
1980	17,412,573	14,743,588	7,522,529	39,678,690	355.5	4,048,441	36.1
1981	17,250,690	14,834,150	10,591,172	42,676,011	367.4	4,691,329	40.3
1982	21,031,628	18,254,912	10,851,814	50,138,353	409.0	3,932,056	32.2
1983	27,567,955	24,140,071	12,025,174	63,733,200	496.8	4,411,772	34.5
1984	32,392,367	28,414,015	14,978,106	75,784,487	562.4	4,894,443	36.0
1985	38,895,838	32,575,907	17,331,589	88,803,333	625.8	5,422,800	37.9
1986	39,442,445	38,281,019	19,174,377	96,897,841	680.5	6,673,169	47.2
1987	42,314,325	40,290,171	19,212,462	101,816,958	697.1	7,342,043	50.4
1988	59,343,359	53,890,067	28,892,936	142,126,362	929.8	8,576,187	56.4
1989	74,281,711	64,667,242	34,926,075	173,875,028	1,027.2	10,261,147	60.6
1990	85,336,070	75,280,033	37,194,897	197,811,000	1,154.0	11,884,000	69.0
1991	92,330,012	83,185,367	39,681,579	215,196,957	1,235.7	14,641,137	84.1
1992	100,187,934	96,061,372	44,035,329	240,284,636	1,343.4	17,289,012	97.0
1993	115,145,290	104,723,051	50,969,009	270,837,350	1,472.5	19,097,426	104.3
1994	137,326,226	120,870,413	59,614,573	317,811,211	1,706.3	22,042,063	118.2
1995	148,579,417	134,714,488	60,654,975	343,948,879	1,821.4	25,778,537	137.0
1996	134,155,940	162,511,561	80,784,400	377,451,902	1,992.9	25,447,259	134.7
1997						33,422,090	176.6
1998						40,949,960	215.9
1999						49,394,453	254.8
2000						55,168,596	284.5

Source: See chapter 3.

A.9. Investment in human capital in Japan 1895-2002 in billion 1990 International USD, converted at PPP

The construction and sources of the following estimates on human capital investments are described in chapter 5.

Table A.9.1: Investment in human capital in Japan (billion constant 1990 USD)

	Gross fixed capital formation	Change in the value of stocks	Gross capital formation	Appreciation	Net capital formation
1895	3.154	1.400	4.554	3.527	8.082
1896	3.200	1.700	4.900	3.734	8.634
1897	3.649	1.754	5.402	3.948	9.350
1898	4.098	1.729	5.827	4.183	10.010
1899	4.561	1.880	6.441	4.439	10.880
1900	5.012	1.915	6.927	4.717	11.645
1901	5.484	1.997	7.482	5.018	12.500
1902	5.939	2.001	7.940	5.343	13.282
1903	6.398	1.918	8.315	5.692	14.007
1904	6.860	1.755	8.615	6.065	14.680
1905	7.324	1.816	9.140	6.465	15.605
1906	7.802	2.033	9.835	6.891	16.726
1907	8.268	2.103	10.371	7.345	17.716
1908	8.703	2.314	11.018	7.828	18.846
1909	9.098	2.577	11.675	8.339	20.014
1910	9.551	2.524	12.076	8.878	20.954
1911	10.002	2.373	12.375	9.448	21.823
1912	10.472	2.247	12.719	10.049	22.768
1913	10.954	2.093	13.047	10.683	23.731
1914	11.441	2.046	13.487	11.352	24.839
1915	11.921	1.990	13.911	12.057	25.968
1916	12.463	2.349	14.812	12.798	27.610
1917	12.896	1.522	14.418	13.579	27.997
1918	13.469	1.921	15.390	14.397	29.787
1919	13.989	2.076	16.065	15.259	31.324
1920	14.588	2.893	17.481	16.163	33.644
1921	15.152	3.345	18.497	17.114	35.611
1922	15.724	3.682	19.406	18.111	37.518
1923	16.232	3.639	19.871	19.157	39.028
1924	16.791	3.885	20.676	20.251	40.927
1925	17.337	3.893	21.230	21.397	42.627
1926	18.233	6.805	25.038	22.594	47.632
1927	18.917	7.082	25.999	23.856	49.855
1928	19.577	7.021	26.599	25.179	51.777
1929	20.196	6.659	26.855	26.562	53.417
1930	20.705	6.178	26.883	28.008	54.890
1931	21.159	5.890	27.049	29.514	56.562
1932	21.663	5.526	27.190	31.080	58.270
1933	22.140	4.935	27.075	32.711	59.786

Continued on the next page

Table A.9.1: Investment in human capital in Japan (billion constant 1990 USD)

	Gross fixed capital formation	Change in the value of stocks	Gross capital formation	Appreciation	Net capital formation
1934	22.707	4.874	27.581	34.407	61.988
1935	23.252	4.340	27.591	36.173	63.764
1936	23.823	4.071	27.894	38.010	65.904
1937	24.418	3.634	28.052	39.921	67.973
1938	24.933	2.610	27.543	41.911	69.453
1939	25.678	3.122	28.801	43.977	72.778
1940	26.131	2.747	28.878	46.131	75.008
1941	24.824	5.312	30.136	48.365	78.501
1942	25.003	4.967	29.969	50.628	80.597
1943	20.527	-0.341	20.185	52.966	73.151
1944	19.676	1.082	20.759	55.369	76.128
1945	19.587	2.032	21.619	57.161	78.780
1946	20.140	3.773	23.913	55.426	79.339
1947	21.833	2.516	24.349	53.810	78.159
1948	22.051	2.872	24.923	53.025	77.948
1949	24.254	1.864	26.118	51.857	77.975
1950	23.307	5.248	28.555	50.412	78.967
1951	25.227	4.065	29.292	48.634	77.926
1952	27.283	3.146	30.429	46.814	77.244
1953	28.241	3.701	31.943	45.149	77.091
1954	27.685	5.612	33.297	43.997	77.293
1955	26.997	7.804	34.801	42.756	77.556
1956	31.289	5.616	36.904	41.570	78.475
1957	34.034	4.545	38.579	40.512	79.092
1958	36.395	3.506	39.901	39.844	79.744
1959	37.104	4.161	41.265	38.366	79.630
1960	38.082	5.420	43.502	36.745	80.246
1961	36.431	9.460	45.891	34.542	80.433
1962	38.292	11.520	49.811	31.114	80.925
1963	55.546	1.860	57.406	27.994	85.399
1964	63.043	0.308	63.352	24.561	87.912
1965	67.867	-0.574	67.293	22.618	89.911
1966	67.080	1.635	68.715	19.936	88.651
1967	66.696	2.791	69.487	19.627	89.114
1968	69.833	3.138	72.972	16.525	89.497
1969	72.245	3.958	76.203	15.101	91.304
1970	73.673	7.322	80.994	12.511	93.505
1971	76.264	9.078	85.343	11.748	97.091
1972	81.715	12.468	94.183	7.525	101.708
1973	86.388	16.742	103.130	2.160	105.290
1974	91.160	19.134	110.295	-1.511	108.784
1975	95.497	18.215	113.713	-1.131	112.582
1976	97.809	19.389	117.199	-4.728	112.470
1977	100.017	21.166	121.182	-7.652	113.530
1978	105.628	25.041	130.669	-12.796	117.874
1979	110.124	26.961	137.085	-15.839	121.246
1980	112.784	27.210	139.994	-17.431	122.563

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Table A.9.1: Investment in human capital in Japan (billion constant 1990 USD)					
	Gross fixed capital formation	Change in the value of stocks	Gross capital formation	Appreciation	Net capital formation
1981	119.252	26.113	145.365	-19.376	125.989
1982	111.394	37.816	149.210	-21.380	127.830
1983	127.504	28.095	155.599	-22.169	133.430
1984	132.917	31.423	164.340	-24.704	139.636
1985	140.856	30.675	171.532	-25.317	146.215
1986	147.438	31.162	178.600	-25.566	153.033
1987	157.601	30.765	188.367	-27.113	161.253
1988	168.536	27.751	196.287	-25.346	170.942
1989	178.562	22.985	201.547	-21.151	180.397
1990	187.661	22.190	209.851	-2.205	207.646
1991	189.708	22.293	212.002	3.108	215.110
1992	194.297	19.914	214.211	23.092	237.303
1993	205.120	6.975	212.095	42.086	254.181
1994	209.761	3.212	212.973	55.204	268.177
1995	204.684	9.202	213.886	66.874	280.760
1996	203.540	10.516	214.056	71.257	285.313
1997	199.377	12.307	211.684	82.689	294.373
1998	190.259	18.001	208.261	76.287	284.548
1999	207.501	-2.955	204.546	100.034	304.580
2000	206.833	2.032	208.865	98.466	307.331
2001	176.562	28.635	205.197	98.443	303.640
2002	176.554	27.362	203.916	107.665	311.581

SourceEstimation: See chapter 5.

A.10. Investment in human capital in Indonesia 1890-2002 in billion 1990 International USD, converted at PPP

The construction and sources of the following estimates on human capital investments are described in chapter 5.

Table A.10.1: Investment in human capital in Indonesia (billion constant 1990 USD)

	Gross fixed capital formation	change in the value of stocks	Gross capital formation	Appreciation	Net capital formation
1890	0.057	0.116	0.172	0.071	0.244
1891	0.087	0.107	0.194	0.075	0.269
1892	0.119	0.085	0.204	0.080	0.284
1893	0.148	0.101	0.249	0.086	0.335
1894	0.175	0.109	0.284	0.093	0.378
1895	0.198	0.127	0.325	0.102	0.427
1896	0.220	0.123	0.343	0.111	0.454
1897	0.240	0.079	0.319	0.121	0.440
1898	0.260	0.105	0.366	0.132	0.498
1899	0.279	0.124	0.403	0.145	0.548
1900	0.300	0.115	0.415	0.158	0.573
1901	0.326	0.089	0.415	0.172	0.586
1902	0.356	0.096	0.452	0.187	0.639
1903	0.386	0.081	0.467	0.204	0.671
1904	0.407	0.105	0.512	0.222	0.734
1905	0.429	0.115	0.544	0.242	0.785
1906	0.450	0.107	0.556	0.262	0.819
1907	0.469	0.103	0.572	0.284	0.856
1908	0.493	0.110	0.603	0.308	0.911
1909	0.516	0.139	0.655	0.332	0.987
1910	0.535	0.161	0.696	0.359	1.055
1911	0.559	0.144	0.703	0.386	1.089
1912	0.587	0.125	0.712	0.416	1.127
1913	0.613	0.163	0.776	0.446	1.222
1914	0.638	0.152	0.790	0.479	1.269
1915	0.663	0.185	0.848	0.514	1.362
1916	0.690	0.193	0.883	0.550	1.433
1917	0.722	0.182	0.904	0.588	1.493
1918	0.753	0.131	0.884	0.629	1.513
1919	0.784	0.203	0.988	0.672	1.659
1920	0.813	0.119	0.933	0.717	1.649
1921	0.842	0.204	1.046	0.764	1.810
1922	0.877	0.164	1.041	0.814	1.854
1923	0.916	0.148	1.064	0.866	1.930
1924	0.948	0.177	1.125	0.921	2.046
1925	0.978	0.214	1.191	0.979	2.170
1926	1.011	0.234	1.246	1.039	2.285
1927	1.032	0.279	1.311	1.103	2.414
1928	1.064	0.297	1.361	1.169	2.530
1929	1.102	0.298	1.400	1.238	2.638

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Table A.10.1: Investment in human capital in Indonesia (billion constant 1990 USD)					
	Gross fixed capital formation	change in the value of stocks	Gross capital formation	Appreciation	Net capital formation
1930	1.131	0.320	1.451	1.310	2.761
1931	1.177	0.307	1.484	1.386	2.869
1932	1.219	0.327	1.545	1.465	3.010
1933	1.268	0.326	1.594	1.548	3.141
1934	1.323	0.225	1.549	1.635	3.183
1935	1.370	0.102	1.472	1.726	3.198
1936	1.407	0.063	1.470	1.822	3.291
1937	1.443	-0.047	1.396	1.922	3.318
1938	1.475	-0.059	1.417	2.026	3.442
1939	1.503	-0.063	1.440	2.487	3.927
1940	1.542	-0.041	1.501	2.434	3.935
1941	1.568	-0.025	1.543	2.371	3.914
1942	1.561	-0.036	1.526	2.370	3.895
1943	1.760	-0.146	1.614	2.349	3.962
1944	1.704	-0.042	1.662	2.353	4.015
1945	1.527	0.241	1.767	2.346	4.113
1946	1.550	0.231	1.781	2.326	4.108
1947	1.559	0.274	1.834	2.336	4.170
1948	1.590	0.411	2.001	2.327	4.328
1949	1.601	0.490	2.090	2.322	4.412
1950	1.608	0.159	1.767	2.273	4.039
1951	1.663	0.137	1.800	2.143	3.943
1952	1.714	0.216	1.930	1.999	3.929
1953	1.727	0.177	1.904	2.003	3.907
1954	1.778	0.226	2.004	1.970	3.974
1955	1.806	0.115	1.921	1.993	3.914
1956	1.872	0.224	2.096	1.975	4.071
1957	1.370	0.713	2.083	1.923	4.007
1958	1.435	0.618	2.053	1.890	3.942
1959	1.618	0.926	2.544	1.768	4.312
1960	1.672	1.159	2.831	1.707	4.539
1961	1.807	1.314	3.121	1.586	4.707
1962	2.107	1.723	3.830	1.387	5.217
1963	2.241	1.654	3.894	1.390	5.284
1964	2.509	1.704	4.213	1.297	5.510
1965	3.339	1.994	5.333	0.704	6.038
1966	3.165	1.854	5.019	0.968	5.987
1967	3.422	1.605	5.027	0.853	5.881
1968	3.605	1.160	4.766	0.897	5.662
1969	4.336	1.241	5.578	0.520	6.098
1970	4.813	1.293	6.106	0.113	6.219
1971	5.461	1.740	7.201	-0.297	6.904
1972	6.208	2.754	8.962	-0.955	8.007
1973	6.385	2.641	9.026	-1.047	7.980
1974	6.591	2.208	8.798	-1.091	7.708
1975	7.099	3.329	10.428	-1.447	8.981
1976	6.929	2.127	9.056	-1.029	8.027
1977	6.783	1.025	7.807	-0.802	7.005

Continued on the next page

Table A.10.1: Investment in human capital in Indonesia (billion constant 1990 USD)					
	Gross fixed capital formation	change in the value of stocks	Gross capital formation	Appreciation	Net capital formation
1978	4.825	2.756	7.581	-0.976	6.605
1979	5.290	2.819	8.109	-1.392	6.716
1980	8.351	1.829	10.180	-2.216	7.964
1981	8.923	2.217	11.140	-2.647	8.493
1982	9.002	1.764	10.766	-2.672	8.094
1983	9.732	1.479	11.211	-3.273	7.938
1984	10.578	2.492	13.069	-4.003	9.066
1985	11.787	3.912	15.699	-4.804	10.894
1986	13.024	6.805	19.829	-5.848	13.981
1987	12.622	7.162	19.785	-6.179	13.606
1988	13.762	5.285	19.047	-6.030	13.017
1989	14.449	3.978	18.427	-6.132	12.295
1990	19.168	13.503	32.671	-9.651	23.021
1991	21.867	20.442	42.309	-11.457	30.852
1992	22.200	18.377	40.577	-12.397	28.180
1993	22.762	18.605	41.368	-12.200	29.167
1994	26.556	2.490	29.046	-10.878	18.167
1995	26.926	4.664	31.590	-10.660	20.930
1996	29.326	8.268	37.594	-12.267	25.327
1997	33.225	10.745	43.970	-14.299	29.671
1998	32.257	7.364	39.622	-12.110	27.511
1999	31.941	3.251	35.192	-9.763	25.429
2000	38.192	5.336	43.528	-13.941	29.587
2001	39.200	4.328	43.528	-12.761	30.767
2002	37.245	6.283	43.528	-12.053	31.475

Sources: See chapter 5.

A.11. Investment in human capital in India 1890-1999 in billion 1990 International USD, converted at PPP

The construction and sources of the following estimates on human capital investments are described in chapter 5.

Table A.11.1: Investment in human capital in India (billion constant 1990 USD)

	Gross fixed capital formation	change in the value of stocks	Gross capital formation	Appreciation	Net capital formation
1890	0.913	0.683	1.597	-0.323	1.274
1891	0.917	0.723	1.640	-0.341	1.299
1892	0.872	0.641	1.513	-0.360	1.153
1893	0.861	0.682	1.544	-0.379	1.165
1894	0.877	0.830	1.707	-0.397	1.309
1895	0.885	0.870	1.755	-0.416	1.338
1896	0.844	0.684	1.528	-0.435	1.093
1897	0.775	0.474	1.249	-0.454	0.795
1898	0.825	0.769	1.594	-0.473	1.122
1899	0.879	1.022	1.901	-0.492	1.409
1900	0.812	0.660	1.472	-0.511	0.961
1901	0.789	0.671	1.460	-0.529	0.931
1902	0.818	0.875	1.694	-0.548	1.145
1903	0.857	1.122	1.978	-0.567	1.412
1904	0.914	1.218	2.132	-0.586	1.546
1905	0.956	0.994	1.950	-0.605	1.345
1906	1.018	1.035	2.053	-0.625	1.428
1907	1.109	1.066	2.175	-0.645	1.530
1908	1.156	1.022	2.178	-0.666	1.512
1909	1.265	1.148	2.413	-0.687	1.726
1910	1.411	1.336	2.746	-0.709	2.037
1911	1.517	1.512	3.029	-0.732	2.296
1912	1.627	1.403	3.030	-0.757	2.273
1913	1.641	1.427	3.069	-0.782	2.287
1914	1.708	1.441	3.149	-0.807	2.341
1915	1.648	1.015	2.663	-0.834	1.830
1916	1.717	1.372	3.089	-0.859	2.229
1917	1.708	1.363	3.070	-0.886	2.185
1918	1.540	1.268	2.807	-0.912	1.895
1919	1.467	0.782	2.248	-0.937	1.311
1920	1.507	1.130	2.637	-0.961	1.675
1921	1.601	1.306	2.907	-0.986	1.921
1922	1.895	1.892	3.787	-1.011	2.775
1923	2.248	2.404	4.652	-1.040	3.612
1924	2.592	2.651	5.243	-1.072	4.170
1925	2.980	2.835	5.815	-1.108	4.707
1926	3.292	2.794	6.086	-1.149	4.937
1927	3.818	3.412	7.230	-1.194	6.037

Continued on the next page

Table A.11.1: Investment in human capital in India (billion constant 1990 USD)

	Gross fixed capital formation	change in the value of stocks	Gross capital formation	Appreciation	Net capital formation
1928	4.153	3.402	7.555	-1.244	6.311
1929	4.591	3.696	8.287	-1.299	6.987
1930	5.315	4.661	9.975	-1.360	8.615
1931	5.681	4.446	10.127	-1.430	8.696
1932	6.009	4.386	10.395	-1.505	8.889
1933	6.397	4.612	11.009	-1.585	9.424
1934	6.782	4.522	11.304	-1.671	9.632
1935	7.379	4.159	11.539	-1.762	9.776
1936	6.610	2.912	9.521	-1.835	7.687
1937	6.675	3.020	9.694	-1.896	7.799
1938	6.931	3.780	10.711	-1.957	8.754
1939	6.882	3.692	10.573	-1.879	8.694
1940	7.032	3.428	10.460	-1.319	9.141
1941	6.691	3.153	9.844	-0.355	9.489
1942	5.671	1.471	7.141	1.323	8.465
1943	4.542	0.543	5.085	2.865	7.950
1944	4.795	2.789	7.584	2.847	10.432
1945	5.541	4.296	9.837	2.816	12.652
1946	5.825	4.421	10.246	3.595	13.841
1947	5.042	5.043	10.085	5.145	15.230
1948	5.755	6.670	12.425	5.325	17.750
1949	8.643	10.530	19.173	3.182	22.355
1950	10.714	1.778	12.492	3.612	16.104
1951	10.874	1.735	12.610	4.277	16.886
1952	18.128	7.504	25.632	-1.681	23.951
1953	13.568	3.519	17.087	3.308	20.395
1954	15.183	4.387	19.570	2.612	22.182
1955	18.303	6.612	24.915	0.310	25.225
1956	19.435	6.345	25.780	-0.015	25.765
1957	20.265	7.239	27.504	-0.475	27.029
1958	15.682	2.341	18.023	5.087	23.109
1959	16.200	2.712	18.912	5.259	24.171
1960	18.784	3.676	22.460	3.399	25.859
1961	21.054	5.896	26.950	1.612	28.562
1962	22.056	5.655	27.712	1.582	29.294
1963	23.128	6.337	29.465	1.152	30.617
1964	24.361	6.062	30.424	0.976	31.400
1965	26.265	7.106	33.370	0.355	33.725
1966	27.679	7.669	35.348	-0.018	35.330
1967	28.561	8.496	37.058	-0.145	36.912
1968	28.716	7.195	35.911	1.295	37.205
1969	31.387	9.045	40.431	-0.101	40.330
1970	31.519	7.691	39.210	1.015	40.224
1971	29.396	5.781	35.177	3.072	38.248
1972	35.320	9.462	44.782	-2.152	42.630
1973	39.400	13.495	52.895	-7.007	45.888
1974	35.417	7.009	42.425	-3.004	39.421
1975	33.619	7.274	40.893	-2.042	38.851
1976	40.457	10.954	51.411	-8.805	42.606

Continued on the next page

Table A.11.1: Investment in human capital in India (billion constant 1990 USD)

	Gross fixed capital formation	change in the value of stocks	Gross capital formation	Appreciation	Net capital formation
1977	38.825	8.184	47.009	-8.385	38.624
1978	40.695	9.147	49.842	-10.056	39.786
1979	45.773	8.994	54.767	-15.456	39.311
1980	45.318	7.925	53.243	-15.303	37.941
1981	49.711	8.360	58.071	-20.439	37.632
1982	51.887	6.522	58.409	-21.570	36.839
1983	60.632	13.205	73.838	-29.407	44.431
1984	64.116	10.669	74.785	-29.872	44.913
1985	69.508	14.089	83.597	-35.381	48.215
1986	79.293	17.334	96.626	-40.861	55.766
1987	77.144	14.497	91.641	-35.878	55.763
1988	99.936	33.074	133.010	-53.489	79.520
1989	106.591	38.026	144.617	-58.211	86.406
1990	102.043	31.910	133.953	-52.004	81.949
1991	90.996	21.184	112.179	-38.793	73.386
1992	85.684	17.505	103.189	-30.034	73.155
1993	86.549	21.391	107.940	-25.851	82.089
1994	99.253	31.236	130.489	-35.048	95.441
1995	110.621	40.528	151.149	-45.483	105.667
1996	114.212	37.916	152.128	-44.294	107.835
1997	115.707	37.902	153.609	-43.825	109.785
1998	115.434	36.483	151.917	-40.956	110.961
1999	124.300	43.369	167.670	-57.677	109.993
2000	124.548	45.652	170.200	-58.248	111.952

Sources: See chapter 5.

A.12. Stock of Human Capital in India, Indonesia, and Japan, 1890-2002 in billion 1990 International USD, converted at PPP

The construction and sources of the following estimates of the stock of human capital are described in chapter 5.

Table A.12.1: Human Capital Stock in Asia in billion constant 1990 USD

	Japan Total HC Billion USD	Indonesia Total HC Billion USD	India Total HC Billion USD
1890		2.430	81.641
1891		2.592	82.216
1892		2.791	82.728
1893		3.025	83.211
1894	114.152	3.293	83.691
1895	120.837	3.593	84.159
1896	127.775	3.924	84.568
1897	135.375	4.286	84.889
1898	143.660	4.679	85.241
1899	152.664	5.102	85.628
1900	162.398	5.561	85.930
1901	172.905	6.058	86.190
1902	184.192	6.602	86.460
1903	196.286	7.192	86.749
1904	209.216	7.821	87.078
1905	223.010	8.492	87.428
1906	237.710	9.204	87.821
1907	253.330	9.958	88.285
1908	269.868	10.759	88.776
1909	287.313	11.608	89.354
1910	305.750	12.501	90.055
1911	325.208	13.447	90.840
1912	345.738	14.449	91.710
1913	367.385	15.509	92.569
1914	390.189	16.627	93.469
1915	414.178	17.804	94.283
1916	439.451	19.045	95.140
1917	465.938	20.357	95.962
1918	493.817	21.739	96.589
1919	523.079	23.196	97.119
1920	553.845	24.727	97.664
1921	586.126	26.333	98.280
1922	619.978	28.025	99.163
1923	655.384	29.807	100.370
1924	692.445	31.678	101.890
1925	731.197	33.635	103.762
1926	772.044	35.687	105.904
1927	814.839	37.823	108.529

Continued on the next page

Table A.12.1: Human Capital Stock in Asia in billion constant 1990 USD			
	Japan	Indonesia	India
	Total HC	Total HC	Total HC
	Billion USD	Billion USD	Billion USD
1928	859.618	40.057	111.437
1929	906.400	42.398	114.729
1930	955.137	44.840	118.683
1931	1,005.836	47.403	122.934
1932	1,058.608	50.088	127.436
1933	1,113.489	52.905	132.248
1934	1,170.634	55.865	137.359
1935	1,230.090	58.962	142.975
1936	1,291.958	62.192	147.750
1937	1,356.333	65.559	152.529
1938	1,423.214	69.062	157.502
1939	1,492.909	73.055	162.504
1940	1,565.213	77.033	168.217
1941	1,638.445	80.974	174.553
1942	1,714.122	84.907	181.547
1943	1,787.662	89.017	188.954
1944	1,862.758	93.076	196.598
1945	1,939.557	96.950	204.955
1946	2,015.166	100.828	214.376
1947	2,090.845	104.724	224.566
1948	2,165.954	108.642	235.649
1949	2,242.092	112.566	247.475
1950	2,315.836	116.447	261.802
1951	2,389.717	120.254	276.954
1952	2,463.832	123.967	293.400
1953	2,537.237	127.697	310.277
1954	2,608.931	131.446	328.072
1955	2,678.695	135.245	346.686
1956	2,751.564	139.092	366.105
1957	2,826.118	142.386	385.896
1958	2,902.365	145.711	406.666
1959	2,977.841	149.097	428.126
1960	3,052.673	152.477	450.309
1961	3,123.651	155.870	472.974
1962	3,193.059	159.364	496.613
1963	3,276.601	162.995	520.893
1964	3,364.207	166.801	546.230
1965	3,454.693	170.845	572.850
1966	3,541.710	174.978	600.511
1967	3,628.033	179.254	628.927
1968	3,714.392	183.756	658.938
1969	3,801.738	188.612	690.224
1970	3,887.922	193.539	722.757
1971	3,975.935	198.703	755.224
1972	4,065.175	203.956	788.393
1973	4,153.723	209.295	820.785
1974	4,243.372	214.795	853.198

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Table A.12.1: Human Capital Stock in Asia in billion constant 1990 USD

	Japan	Indonesia	India
	Total HC	Total HC	Total HC
	Billion USD	Billion USD	Billion USD
1975	4,337.739	220.447	884.775
1976	4,430.820	226.347	916.427
1977	4,523.184	232.327	946.866
1978	4,616.017	236.176	977.504
1979	4,710.301	240.074	1,007.817
1980	4,805.653	246.208	1,037.829
1981	4,905.529	252.484	1,067.093
1982	4,995.543	258.813	1,097.400
1983	5,100.878	265.271	1,128.604
1984	5,209.090	271.845	1,162.825
1985	5,324.629	278.826	1,196.916
1986	5,446.500	286.000	1,235.297
1987	5,576.987	292.441	1,276.531
1988	5,720.177	300.170	1,322.874
1989	5,877.588	308.484	1,371.130
1990	6,063.044	317.992	1,421.088
1991	6,255.861	328.386	1,473.260
1992	6,473.249	338.169	1,528.897
1993	6,720.457	348.714	1,589.587
1994	6,781.718	364.380	1,653.774
1995	7,255.723	380.637	1,718.877
1996	7,868.083	397.682	1,788.764
1997	8,140.154	416.588	1,860.618
1998	8,406.708	436.724	1,935.075
1999	8,160.215	458.897	2,001.645
2000	8,641.733	483.135	2,064.639
2001	9,123.252	509.564	
2002	9,407.486	534.749	

Source: See chapter 5.

A.13. A method of inserting human capital formation in GDP using the expenditure approach, 1890-2002.

A.13.1 Introduction

After we have calculated the formation and stocks of human capital (chapter 5 and appendices A.8-A.11), one problem remains. If we want to insert human capital in growth equations, we run regressions of GDP on human capital. However, GDP consists of private consumption expenditure, government consumption expenditure, plus exports, minus imports, and plus investment (gross fixed capital formation). However, should this gross fixed capital formation not also include total investment in human capital besides physical capital? In present-day GDP estimates (and older estimates as well) often only direct government and private expenditure on education are included. As a consequence, shares of human capital formation such as 'foregone wages' and 'home education' are not inserted in the national accounts. There are some exceptions however. Kendrick (1976) adjusted GDP for human capital formation not included in the national accounts. Furthermore, in their extensive work on inserting human capital in the national accounts Jorgensson and Fraumeni (1989, table 5.1) did the same, which resulted in a more than doubling of the level of GDP for the United States.

From above perspective, it might be important to incorporate human capital into the national accounts. However, there is also a further, largely theoretical reason to include human capital formation in GDP. In growth theory, where human capital formation is also included, human capital formation can be defined as a part of GDP or it can be seen as separated from GDP, although the latter would seem to be somewhat odd. However, human capital formation can not completely be seen as a part of GDP as GDP excludes such human capital components as foregone wages and home education. On the other hand, human capital also cannot be seen as completely separated from GDP as GDP includes private and government direct expenditure on education (Barro and Sala-i-Martin 2004, 248). This may make a difference. Kendrick (1976, table A-1 and B-2) estimated that about 50% of gross human capital formation was included in the national accounts. Jorgenson and Fraumeni (1989) estimated this figure to be lower because of their valuation of non-market time as human capital which is excluded from current GDP estimates.

Therefore, it is important to see how GDP increases when the complete estimated human capital accumulation is included. We start by applying this method on the data on current GDP derived using the expenditure approach for Indonesia (appendix A.4). This allows us to see how the human capital formation relates to the other parts of GDP. Yet, as also indicated in appendix A.4, the constant prices series estimated using the production approach from Van der Eng (2003) are more acurate. Therefore, when we present in table A.13.3 the GDP figures corrected for human capital formation for all three countries in mln. constant 1990 intl. dollars we will use the more accurate estimates from Van der Eng (2003).

A.13.2 Inserting human capital formation in Indonesian GDP using the expenditure approach

From appendix A.4 we have GDP and its components in current prices and from appendix A.10 we have the gross human capital formation. Unfortunately, we cannot simply insert gross human capital formation in the national accounts as the direct expenditure from individuals and the government are already included in the household and government consumption expenditure respectively. Therefore we deducted government expenditure on education and private expenditure on education as given in chapter 3 and appendix A.8 from government consumption expenditure and household consumption expenditure respectively. Next, we inserted Gross Human Capital Formation in the national accounts to arrive at the new GDP.

The first thing that we may notice is that the share of human capital in GDP was fairly low, at least somewhat lower than that of physical capital.[186] The share of human capital formation in GDP seems to increase continuously over the twentieth century. However, the

Table A.13.1: Comparison between GDP in current prices with and without human capital formation in Indonesia using the expenditure approach

	Share in GDP		Share HC not in National Accounts	GDP with HC/Normal GDP
	Physical capital	Human Capital		
1890	0.64%	0.54%	56.25%	100.30%
1900	1.41%	1.06%	80.22%	100.86%
1910	2.19%	2.00%	80.14%	101.63%
1920	5.35%	2.61%	79.15%	102.11%
1930	6.88%	2.15%	60.61%	101.32%
1940	8.23%	2.46%	69.61%	101.74%
1950	5.67%	4.80%	92.92%	104.67%
1960	7.33%	6.12%	78.95%	105.08%
1970	8.70%	10.32%	70.70%	107.87%
1980	20.72%	6.57%	11.23%	100.74%
1990	31.37%	10.75%	43.55%	104.91%
2000*	18.06%	6.23%	12.68%	100.80%

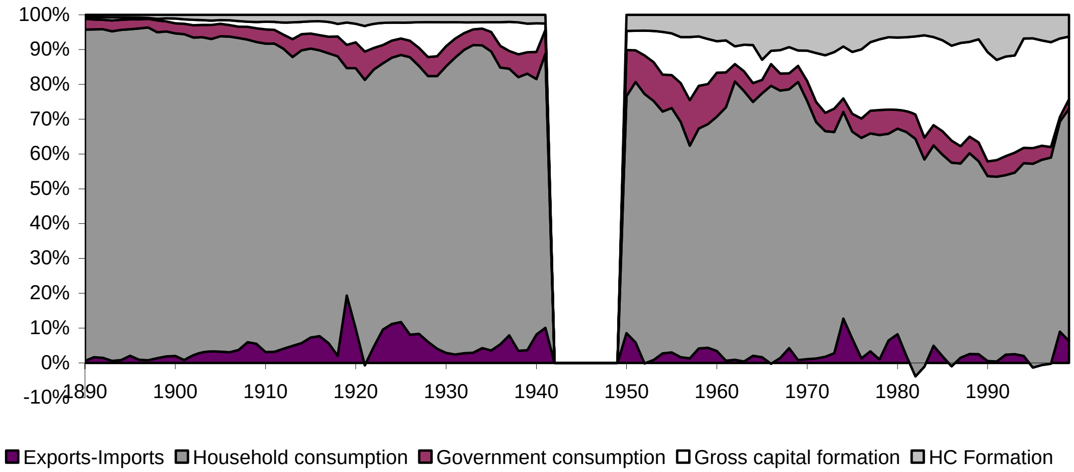
*1999

[186] Note that these are not factor shares because we are talking about GDP calculated using the expenditure approach.

maximum is around 10% of the GDP. This low figure might partly be caused by the lower depreciation (or even appreciation) of human capital compared to physical capital. As a consequence, as we already noted in chapter 5, the human and physical capital stock are of about the same magnitude while the gross human capital formation is lower than that of physical capital. Therefore, our results diverge somewhat from the results found by Kendrick (1976) and Jorgenson and Fraumeni (1986). This is of course not surprising as our definition and construction of human capital differs significantly from theirs. A second point to note is that the share of human capital formation not included in GDP is significantly different at the

Figure A.13.1

Percentage division of GDP in Indonesia 1890-2000 in current prices in expenditure shares including human capital formation



Note: We included exports minus imports. In years when the value of the imports were larger than the value of the exports the other parts of GDP first have to make up this negative difference. Hence, for some years there is a negative value.

start of the twentieth century than at the end. Indeed, we note that around 1900 about 80% of human capital formation was not inserted in GDP. This may come as no surprise as much of this education was informal. When formal education increased strongly in Indonesia, we see that the share of human capital not included in GDP decreased. A third important point to note is that GDP increases due to the insertion of human capital. This follows logically from the situation that part of human capital was not inserted in the 'normal' GDP figures. On average it seems that the GDP increases by about 2% due to the inclusion of human capital. Finally, whereas the shares of human and physical capital were about equal until 1970, they diverged strongly afterwards. This is what we also found in chapter 5. There, we pointed out that the per capita stock of human capital had a logistic curve with strong growth between the 1930s and 1960s. As a consequence, the growth of the gross human capital formation was less strong after the 1970s. The gross physical capital stocks, however, increased strongly after that period thus increasing the share of gross physical capital formation in GDP relative to gross human capital formation.

Table A.13.2: GDP (expenditure approach) corrected for human capital in billion current rupiah in Indonesia, 1890-2000

	Household consumption	Government consumption	Gross capital formation	Gross Human capital Formation	Exports-Imports	GDP
1890	2.66	0.09	0.02	0.02	0.02	2.80
1891	2.69	0.08	0.02	0.02	0.05	2.86
1892	2.83	0.08	0.02	0.02	0.04	3.00
1893	2.52	0.08	0.02	0.02	0.02	2.66
1894	2.80	0.09	0.02	0.02	0.02	2.96
1895	2.95	0.09	0.02	0.02	0.06	3.14
1896	3.20	0.09	0.02	0.03	0.03	3.36
1897	3.53	0.09	0.01	0.03	0.03	3.69
1898	2.55	0.09	0.01	0.03	0.04	2.72
1899	2.93	0.09	0.03	0.03	0.06	3.14
1900	2.92	0.09	0.04	0.03	0.06	3.15
1901	3.02	0.10	0.04	0.04	0.03	3.23
1902	2.60	0.10	0.04	0.04	0.06	2.85
1903	2.62	0.10	0.04	0.05	0.09	2.89
1904	2.34	0.11	0.03	0.04	0.09	2.61
1905	2.64	0.10	0.03	0.05	0.09	2.91
1906	2.79	0.10	0.04	0.05	0.09	3.08
1907	2.85	0.10	0.05	0.06	0.12	3.18
1908	2.77	0.12	0.05	0.06	0.19	3.19
1909	2.74	0.13	0.06	0.06	0.17	3.16
1910	3.06	0.14	0.08	0.07	0.11	3.45
1911	3.37	0.15	0.09	0.08	0.12	3.81
1912	3.45	0.16	0.14	0.09	0.16	4.00
1913	3.22	0.20	0.18	0.09	0.19	3.89
1914	3.78	0.21	0.16	0.09	0.26	4.49
1915	4.21	0.22	0.18	0.09	0.37	5.08
1916	4.52	0.24	0.22	0.10	0.42	5.50
1917	4.36	0.25	0.22	0.11	0.30	5.24
1918	4.70	0.31	0.20	0.14	0.11	5.46
1919	4.63	0.47	0.46	0.16	1.37	7.09
1920	7.03	0.70	0.50	0.24	0.93	9.40
1921	5.82	0.58	0.52	0.23	-0.05	7.10
1922	6.25	0.49	0.55	0.20	0.37	7.86
1923	5.89	0.40	0.49	0.18	0.74	7.70
1924	5.86	0.38	0.39	0.18	0.85	7.66
1925	6.21	0.38	0.37	0.18	0.95	8.10
1926	6.62	0.40	0.43	0.19	0.67	8.31
1927	6.76	0.45	0.65	0.19	0.73	8.78
1928	7.07	0.50	0.93	0.19	0.56	9.25

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Table A.13.2: GDP (expenditure approach) corrected for human capital in billion current rupiah in Indonesia, 1890-2000

	Household consumption	Government consumption	Gross capital formation	Gross Human capital Formation	Exports-Imports	GDP
1929	7.41	0.54	0.93	0.20	0.38	9.46
1930	7.69	0.54	0.64	0.20	0.27	9.34
1931	7.32	0.47	0.40	0.18	0.21	8.59
1932	6.40	0.36	0.23	0.16	0.20	7.35
1933	5.79	0.30	0.13	0.15	0.19	6.55
1934	5.28	0.29	0.11	0.13	0.26	6.07
1935	4.86	0.32	0.16	0.12	0.20	5.66
1936	4.30	0.34	0.37	0.11	0.29	5.41
1937	4.41	0.29	0.48	0.12	0.46	5.76
1938	4.28	0.36	0.50	0.12	0.19	5.44
1939	4.98	0.38	0.52	0.16	0.23	6.27
1940	3.99	0.42	0.45	0.13	0.44	5.43
1941	4.78	0.41	0.11	0.15	0.61	6.06
1942	5.20			0.21		5.42
1943	3.89			0.21		4.10
1944	5.59			0.33		5.91
1945	6.20			0.49		6.69
1946	8.28			0.85		9.13
1947	11.45			1.24		12.69
1948	16.84			1.76	-0.80	17.80
1949	24.31			2.25	-0.60	25.97
1950	32.75	6.39	2.64	2.23	4.13	48.14
1951	61.30	7.42	4.59	3.79	4.81	81.92
1952	72.32	10.35	6.63	4.29	-0.16	93.42
1953	72.60	10.87	8.81	4.50	0.86	97.64
1954	69.90	10.67	12.27	5.03	2.73	100.60
1955	83.65	11.25	14.25	6.38	3.63	119.16
1956	84.02	13.85	16.42	7.98	2.03	124.31
1957	82.85	17.77	24.56	8.70	1.77	135.66
1958	126.60	24.69	28.36	12.49	8.29	200.42
1959	173.20	31.08	34.91	18.71	11.74	269.64
1960	227.65	42.68	30.70	25.65	11.59	338.26
1961	381.91	52.43	48.10	38.70	3.10	524.24
1962	1,168.71	72.92	74.80	132.07	13.14	1,461.64
1963	2,700.41	198.66	263.00	300.28	13.43	3,475.78
1964	5,765.59	431.86	862.00	688.90	165.10	7,913.43
1965	20,702.45	1,041.32	1,586.70	3,529.75	451.22	27,311.45
1966	300.40	23.49	14.30	38.90	-0.94	376.15
1967	778.48	49.70	67.90	103.24	14.64	1,013.96
1968	1,754.25	108.78	177.90	219.74	101.28	2,361.95
1969	2,337.63	135.78	129.11	300.42	23.90	2,926.84
1970	2,669.80	207.18	313.13	371.43	38.64	3,600.18
1971	2,805.49	238.86	580.00	454.82	52.61	4,131.78
1972	3,362.54	276.00	857.00	604.24	92.47	5,192.26
1973	4,726.54	497.80	1,208.00	797.43	204.33	7,434.10
1974	7,147.51	470.32	1,797.00	1,094.37	1,535.79	12,044.98
1975	8,593.95	742.01	2,571.70	1,543.52	1,005.18	14,456.36

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Table A.13.2: GDP (expenditure approach) corrected for human capital in billion current rupiah in Indonesia, 1890-2000						
	Household consumption	Government consumption	Gross capital formation	Gross Human capital Formation	Exports-Imports	GDP
1976	10,235.06	900.03	3,204.90	1,607.25	207.50	16,154.75
1977	12,172.65	1,270.36	3,826.40	1,536.83	648.60	19,454.83
1978	14,819.87	1,665.74	4,670.70	1,612.63	231.90	23,000.84
1979	19,110.54	2,219.86	6,704.30	2,076.87	2,074.00	32,185.56
1980	27,026.90	2,492.45	9,485.20	3,009.71	3,769.40	45,783.67
1981	34,933.77	3,216.88	11,553.40	3,527.26	1,125.70	54,357.01
1982	40,909.64	4,166.22	13,467.10	3,732.16	-2,336.50	59,938.63
1983	43,889.89	4,645.37	21,668.40	4,344.40	-787.40	73,760.66
1984	50,394.25	5,120.51	22,176.70	5,594.05	4,357.70	87,643.21
1985	55,713.93	6,491.33	25,136.20	7,037.22	1,833.60	96,212.29
1986	62,028.12	6,734.13	28,888.20	9,406.77	-1,026.30	106,030.92
1987	70,419.58	6,253.74	37,491.02	10,256.23	1,918.50	126,339.07
1988	79,210.88	6,568.80	37,453.52	10,668.16	3,494.20	137,395.56
1989	86,669.18	8,523.72	46,318.96	10,983.38	3,904.00	156,399.24
1990	103,729.30	8,305.04	61,255.39	20,994.55	1,007.40	195,291.69
1991	121,649.66	11,030.78	65,880.06	29,746.49	888.10	229,195.08
1992	131,824.29	13,816.29	73,129.89	30,676.94	6,047.80	255,495.21
1993	153,183.88	16,873.83	82,003.36	34,303.31	7,389.60	293,753.98
1994	211,800.80	16,989.06	120,034.84	26,137.56	7,563.70	382,525.96
1995	269,214.08	20,733.49	145,056.33	31,108.93	-6,064.00	460,048.83
1996	320,036.92	21,807.35	164,181.80	39,971.98	-3,278.70	542,719.35
1997	373,878.66	19,027.50	190,189.36	49,663.93	-1,728.50	631,030.95
1998	626,694.69	13,969.23	233,981.93	70,882.37	93,186.70	1,038,714.91
1999	812,303.32	32,187.02	219,788.69	75,857.94	76,839.90	1,216,976.87

A.13.3 GDP figures including human capital formation for Japan, India, and Indonesia, 1890-2000 in 1990 Intl. USD.

These figures are estimated in the same way as is done for Indonesia in appendix A.13.2. However, the difference between these estimates for Indonesia and those from appendix A.13.2 is, besides that these are in constant 1990 intl. USD, that here we made use of the, more reliable, GDP estimates of Van der Eng (2002). Readers interested in the increase in GDP due to the inclusion of human capital formation are referred to table 7.8 in chapter 7.

Table A.13.3: GDP corrected for Gross Human Capital Formation in Japan, India, and Indonesia 1890-2000 in 1990 International USD, converted at PPP (millions)			
	Japan	India	Indonesia
1890		79,964.14	24,701.77
1891		82,583.29	25,355.06
1892		85,201.81	26,387.13
1893		88,131.25	27,155.35
1894		89,083.39	27,587.96

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Table A.13.3: GDP corrected for Gross Human Capital Formation in Japan, India, and Indonesia 1890-2000 in 1990 International USD, converted at PPP (millions)

	Japan	India	Indonesia
1895	50,963.03	88,989.51	28,123.50
1896	48,731.53	89,595.72	28,157.73
1897	50,074.58	91,587.67	28,696.67
1898	59,027.02	94,120.32	29,141.76
1899	55,436.95	95,917.43	30,873.02
1900	57,977.98	96,853.27	32,080.59
1901	60,270.06	99,903.22	31,704.65
1902	57,908.55	103,386.54	31,280.92
1903	61,907.90	101,614.73	33,036.67
1904	62,801.18	106,036.27	33,739.43
1905	62,351.84	107,327.89	34,270.64
1906	69,985.48	110,610.45	35,336.13
1907	72,361.42	114,894.35	36,181.10
1908	73,161.16	120,646.38	36,314.46
1909	73,463.65	133,188.34	38,197.81
1910	74,829.37	129,505.38	40,737.39
1911	78,660.57	131,179.59	43,001.12
1912	81,494.50	131,814.87	43,397.42
1913	83,014.99	134,568.98	45,755.95
1914	81,140.05	137,776.48	45,665.45
1915	87,770.65	142,597.00	46,255.17
1916	100,477.28	145,715.15	47,002.55
1917	103,184.85	142,418.47	47,186.15
1918	105,168.85	144,116.59	48,296.23
1919	115,124.97	139,936.47	52,118.19
1920	109,658.77	147,093.04	51,516.55
1921	120,448.43	149,268.35	51,972.83
1922	120,627.30	154,452.08	52,769.96
1923	120,866.86	155,771.11	53,610.56
1924	124,383.18	154,988.50	56,458.48
1925	129,260.69	157,495.88	58,392.76
1926	133,296.98	157,895.88	61,578.08
1927	135,452.98	161,246.53	65,798.50
1928	145,099.10	163,581.61	68,918.14
1929	149,161.85	167,377.75	70,844.07
1930	139,530.32	170,579.16	71,403.39
1931	140,062.15	172,899.89	66,078.88
1932	150,160.96	173,953.29	65,337.14
1933	162,654.18	175,591.09	64,927.11
1934	163,114.04	174,904.11	65,261.08
1935	166,791.91	175,406.47	67,585.88
1936	177,559.80	171,902.97	72,459.65
1937	185,446.65	169,246.48	79,452.44
1938	196,364.63	169,877.86	81,036.10
1939	225,701.12	170,761.57	81,882.66
1940	231,722.94	172,374.55	87,725.98
1941	236,592.91	174,225.10	90,391.94

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Table A.13.3: GDP corrected for Gross Human Capital Formation in Japan, India, and Indonesia 1890-2000 in 1990 International USD, converted at PPP (millions)

	Japan	India	Indonesia
1942	235,992.22	174,322.76	72,704.71
1943	229,940.04	177,147.47	59,031.48
1944	222,780.09	181,231.63	46,909.45
1945	120,845.68	185,700.77	41,673.92
1946	131,860.21	189,826.56	43,294.88
1947	141,012.44	192,682.78	49,955.14
1948	158,543.25	202,156.41	58,430.16
1949	167,931.48	216,232.63	63,771.21
1950	181,592.59	222,342.79	67,999.67
1951	201,985.36	236,821.36	72,832.31
1952	222,529.21	256,031.08	76,188.76
1953	237,436.02	262,329.67	79,925.97
1954	250,179.90	274,651.74	84,934.02
1955	270,670.14	285,277.40	87,179.87
1956	290,507.44	301,797.88	88,472.68
1957	310,597.74	300,036.50	94,351.00
1958	327,079.20	311,422.52	91,003.15
1959	354,749.53	317,919.62	95,259.41
1960	398,132.79	342,023.95	99,317.57
1961	443,053.59	355,718.77	106,030.59
1962	481,562.57	363,689.04	106,533.17
1963	523,272.45	382,287.41	102,542.37
1964	583,072.70	410,532.19	106,448.33
1965	616,233.75	398,226.79	108,665.18
1966	676,889.72	402,689.25	108,177.84
1967	746,556.19	434,713.15	105,776.66
1968	839,950.00	443,967.56	115,306.83
1969	940,980.77	475,597.09	129,407.80
1970	1,039,378.87	496,393.38	142,928.75
1971	1,085,959.40	497,899.57	151,354.69
1972	1,177,033.26	506,167.80	169,083.89
1973	1,271,535.02	534,966.50	192,730.08
1974	1,256,910.84	530,335.74	201,299.07
1975	1,294,794.92	572,600.41	202,327.81
1976	1,345,339.06	587,034.85	217,551.99
1977	1,402,013.57	625,368.83	232,594.28
1978	1,476,165.04	658,199.66	242,050.95
1979	1,556,862.01	631,416.15	254,586.32
1980	1,601,007.04	670,341.97	276,948.12
1981	1,654,083.62	715,185.13	295,810.26
1982	1,706,728.41	735,555.13	284,804.81
1983	1,749,962.17	804,971.95	295,458.74
1984	1,823,618.30	832,507.73	317,051.71
1985	1,905,710.71	869,819.52	326,778.21
1986	1,963,212.76	916,391.75	349,798.28
1987	2,048,568.87	949,825.66	365,447.97
1988	2,175,679.40	1,076,429.82	384,642.56

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Table A.13.3: GDP corrected for Gross Human Capital Formation in Japan, India, and Indonesia 1890-2000 in 1990 International USD, converted at PPP (millions)

	Japan	India	Indonesia
1989	2,280,928.80	1,148,279.40	417,003.22
1990	2,396,762.29	1,189,408.85	465,130.68
1991	2,469,924.85	1,183,394.71	497,299.92
1992	2,491,992.98	1,232,434.28	545,256.41
1993	2,499,377.68	1,300,925.80	580,154.57
1994	2,525,531.58	1,409,666.78	607,417.22
1995	2,560,483.84	1,524,148.50	657,679.44
1996	2,647,031.34	1,636,498.03	713,018.05
1997	2,691,819.50	1,704,380.12	746,864.27
1998	2,662,275.68	1,801,892.98	644,650.29
1999	2,676,887.67	1,907,249.35	649,026.85
2000	2,740,612.23	2,002,061.24	

Sources: Appendices A.2; A.7; A.8-A.10.

A.14. Correcting for the bias caused by using a dynamic model to estimate Lucasian growth (converting a dynamic model into a static model)

If we write the Lucasian production function in such way that it is empirically estimable, we end up with a regression of the growth of per capita GDP on the growth of per capita human capital at time *t*. However, many studies (ours included) replace the growth of human capital with its first lag ($\Delta ln\, h_{t-1}$) because of the endogeneity.

However, in the Lucas model we should have used variables at time *t*. Normally one would expect that the inclusion of time lags of the independent variables would not make much difference for the estimated coefficients. Indeed, this is what is done in much of the literature.[187] Unfortunately, in the specific Lucasian case there might be another problem which stems from the second sector (in which human capital is formed). When we use time lags, our regression may suffer from an omitted variable bias, which may create a bias in the human capital coefficient. To see this, take a regression with human capital (for simplicity without the imbalance effect and without a trend and constant as we used in chapter 7):

$$\Delta ln\, y_t = \beta_2 \Delta ln\, y_{t-1} + \beta_3\, ln\, y_{t-1} + \beta_4 \Delta ln\, h_{t-1} \qquad \text{(A.15.1)}$$

Rewriting this model gives:

$$ln\, y_t - ln\, y_{t-1} = \beta_2\, ln\, y_{t-1} - \beta_2\, ln\, y_{t-2} + \beta_3\, ln\, y_{t-1} + \beta_4\, ln\, h_{t-1} - \beta_4\, ln\, h_{t-2} \qquad \text{(A.15.2)}$$

Now, as we have seen in chapter 6, the accumulation of human capital, under the assumption of constant marginal returns, can be written as:

$$\Delta h_t = B_t \left(1 - u_t\right) h_{t-1} \qquad \text{(A.15.3)}$$

Or in levels:

$$h_t = \left[1 + B_t \left(1 - u_t\right)\right] h_{t-1} \qquad \text{(A.15.4)}$$

Now, we rewrite this in logarithm:

$$ln\, h_t = ln\left[1 + B_t \left(1 - u_t\right)\right] + ln\, h_{t-1} \qquad \text{(A.15.5)}$$

Now inserting this in equation A.15.2 gives:

$$ln\, y_t - ln\, y_{t-1} = \beta_2\, ln\, y_{t-1} - \beta_2\, ln\, y_{t-2} + \beta_3\, ln\, y_{t-1} + \beta_4\, ln\, h_{t-1} - \beta_4\, ln\, h_{t-2}$$

$$= \beta_2\, ln\, y_{t-1} - \beta_2\, ln\, y_{t-2} + \beta_3\, ln\, y_{t-1} + \beta_4\, ln\left[1 + B_{t-1}\left(1 - u_{t-1}\right)\right] + \beta_4\, ln\, h_{t-2} - \beta_4\, ln\left[1 + B_{t-2}\left(1 - u_{t-2}\right)\right]$$

$$-\beta_4\, ln\, h_{t-3}$$

That is:

[187] Sianesi and Van Reenen (2003) suggest that lags may solve the endogeneity problem. However, they remain sceptical.

$$\Delta ln\, y_t = \beta_2\, ln\, y_{t-1} - \beta_2\, ln\, y_{t-2} + \beta_3\, ln\, y_{t-1} + \beta_4 \Delta ln\, h_{t-1} =$$

$$= \beta_2 \Delta ln\, y_{t-1} + \beta_3\, ln\, y_{t-1} + \beta_4 \Delta ln\left[1 + B_{t-1}\left(1-u_{t-1}\right)\right] + \beta_4 \Delta ln\, h_{t-2} + \beta_5\, ln\left[1 + B_{t-2}\left(1-u_{t-2}\right)\right]$$

$$+\beta_5\, ln\, h_{t-2}$$

In above equation we can see that, when using the lag of the growth of human capital, in fact one omits $\beta_4 \Delta ln\left[1 + B_{t-1}\left(1-u_{t-1}\right)\right]$ from the equation. Therefore, although theoretically the effect of $\Delta \ln hc$ on per capita GDP growth (in the static model) can be written as $1+\gamma$, where γ is the external effect of the growth of the per capita stock of human capital (see chapter 2) now part of $1+\gamma$ cannot be estimated. Admittedly, this problem is likely to be more serious for the log-level of human capital than for the growth of human capital because the time lags of *u* and *B* are stronger correlated in the latter case. Indeed, doing a preliminary test with the log-level of human capital and the growth of human capital side by side in an equation showed that this was indeed the case. This is in itself interesting because the omission of $\beta_4 \Delta ln\left[1 + B_{t-1}\left(1-u_{t-1}\right)\right]$ would only be a problem if *B* and/or *u* are not constant which is what we argued in chapter 6. Nevertheless, in both cases there is an effect. Now, if we refer to the estimated biased coefficient as β_4, than by correcting for the bias we can calculate $1+\gamma$ as:

$$\beta_4 = \frac{\Delta ln\left[1 + B_{t-1}\left(1-u_{t-1}\right)\right]}{\Delta ln\, h_{t-2}}\left(1+\gamma\right) + \left(1+\gamma\right) \qquad \text{(A.15.8)}$$

Rewriting gives:

$$\left(1+\gamma\right) = \beta_4 \cdot \left[1 + \frac{\Delta ln\left[1 + B_{t-1}\left(1-u_{t-1}\right)\right]}{\Delta ln\, h_{t-2}}\right]^{-1} \qquad \text{(A.15.9)}$$

Equation A.15.9 offers a way to correct the coefficient of the growth and the level of human capital for the use of one time lag. But how can we empirically estimate these equations? We first have to correct for the omission of B*(1-u), as indicated in equation A.15.6. This can easily be achieved. We rewrite the equation (A.15.3):

$$\dot{h}_t = B_t\left(1-u_t\right)h_{t-1} - \delta h_{t-1} \qquad \text{(A.15.12)}$$

However, as we have the gross fixed human capital formation (the increase in the stock, while ignoring the depreciation) we can also write:

$$GFHCF_t = B_t\left(1-u_t\right)h_{t-1} \qquad \text{(A.15.13)}$$

, or $GFHCF_t / h_{t-1} = B_t \left(1 - u_t\right)$. In other words, dividing the gross fixed human capital investment in year *t* by the human capital stock in year *t-1*, gives $B_t\left(1 - u_t\right)$ which we need in order to correct the coefficient of $\Delta \ln h_{t-1}$ for it to capture the effect of $\Delta \ln h_t$ on $\Delta \ln y_t$ (see equation A.15.9).

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Summary

After World War II at the height of decolonization, the analysis of the underlying process of economic growth became a topic of high priority. The neo-classical, Solowian, growth theory, with all its limitations, was embraced by economists and historians alike, resulting in countless growth accounting studies and further research into country-specific institutional developments. Later, however, especially with the introduction of new growth theories, economics and other social sciences have drifted somewhat apart. Economics preserved its focus on both the theory and empirics of economic growth, while the focus on country-specific institutional development remained largely absent. This practice, however, set a limit to the possibilities to apply new growth theories to the real-world economic development. Also, given its strong relationship with the Solowian growth theory, it is not surprising that even within economics one may encounter the view that the new growth theories have nothing new to offer after all.

Before drawing such a premature conclusion, however, it is advisable to establish a link among new growth theories and History in order to find out whether the latter offers new insights into the root of differences in economic performance. This thesis focuses on three Asian countries, a successful (Japan) and two less successful economic developers (India and Indonesia). Our main question is whether the new growth theories can explain why Japan was successful in economic development relative to India and Indonesia.

One reason why new growth theory is still in limited use in historical research is its focus on complicated equations. Yet, its message is actually quite simple. Our argument is that the main difference between the Lucasian and Romerian models rests on whether a country is at the technological frontier. If this is the case, it cannot adopt technologies from outside and, therefore, technology must be endogenously generated. In those countries, a part of human capital will be used to create new technologies and a part to use these technologies in the productive process (Romerian growth). In the follower countries, however, technologies can be adopted from other countries. Hence, human capital is used solely to apply these technologies in the productive process (Lucasian growth). This line of thinking leads to the hypothesis that when human capital passes a

certain threshold level (a country arrives at the technological frontier), a switch is made to Romerian growth. In both models, however, human capital is the crucial variable.

As mentioned above, many economic studies so far have mostly focussed on the development of the theory itself and the empirical testing. However, this came at the cost of understanding country-specific aspects. In addition, often even the choice of human capital variable used in these analyses is not explained. Our focus is thus mainly on the latter two issues although we will address the first two as well as far as they show how the choice of human capital variable and the institutional analysis may change the use of growth theory and its application in empirical analysis.

The first question when analysing the explanatory power of the new growth theories is what human capital actually is. In chapter 2 we discussed some of the more common human capital variables. However, the most often used human capital proxy ‘average years of schooling in the population’ only captures the quantity of human capital. Hence, each extra year of schooling is valued as if it had the same effect. Still, bearing in mind that an increase from say 10 to 11 years of schooling is more costly than from 2 to 3 years, it is likely that one will find decreasing marginal returns to human capital accumulation. If one allows an increase in the quality of human capital over time in the model, however, the often debated constant marginal return assumption of Lucas becomes more realistic. ‘Average years of education’ may also be an unfortunate choice as a human capital proxy since it enters into the second, human capital producing, sector of the Lucas model as an input. As a result, by inserting the level and the change of ‘average years of schooling’ in a growth regression, one can test the Lucasian theory of growth, but not the model of Romer. Therefore, it is preferable to use alternative human capital measures including both the quantitative and qualitative aspects of human capital.

The second question that is important for analyzing the relationship between human capital and economic growth relates to institutions. In chapter 4 we conclude that the differences among India, Indonesia, and Japan in human capital formation can be traced back to the construction of their education systems. In Japan, as in most Western countries, the education system arose in the late eighteenth and early nineteenth century from the need for economic development and was responsive to the special characteristics of the respective societies. In India and Indonesia, on the other hand, similarly to most developing economies, it were largely ideas of ‘creating an indigenous class of literati’, a ‘moral duty of the colonizer country’, nationalism, and, after World War II, the ‘idea of progress by education’, ‘lack of finances’, and ‘policies of international organisations’ that drove educational development. In other words, the education systems of India and Indonesia were influenced by global, or at least external, factors.

These institutional developments resulted in two major differences between, on the one hand, India and Indonesia, and, on the other hand, Japan. First, in all three countries the level of education steadily increased over time. Since most of the literature suggests the human capital coefficients in growth regressions to differ by the levels of education, this means that the pattern of the human capital coefficients over time is the same in all three countries. Second, because the Japanese education system developed naturally from an internal, societal, demand, the process of increasing formal education started earlier and was more efficient. This means that 1) the breakpoints in the human capital coefficient in Japan precede those in India and Indonesia, and 2) because of the higher efficiency, the human capital coefficient of Japan was higher than that of India and Indonesia.

The third question, which is often the subject of debate in the economic literature, concerns the application of the theories of economic growth. Before trying to estimate a final model, it is crucial to determine which model is applicable. Given our newly estimated human capital variable, we find Lucasian growth in India and Indonesia while in Japan it is only present in the first half of the twentieth century. As we just argued that Romerian growth is characteristic of technological frontier countries, it is not surprising that we found Romerian growth in Japan in the second half of the twentieth century.

Only in fourth instance we arrive at the actual regressions in chapter 7. These regressions now offer us the possibility not only to find but also to identify the breakpoints in the human capital coefficients as corresponding to the institutional development in formal education. In addition, they show that economic growth is largely Lucasian (except for Japan in the second half of the twentieth century). Also we find that an imbalance effect seems present during Lucasian growth. These results do not change if we correct for inclusion of physical capital. It also shows that, under rather strict circumstances, physical capital can be left out of the regression.

Discussing these four questions shows that new growth theory cannot be disregarded that easily for analysing economic divergence. However, to explain why Japan was a successful developer while India and Indonesia were not, it is important to add two extra elements. First, one needs to use a series that reflects all aspects of human capital that are also crucial in these theories. If one wants to test whether there are constant marginal returns to human capital accumulation, excluding the quality of human capital (which might be an important source of constant marginal returns) will bias your findings. Second, it is crucial to keep account of the institutional developments both between countries and over time. They are not only necessary for a sound economic interpretation of any regression results, but also may hint which variables to include in a regression between human capital and growth. Applying these four steps to the countries in our study shows that human capital can explain from around 80% of the economic divergence in the first half of the century to around 30% in the second half.

Samenvatting

Het hoogtepunt van de dekolonisatiegolf na de Tweede Wereldoorlog leidde ertoe dat de analyse van de onderliggende processen van economische groei hoog op de agenda kwam te staan. Dit resulteerde in een neoklassieke, Soloviaanse, groeitheorie die, met al zijn beperkingen, door zowel economen als historici werd omarmd. Dit leidde zowel tot een groot aantal growth accounting studies als tot studies naar landenspecifieke institutionele ontwikkelingen. Echter, vooral sinds de introductie van de nieuwe groeitheorie in de jaren ’80, zijn de economie en de overige sociale wetenschappen enigszins uit elkaar gegroeid. Dit leidde binnen de economische discipline tot een focus op theorie en empirie terwijl de landenspecifieke institutionele ontwikkeling vrijwel geheel afwezig was. Dit beperkte de mogelijkheden om de, hoofdzakelijk theoretische, nieuwe groeitheorieën toe te passen op praktische economische ontwikkeling. Mede vanwege hun sterke relatie met de neoklassieke groeitheorie is het niet verrassend dat zelfs binnen de economische

discipline soms het argument naar voren wordt gebracht dat de nieuwe groeitheorieën niets nieuws te bieden hebben.

Voordat een dergelijke conclusie getrokken kan worden is het belangrijk om de nieuwe groeitheorie beter te laten aansluiten bij de geschiedschrijving om op deze manier te analyseren of de historische discipline nieuwe inzichten kan bieden in de wortels van economische divergentie. Dit proefschrift richt zich op drie Aziatische landen waarvan één land (Japan) een succesvolle en twee (India en Indonesië) een minder succesvolle economische ontwikkeling doormaakten. Onze hoofdvraag is of de nieuwe groeitheorieën kunnen verklaren waarom Japan een relatief succesvolle economische ontwikkeling kende in vergelijking met India en Indonesië.

Een mogelijke reden waarom de nieuwe groeitheorieën nog steeds weinig in historisch onderzoek worden toegepast is hun focus op gecompliceerde mathematische vergelijkingen. Hun eigenlijke boodschap is echter vrij eenvoudig. Het belangrijkste verschil tussen de twee groepen binnen de nieuwe groeitheorieën berust op de vraag of een land voorop loopt in technologische ontwikkeling. In een dergelijk geval kan een land geen technologieën overnemen van andere landen. Daarom moet verdere technologische ontwikkeling endogeen gegenereerd worden. In dergelijke landen zal een gedeelte van het menselijk kapitaal ingezet worden om nieuwe technologieën te creëren en een gedeelte om deze technologieën toe te passen in het productieproces (Romeriaanse groei). Als een land niet op de technologische grens zit dan zal het technologieën kopiëren van andere landen. In dat geval wordt menselijk kapitaal uitsluitend gebruikt om deze technologieën toe te passen in het productieproces (Lucasiaanse groei). Dit betekent in de praktijk dat als menselijk kapitaal een zekere drempelwaarde overschrijdt, Lucasiaanse groei wordt vervangen door Romeriaanse omdat dat land nu aan de technologische grens is gekomen. In beide modellen is menselijk kapitaal dus de cruciale variabele.

Zoals opgemerkt, de focus in de meeste economische studies is tot dusverre gericht op de theorie zelf en op het empirisch testen daarvan. Dit is echter ten koste gegaan van de landenspecifieke aspecten. Bovendien wordt vaak zelfs de keuze van de menselijk kapitaal variabele in deze studies niet verklaard. De nadruk zal dus liggen op deze laatste twee aspecten, ofschoon we ook de eerste twee kwesties zullen behandelen in zoverre als dezen beïnvloed worden door de keuze van de menselijk kapitaal variabele en de landenspecifieke institutionele analyse.

De eerste vraag die van belang is bij het analyseren van de verklarende kracht van de nieuwe groeitheorieën is wat menselijk kapitaal eigenlijk is. In hoofdstuk twee behandelen we sommige van de gebruikelijkere menselijk kapitaal variabelen. Echter, de meest gebruikte menselijk kapitaal proxy, 'gemiddeld aantal jaren scholing in de totale bevolking', geeft slechts een indicatie van de kwantiteit en niet van de kwaliteit van menselijk kapitaal. Dit betekent dat elk extra jaar scholing op dezelfde manier wordt gewaardeerd. Omdat een stijging in aantal jaren scholing van 10 naar 11 jaar duurder is dan van 2 naar 3 jaar, is het aannemelijk dat, met deze proxy, afnemende meeropbrengsten in menselijk kapitaal accumulatie gevonden zal worden. Als men echter de toename van de kwaliteit van scholing over tijd opneemt in de variabele, dan zijn constante meeropbrengsten (en dus Lucasiaanse groei) waarschijnlijker. 'Gemiddeld aantal jaren onderwijs' is ook een ongelukkige keuze als menselijk kapitaal proxy in de nieuwe groeitheorieën omdat het ook gebruikt kan worden als een input in de Lucasiaanse tweede sector (waar menselijk kapitaal wordt gevormd). In dat geval zal het gebruik van het niveau van 'gemiddeld aantal jaren onderwijs' in regressies niet leiden tot het testen van Romeriaanse groei (die afhangt van het niveau van menselijk kapitaal) maar van Lucasiaanse groei (die afhangt van de groei van menselijk kapitaal).

De tweede vraag die belangrijk is voor de analyse van de relatie tussen menselijk kapitaal en economische groei heeft betrekking op institutionele ontwikkeling. Dit kan een effect hebben op de landenspecifieke schattingen van de relatie tussen menselijk kapitaal en economische groei, omdat efficiëntere instituties ertoe kunnen leiden dat een zelfde toename van het menselijk kapitaal een groter effect heeft op groei. Hoofdstuk 4 geeft aan dat het verschil in menselijk kapitaal accumulatie tussen India, Indonesië en Japan teruggevoerd kan worden op de constructie van hun onderwijssystemen. In Japan, net zoals in de meeste Westerse landen, ontwikkelde het moderne onderwijssysteem aan het einde van de achttiende en het begin van de negentiende eeuw vanuit een maatschappelijke en economische vraag. Dit betekent dat scholing steeds belangrijker werd voor economische ontwikkeling. In India en Indonesië, net als in de meeste ontwikkelingslanden, waren het vooral de ideeën van 'de creatie van een klasse van inheemse literati', een 'morele plicht van het moederland', nationalisme en, na de Tweede Wereldoorlog, het 'idee van economische groei door scholing van de bevolking', 'tekort aan financiën om het onderwijsstelsel ingrijpend te veranderen', en 'het beleid van internationale organisaties' die hun onderwijsontwikkeling bepaalden. Met andere woorden, het waren vaak globale, of althans externe, factoren die de onderwijssystemen van India en Indonesië beïnvloedden.

Deze institutionele ontwikkelingen verschilden op twee manieren tussen, aan de ene kant, India en Indonesië, en, aan de andere kant, Japan, hetgeen wordt weerspiegeld in de veranderingen van de menselijk kapitaal coëfficiënten over tijd en tussen deze landen. Een eerste punt is dat India en Indonesië het Japanse patroon van een toenemende participatie in primair onderwijs naar een toenemende participatie in secondair, en ten slotte hoger onderwijs volgden. Omdat in de literatuur wordt gesteld dat het effect van menselijk kapitaal op economische groei verschilt per onderwijsniveau, betekent dit dat het patroon van toe- en afnemende menselijk kapitaal coëfficiënten hetzelfde is in de drie de landen. Een tweede punt is dat, omdat het onderwijssysteem in Japan een natuurlijke ontwikkeling kende vanuit haar eigen maatschappij, het proces van de groei in formeel onderwijs niet alleen efficiënter was maar ook eerder startte. Dit betekent dat 1) de breekpunten in de menselijk kapitaal coëfficiënt in Japan eerder plaatsvinden dan in India en Indonesië, en 2) vanwege de hogere efficiëntie in Japan de menselijk kapitaal coëfficiënt daar hoger was.

De derde vraag, die vaak aan de orde komt in de economische literatuur, heeft betrekking op de toepassing van de groeitheorieën. Voordat iemand empirisch het effect van menslijk kapitaal probeert te bepalen, is het cruciaal om het toe te passen model te bepalen. Met behulp van onze alternatieve schatting van menselijk kapitaal vinden we Lucasiaanse groei in India en Indonesië terwijl dit in Japan alleen in de eerste helft van de twintigste eeuw het geval is. Omdat we zojuist hebben gesteld dat Romeriaanse groei karakteristiek is voor landen die op de technologische grens zitten, is het niet verrassend dat we Romeriaanse groei vinden in Japan in de tweede helft van de twintigste eeuw.

Pas in de vierde vraag komen we aan bij de daadwerkelijke empirische analyse. De regressies in hoofdstuk 7 bieden nu de mogelijk om niet alleen de breekpunten in de menselijk kapitaal coëfficiënten te vinden, maar ook om deze te identificeren als corresponderend met de institutionele ontwikkeling van formeel onderwijs zoals geschetst in hoofdstuk 4. Bovendien bevestigen deze regressies dat de economische groei voornamelijk Lucasiaans was (met uitzondering van Japan in de tweede helft van de twintigste eeuw). Tevens vinden we een imbalance effect in fases van Lucasiaanse groei. Deze resultaten veranderen niet als we de groei van fysiek kapitaal in de regressie invoegen. Het geeft ook aan dat, onder strikte omstandigheden, fysiek kapitaal uit de regressies weg kan worden gelaten.

Het behandelen van deze vier vragen geeft aan dat de nieuwe groeitheorieën niet zonder meer verworpen kunnen worden als een instrument voor het analyseren van economische divergentie. Om te kunnen verklaren waarom Japan een relatief succesvolle economische ontwikkeling doormaakte in vergelijking met India en Indonesië moeten, naast de theoretische en empirische analyses die nu de economie domineren, twee extra elementen in de analyse worden meegenomen. Ten eerste is het van belang om een variabele te gebruiken die een indicatie is van alle aspecten van het menselijk kapitaal die van belang zijn voor de groeitheorieën. Als men wil testen of er constante meeropbrengsten zijn, dan zal het gebruik van een variabele die de kwaliteit van menselijk kapitaal (hetgeen een belangrijke bron van constante meeropbrengsten kan zijn) niet oppikt leiden een afwijking in de resultaten. Ten tweede is het belangrijk om de institutionele effecten zowel over tijd als tussen landen mee te nemen. Deze zijn niet alleen belangrijk voor een degelijke interpretatie van de resultaten van de regressie maar kunnen tevens een aanwijzing zijn voor welke variabelen in de regressie moeten worden ingebracht. Als we dit toepassen op de landen uit deze studie dan vinden we dat menselijk kapitaal ongeveer 80% van de economische divergentie verklaart in de eerste helft en 30% in de tweede helft van de twintigste eeuw.