

2 The long view on economic growth: New estimates of GDP

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GDP estimates form the backbone of our understanding of economic change in the past and the present. This chapter presents and discusses the results of an update of the Maddison Project, which aimed to incorporate the results of the 2011 round of the International Comparison Programme (ICP), and of the efforts of many scholars who have extended and deepened the work on historical national accounts. A method is presented to test the reliability of various approaches to back-project historical time series of GDP, and it is concluded that Maddison's 1990 benchmark still produces the most plausible results. The implications for this for the growth of the world economy since 1820 are discussed.

Introduction

This chapter presents long-term trends in GDP per capita in a global perspective. GDP per capita is both an important indicator for measuring the economic performance of countries and a crucial driver of economic well-being. In this chapter, we build on the work by Angus Maddison and the Maddison Project, and add to the existing work in two ways. First, we include all the new historical national account estimates that have become available since the publication of *How Was Life?* in 2014 (van Zanden et al.^[1]). Second, we explore the consequences of using alternative measures of relative price levels for reconstructing the shape of long-run GDP growth at the global level, developing a way to assess the biases associated with the different alternatives. Finally, we present and discuss the global trends in GDP per capita since 1820 using all the new historical estimates that are currently available. As will become clear, using an alternative set of relative prices for reconstructing historical series of GDP per capita has important implications for our understanding of long-run economic development. This justifies a more in-depth discussion of relative price estimates and an analysis of the consequences of using different relative price estimates. In doing so, the structure of this chapter deviates slightly from that of the other chapters in this volume.

In order to compare GDP per capita levels both across countries and over time, it is necessary, first, to express all countries' GDP estimates in a common currency and, second, to take into account the differences in price levels and structures between countries. The original Maddison and Maddison Project series are based on a single set of cross-country comparisons of relative income levels in 1990 using 1990 Purchasing Power Parities (PPPs). These relative income levels are then projected forwards and backwards using historical data on the real growth of GDP per capita. Since then, newer and arguably better Purchasing Power Parity (PPP) benchmarks have become available, most specifically the 2011 benchmark (Deaton, 2011^[2]). In this chapter, we compare historical GDP per capita estimates based on these 2011 PPPs with estimates of relative levels of GDP per capita in the period before 1940 based on the "traditional" Maddison approach, which makes use of 1990 PPPs. Further, we compare these results with a third approach, building on the estimates provided by the Penn World Tables (2011^[3]) for the period from 1950 to the present, linking the historic (pre-1950) time series to the PWT estimates for that year. By comparing these three approaches with independent benchmarks of relative levels of GDP per capita for groups of countries in the 19th and early 20th century, we can get an idea of the biases involved in the three approaches, and of the consequences of using alternative relative prices for our understanding of long-run global development.

The focus of this chapter is on the consequences of using alternative measures of relative prices for measuring per capita GDP for the years before 1950. We test various ways of back-projecting historical estimates of GDP per capita against a dataset of independent benchmark estimates of relative levels of GDP per capita for the period before 1940. We find that simply moving from the 1990 to the 2011 PPP benchmark does not improve GDP estimates for the historical period, probably due to the greater distance between 2011 and the historical benchmark estimates in the dataset. The PWT approach, which uses all post-1950 PPP benchmark estimates, does not suffer from this bias but does result in a rather high share of countries with below-subsistence levels of GDP per capita in the earlier years, which is also problematic. We conclude that the 1990 benchmark created by Maddison is probably the best compromise solution for historical analysis, in particular when used in combination with the 2011 PPPs for the post-1990 period and with the various historical benchmark estimates of relative levels of GDP that are available in the literature. We propose such a hybrid dataset as the best way to use the available information on long-term economic growth and relative levels of GDP per capita. Moreover, the estimates presented here are used in the other chapters to analyse the correlation between the other variables presented and GDP per capita, and the underlying nominal values are, for example, used to estimate the share of social transfers in GDP in Chapter 4.

Description of the concepts used

This chapter centres on Gross Domestic Product (GDP) per head of the population for understanding long-term trends in economic well-being. We also include a discussion of prices between countries, as both the structure of relative prices and the absolute level of prices are correlated with levels of economic development. On average, price levels are higher in more developed countries. If these differences are not taken into account when comparing GDP levels between countries, the output and incomes of developed countries are overestimated and those of developing countries are underestimated. Finally, we include a short discussion of historical comparisons of relative income. These direct estimates of past relative income levels between countries provide benchmarks against which we can compare our GDP per capita series to get an idea of which relative price levels produce the most consistent historical income series for a global set of countries.

Gross Domestic Product per capita

There are three basic ways to measure a country's GDP: as the total income earned by residents in a country, as the sum total of final expenditures and as the total output of goods and services produced in a country.¹

The Income approach to measuring GDP

The income approach to measuring a country's GDP sums the total income earned by all households and firms within a country in a given year. This includes incomes received by residents as wages, rents, profits and interest incomes. Due to the limits of historical information, no adjustments are generally made to account for income flows accruing to residents from abroad or for income from domestic production paid abroad.

The Expenditure approach to measuring GDP

The expenditure approach to GDP sums up the total value of all domestic expenditures made on final goods and services within a country in a given year. This includes consumption expenditure, government expenditure, investment expenditure and net exports. The expenditures made on final goods and services equal the incomes received as wages, rents, interest incomes and profits.

The Production approach to measuring GDP

The final method of determining GDP sums the value-added generated from the production of goods and services within a country in a given year. This method, also known as the Value-added method or the Net Product method, is based on the production of all sectors in the economy and involves three steps. First, the gross value of output is estimated for all sectors. Second, the intermediate consumption for each sector, such as the cost of intermediate inputs used in the production of final output, is derived. Third, net production is determined by deducting the intermediate consumption from the total gross output.

The construction of historical national accounts relies on all three methods discussed above and combines various pieces of information to obtain a GDP per capita measure.² Comparing GDP per capita levels both across countries and over time requires first that the data are expressed in a common currency, and second that differences in price levels and structures between countries are taken into account.

Relative prices

Price differences between countries are important as, generally, price levels are correlated with levels of economic development. This means that on average prices are higher in more developed countries, so

that any currency can buy less of the same good in a developed country than in a developing country. As the trading of goods makes prices converge between countries, the price differences between developing and developed countries are typically largest for non-traded goods such as domestic transport, housing and many services. If these differences are not taken into account when comparing GDP levels between countries, the incomes of developed countries are overestimated, and those of developing countries are underestimated.

The original Maddison data are expressed in 1990 constant prices (Maddison, 2003^[4]). In other words, a benchmark year PPP is estimated for the year 1990, which is used to compute GDP levels for all countries for that year. From this benchmark year, the GDP per capita series for all countries are extrapolated (backward and forward) by using volume growth rates of GDP for the countries included in the set. In practice, Maddison could not always use PPPs based on 1990 relative prices, because many countries were not covered by the PPP exercise in 1990. To circumvent this problem, he used information from earlier rounds of the International Comparison Programme (ICP) of the World Bank, or he used estimates from the PWT or other proxies (Maddison, 2006^[5], p. 610. In his final set of estimates (Maddison, 2006^[6]), data for 43 countries (representing almost 80% of world GDP at the time) were based on ICP or ICP-equivalent estimates; those for the other 113 countries (“non-sample”) were based on PPPs from the Penn World Tables (2011^[3]) and on proxy estimates. The PWT PPPs were, in turn, estimated by Summers and Heston (1991^[6]) based on cost-of-living estimates for expatriates and foreign diplomats.

Since 1990, however, there have been multiple ICP rounds, which have resulted in more up-to-date and, especially in the case of the 2011 round, more accurate estimates of relative and absolute prices for a common basket of goods and services. One of the aims of this chapter is to explore whether these more up-to-date PPP benchmarks also lead to improved long-run comparisons of per capita GDP.

Finally, the most recent version of the Penn World Tables uses a new methodology that no longer relies on a single PPP benchmark but instead integrates all the official ICP PPP benchmarks that have become available since 1950 (Feenstra, Inklaar and Timmer, 2015^[7]). For example, for 1980 the methodology takes as the “best” estimate of PPP the value from the ICP round for 1980, while for 2005 it relies on PPPs from the ICP round of 2005. Income estimates of different countries in a common currency for 1980 and 2005 are then generated based on these two sets of price data.³ The GDP per capita series are subsequently tied to these relative income levels. An advantage of this approach is that it takes into account the relative price changes between the different benchmark years. The major disadvantage is that the growth rate of GDP per capita between two benchmarks is determined not only by the national accounts statistics of the country involved, but also by the differences between the PPPs of earlier and later years. Moreover, this methodology assumes that all ICP rounds are correct, which may be problematic, especially for the earlier ones. In this chapter, we explore the implications of using all available PPPs for constructing long-term GDP series, and analyse how this approach compares to the GDP per capita series based on a single benchmark PPP, e.g. the 1990 or the 2011 PPP rounds.

Historical GDP Benchmarks

Benchmark studies in this field essentially examine the ratios of incomes or output between two or more countries in the past. For each country in the comparison, the performance of the economy is measured in a consistent way for a given year, making it possible to compare levels of GDP per capita across countries for that year (for example, a benchmark study may compare GDP per capita in Germany, the United Kingdom and the United States for 1913). We collected the available benchmark studies for the pre-1940 period (the post-1950 benchmarks are already available in the PWT) and used them to anchor the estimates of GDP per capita, which were based on back-projections of the 1990 (Maddison, 2003^[4]; Maddison, 2006^[5]; Maddison, 2007^[8]) or 2011 benchmarks.

Historical sources and data quality

The basis for the GDP per capita series presented in this chapter is the same as for the *How Was Life?* report, i.e. sourced directly from the Maddison Project (Bolt and van Zanden, 2020^[9]). The present dataset additionally includes all new historical estimates that have become available since then, as well as estimates for the most recent years up until 2016. The underlying historical sources for this overview are the following. For the recent period, national statistical agencies produce estimates of GDP and its components that are harmonised and standardised by various international organisations (OECD, United Nations, World Bank), which then feed in secondary datasets such as the Penn World Tables⁴ and the Maddison dataset. The PPPs used to convert GDP measures (expressed in current prices of a particular country) into an international standard are derived from the ICP programme organised by the World Bank.⁵ Historical studies covering the period before 1950 (or before 1913, since some statistical agencies have done work on the first half of the 20th century as well) use a large variety of sources to reconstruct the development of national income and product. This includes labour force and production censuses, tax records, data on international trade, wage and price data from different sources, etc.

In general, the accuracy of GDP estimates decreases going back in time with the declining availability of modern statistical sources. But, as explained earlier, historians use a broad range of sources (on the total output of the economy, total expenditures and total income earned) as pieces in a large jigsaw puzzle: historians almost never have all the pieces, but quite often they have enough to get a good picture of the economy concerned.

For the recent period, the most important new work included in the dataset is Harry Wu's reconstruction of Chinese economic growth since 1950, which produces state-of-the-art estimates of GDP and its components for this country (Wu, 2014^[10]). Given the large role that China plays in any reconstruction of global economic development, this is a major addition to the dataset. Moreover, as we shall see below, these revised estimates of GDP growth are in general lower than the official estimates produced by the Chinese Statistical Office. Lower GDP growth between 1952 and the present, however, substantially increases the estimates of the absolute level of Chinese GDP in the 1950s (given the fact that their absolute level is determined by a benchmark in 1990 or 2011) (see also Figure 2.3). We will revert to this point below.

Most of the other additions to the Maddison Project dataset relate to the period before 1914 (Table 2.1). Again, important new work has been done for China, in particular by Broadberry, Guan and Li (2018^[11]) and Xu et al. (2016^[12]). It is reassuring that these two independent teams of scholars who set out to quantify Chinese economic growth before 1900 produced very similar estimates, showing a strong decline (by about one-third) of GDP per capita in the 18th century and quasi-stability in the 19th century.

As is clear from this overview, historical research – in particular work on the early modern period (1500–1800) – is producing new time series of per capita GDP, often making use of indirect methods to estimate its long-term development. The “model” for making such estimates – based on the links between real wages, the demand for foodstuffs and agricultural output, as developed by Malanima (2011^[13]), (Álvarez-Nogal and De La Escosura (2013^[14]) and others – has now also been applied to Poland (Malinowski and van Zanden, 2017^[15]), Spanish America (Arroyo and van Zanden, 2016^[16]) and France (Ridolfi, 2016^[17]). A detailed overview of these new estimates is provided by Bolt and van Zanden (2020^[9]).

Table 2.1. New GDP estimates integrated into the Maddison Project Database

	Country	Period	Source
Latin America	Bolivia	1846-1950	Herranz-Loncán and Peres-Cajías (2016 _[18])
	Brazil	1850-1899	Barro and Ursua (2008 _[19])
	Chile	1810-2004	Díaz, Lüders and Wagner (2007 _[20])
	Cuba	1902-1958	Ward and Devereux (2012 _[21])
	Cuba	1690-1895	Santamaria Garcia (2005 _[22])
	Mexico	1550-1812	Arroyo and van Zanden (2016 _[16])
	Mexico	1812-1870	Prados de la Escosura (2009 _[23])
	Mexico	1870-1895	Bértola and Ocampo (2012 _[24])
	Mexico	1895-2003	Barro and Ursua (2008 _[19])
	Panama	1906-1945	De Corso and Kalmanovitz (2016 _[25])
	Peru	1600-1812	Arroyo and van Zanden (2016 _[16])
	Peru	1812-1870	Seminario (2015 _[26])
	Uruguay	1870-2014	Bértola (2016 _[27])
Venezuela	1830-2012	De Corso (2013 _[28])	
Europe	England	1252-1870	Broadberry et al. (2015 _[29])
	Finland	1600-1860	Eloranta, Voutilainen and Nummela (2016 _[30])
	France	1250-1800	Ridolfi (2016 _[17])
	Holland	1348-1807	van Zanden and van Leeuwen (2012 _[31])
	Italy (north)	1310-1871	Malanima (2011 _[13])
	Norway	1820-1930	Grytten (2015 _[32])
	Poland	1409-1913	Malinowski and van Zanden (2017 _[15])
	Portugal	1530-1850	Palma and Reis (2019 _[33])
	Romania	1862-1995	Axenciuc (2012 _[34])
	Spain	1850-2016	Prados de la Escosura (2017 _[35])
	Sweden	1300-1560	Krantz (2017 _[36])
	Sweden	1560-1950	Schön and Krantz (2015 _[37])
	Switzerland	1850-2011	Stohr (2016 _[38])
United Kingdom	1700-1870	Broadberry et al. (2015 _[29])	
Asia	People's Republic of China	1952-2008	Wu (2014 _[10])
	People's Republic of China	1661-1933	Xu et al. (2016 _[12]); Broadberry, Guan and Li (2018 _[11])
	India	1600-1870	Broadberry, Custodis and Gupta (2015 _[39])
	Japan	724-1874	Bassino et al. (2018 _[40])
	Japan	1874-1940	Fukao et al. (2015 _[41])
	Korea, Republic of	1911-1990	Cha et al. (2020 _[42])
	Korea, DRP of	1911-1940; 1990-2015	Cha et al. (2020 _[42])
	Malaysia	1900-1939	Nazrin (2016 _[43])
	Turkey	1500-1820	Pamuk (2009 _[44])
Singapore	1900-1959	Sugimoto (2011 _[45])	
Middle East	Syria	1820, 1870, 1913, 1950	Pamuk (2006 _[46])
	Lebanon	1820, 1870, 1913, 1950	Pamuk (2006 _[46])
	Jordan	1820, 1870, 1913, 1950	Pamuk (2006 _[46])
	Egypt	1820, 1870, 1913, 1950	Pamuk (2006 _[46])
	Saudi Arabia	1820, 1870, 1913, 1950	Pamuk (2006 _[46])
	Iraq	1820, 1870, 1913, 1950	Pamuk (2006 _[46])
	Iran	1820, 1870, 1913, 1950	Pamuk (2006 _[46])
Africa	Cape Colony/ South Africa	1700-1900	Fourie and van Zanden (2013 _[47])

The quality of the National Accounts estimates made by official statistical agencies is in general high (Table 2.2). However, some problems do remain even for the most recent period. Regular revisions of GDP estimates by these agencies – the result of new information and/or revisions of the internationally

accepted System of National Accounts (SNA) – sometimes result in breaks in historical time series that limit comparison in time and space. The quality of the official GDP statistics, in turn, is related to the quality of censuses and, more generally, to the capacity of the state to register and “monitor” the population and its economic activities. In particular new, relatively weak states may be unable to produce state-of-the-art estimates of national accounts, or may have an incentive to underestimate their economic performance, for example, to qualify for certain forms of international aid.

Moreover, as will be discussed below, international comparisons are constrained by the limitations of the PPP approach and of the various ICP rounds. Modern statistical work in this field began on a global scale in the 1950s. Almost all estimates for the period before the 1940s are the result of historical research in this area, which began in earnest in the 1950s. The classification of the quality of the historical GDP estimates presented in Table 2.2 is subjective, based on what is known about available sources and studies (for a recent overview see Bolt and van Zanden (2014_[48])). Most problematic are the estimates for sub-Saharan Africa, which, with the exception of the estimates for South Africa, are highly speculative for the pre-1950 period and, also, comparatively weak for the second half of the 20th century. Western Europe, the Western Offshoots and Japan have the highest quality data for the 19th century.

Table 2.2. Quality of the sources of GDP data by decade and world region

	Western Europe	Eastern Europe	Western Offshoots	Latin America and Caribbean	Sub-Saharan Africa	Middle East and North Africa	East Asia	South and Southeast Asia
1820	3	4	3	4	4	4	3	4
1870	2	3	3	3	4	4	3	4
1920	2	3	2	3	4	3	3	3
1950	1	1	1	1	1	1	1	1
1970	1	1	1	1	1	1	1	1
2000	1	1	1	1	1	1	1	1

Note: 1. High quality: the product of official statistical agency (national or international); 2. Medium quality: the product of economic-historical research using the same sources and methods as applied by official statistical agencies; 3. Moderate quality: economic historical research, but making use of indirect data and estimates; and 4. Low quality: estimates based on a range of proxy information. In case of multiple sources, the lowest quality source is given.

Long-run global developments in per capita GDP: Comparing the three approaches

In this section we compare three different long-term GDP series, each one based on different estimates of relative prices. The baseline series is the one included in the original Maddison Project, integrated with the new historical estimates that have become available since 2014. These series are based on the 1990 PPPs, extrapolated backwards and forwards using official national accounts GDP growth rates, in a similar fashion to Maddison (2003_[4]) and the Maddison Project 2013 update (Bolt and van Zanden, 2014_[48]).

The first alternative series is based on the latest PPP estimates produced by the ICP for 2011 (World Bank, 2014_[49]), extrapolated backwards and forwards using the same GDP growth rates (derived from SNA) as for our baseline series using the 1990 benchmark. The second alternative series uses the Penn World Tables approach for the series between 1950 and 2016, extrapolated backwards from 1950 using the national accounts GDP growth rates.

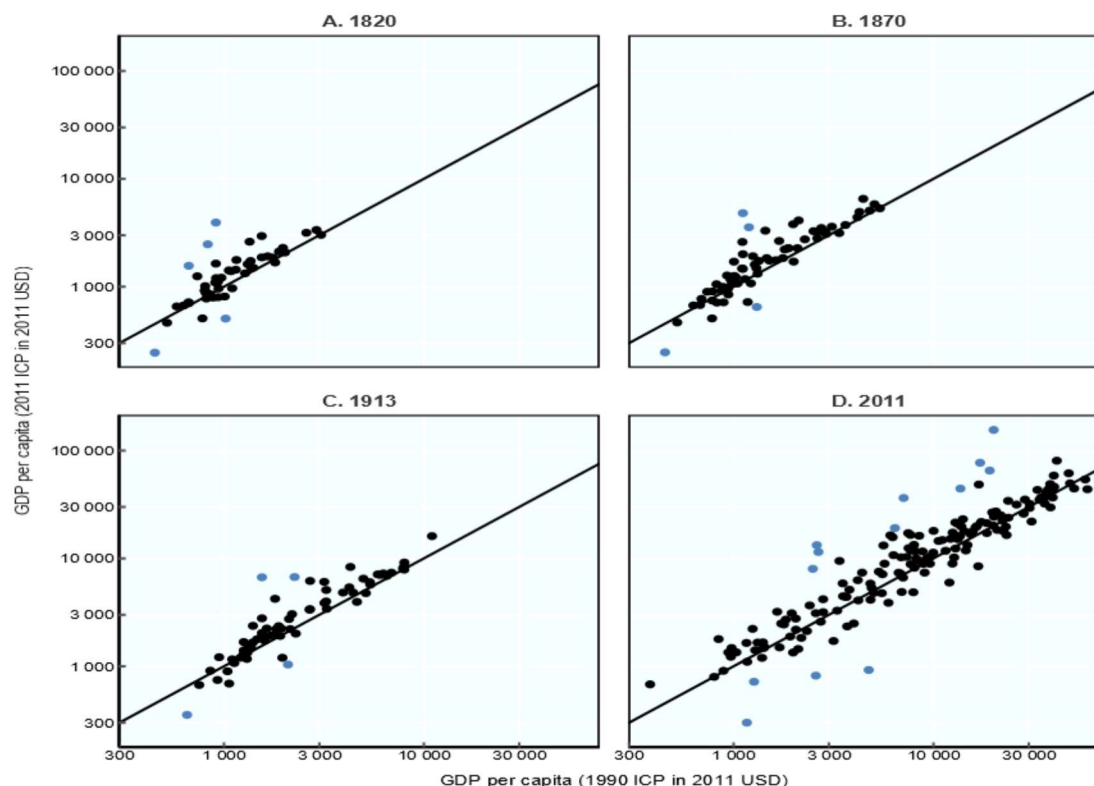
This provides us with three PPP-based estimates of GDP per capita: the first one expressed in 1990 USD using 1990 constant prices; the second one expressed in USD using 2011 constant prices; and the third one expressed in USD using constant prices from the first available benchmark for each country (which varies between individual countries).

The difference between the series using the 1990 PPP and the series using the 2011 PPP is essentially a level shift in GDP estimates. For example, for those countries that experienced an increase in prices between 1990 and 2011 vis-à-vis the United States, the original GDP series in nominal prices produced by the statistical agency of each country have been divided by the higher relative prices in the 2011 PPP series, leading to a lower level of real GDP relative to the United States. And for those countries that have experienced a decrease in prices during that period relative to the United States, GDP estimates shift upwards. In a similar fashion, we can compare the series based on 1990 PPPs and the PWT series using multiple PPP benchmarks. For those countries that experienced an increase in prices relative to the United States between the first benchmark available for that country and 1990, the level of real GDP relative to the United States for the first benchmark was higher than their relative GDP in 1990. This leads to a reshuffling of the level of historical GDP series for various countries.

One way of presenting this comparison is by looking at the consequences of making use of the two benchmarks (2011 and 1990) for the historical GDP estimates (Figure 2.1).

Figure 2.1. GDP per capita in various years based on Maddison 1990 and ICP 2011 PPPs

Values in 2011 US dollars



Note: The original GDP per capita values based on Maddison's 1990 PPPs have been converted to 2011 US dollar values (to make the numeraire comparable) by multiplying all observations by 1.59, which corresponds to US inflation between 1990 and 2011. Darker dots standing out from the general pattern: Angola (2011); United Arab Emirates (2011); Burundi (2011); Bahrain (2011); Cuba (2011, 1820, 1870, 1913); Iraq (2011, 1820, 1870, 1913); Kuwait (2011); Liberia (2011); Libya (2011); Mozambique (2011); Oman (2011); Qatar (2011); Somalia (2011); Algeria (1820); North Korea (1820, 1870, 1913); Syria (1820, 1870, 1913). Blue dots are all the remaining countries.

Source: Bolt and van Zanden (2020₁₉), "Maddison style estimates of the evolution of the world economy. A new 2020 update", *Maddison Project Working paper 15*.

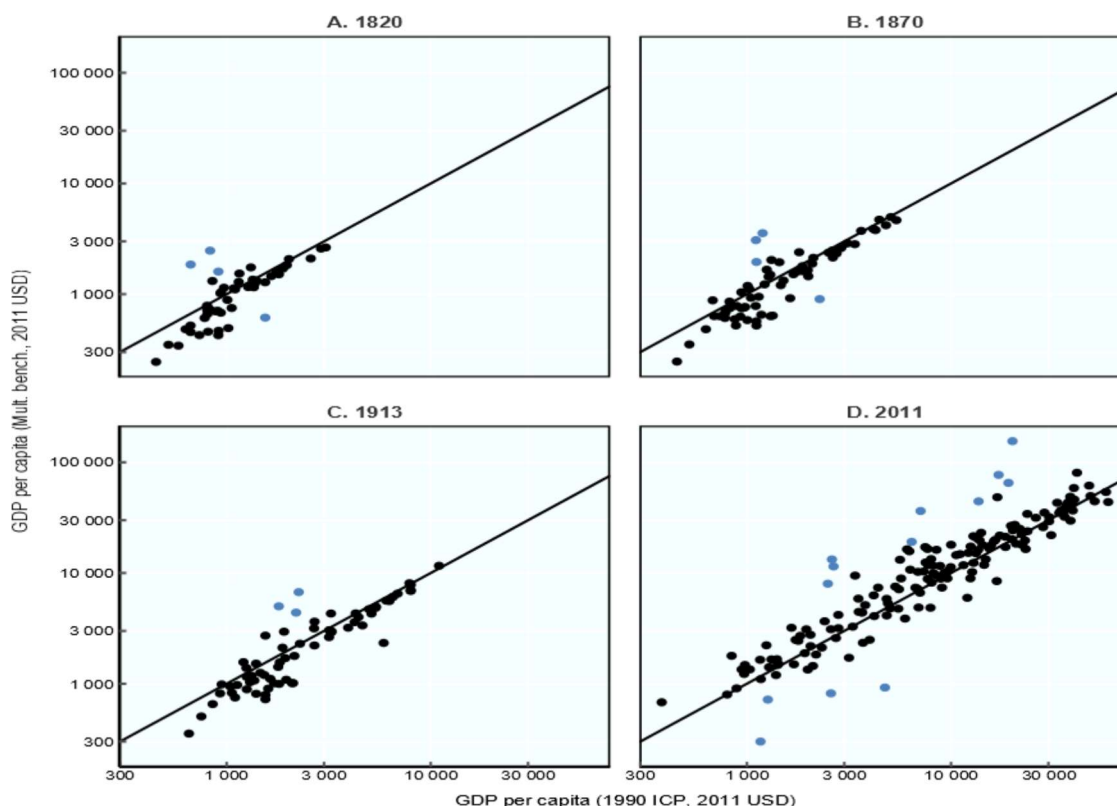
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The most notable differences between the two estimates relate to the oil-rich countries in the Middle East (Qatar, Kuwait, United Arab Emirates, Bahrain, Oman, Saudi Arabia, Iraq and Syria), highlighted with darker dots in Figure 2.1, whose GDP per capita increases significantly when switching to the 2011 benchmark. This may reflect limits in the Maddison 1990 estimates. These countries were included in the “non-sample” group in the original Maddison database, as they were not covered by the ICP rounds underlying Maddison’s 1990 PPP calculations. The price estimates for 1990 used by Maddison (based on information on the prices paid by expatriates in different countries) probably overestimated the actual prices in these countries, and hence underestimated their GDP levels. However, the shift of the GDP levels of the Gulf states may also reflect the strong increase in the relative price of oil between 1990 (when oil prices were rather low) and 2011 (when they peaked), which drove up the relative income levels of these countries. Extrapolating the 2011 GDP levels back into the past, on the basis of the estimated GDP growth rates of these countries, may therefore result in implausibly high incomes in earlier periods, as shown in Figure 2.1. According to this combination of data (the 2011 PPPs and the estimated growth rates of GDP per capita), Iraq would be the wealthiest country in the world in 1820 (and close to that position in 1870), which is implausible. Other notable outliers are, for 1820, 1870 and 1913, Korea (PRK), the Palestinian territory and Lebanon; and Angola, Mozambique, Uzbekistan and Armenia for 2011.

Comparing the 1990 GDP benchmark estimates to the multiple benchmark estimates based on the PWT approach, we find that most countries are located very close to the 45-degree line for all years analysed (Figure 2.2). Notable outliers for 1820, 1870 and 1913 are Argentina and Cuba. For Cuba, the benchmark value of GDP per capita based on the 1990s PPP estimate is around one-third of the level based on the PWT approach. In contrast, for Argentina the benchmark GDP level based on 1990 PPPs is around three times larger than the one based on the PWT approach. Likewise, GDP per capita in Syria and Iran are also much higher using the 1990 PPPs compared to the PWT approach.

Figure 2.2. GDP per capita in various years based on Maddison 1990 and the multiple benchmark (PWT) approach

Values in 2011 US dollars



Note: Values in 2011 USD. Darker dots standing out from the general pattern: Angola (2011); United Arab Emirates (2011); Burundi (2011); Bahrain (2011); Cuba (2011, 1820, 1870, 1913); Iraq (2011, 1820, 1870); Kuwait (2011); Liberia (2011); Libya (2011); Mozambique (2011); Oman (2011); Qatar (2011); Somalia (2011); Argentina (1820, 1870); Algeria (1820, 1870, 1913); Russia (1913).

Source: Bolt and van Zanden (2020^[9]), "Maddison style estimates of the evolution of the world economy. A new 2020 update", *Maddison Project Working paper 15*.

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The first test: Subsistence income

One of the implications of moving from PPPs in 1990 prices to PPPs in 2011 prices is that estimates of subsistence income change. With the 1990 price levels, subsistence income was between USD 350 and 400 per year (Maddison, 2003^[4]). The poverty line therefore was equal to around USD 1 a day, as reflected in the first international poverty line set in 1990 by the World Bank at USD 1.01 per day using 1985 PPPs, later updated to USD 1.08 per day using the 1993 PPPs (Ravallion, Datt and van de Walle, 1991^[50]; Chen and Ravallion, 2001^[51]). When using other relative prices, this level of subsistence income changes. In 2015, the World Bank moved to a threshold for extreme poverty of USD 1.90 a day (or USD 694 per year) based on the 2011 PPPs.

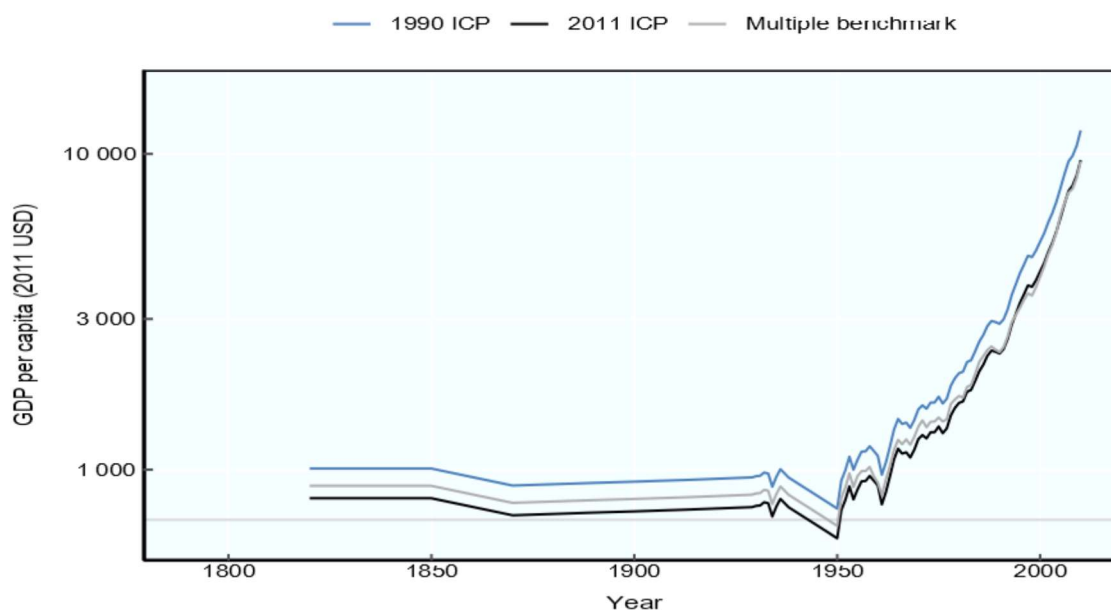
The effects of using alternative PPPs instead of the original Maddison estimates are most notable for countries that experienced substantial price changes relative to the United States between the benchmark years. China is a case in point. According to the 2005 PPPs, prices for China had increased so much since 1990 relative to those in the United States that its level of GDP per capita was around 40% lower than the level based on earlier price estimates (Deaton and Heston, 2010^[52]; Feenstra et al., 2013^[53]). This led to

implausibly low historical GDP estimates for China, given that the original Maddison's estimates were already very close to subsistence around 1950 (Maddison, 2007^[8]).

In the years since the release of the 2005 PPPs, a consensus arose about the shortcomings of the 2005 ICP round, most of which were corrected in the 2011 ICP round. Still, prices in China relative to the United States were substantially higher in 2011 compared to 1990, which lowers China's PPP-adjusted GDP per capita in 2011 by 23%. In this chapter, we have updated China's GDP estimates of the Maddison Project based on Wu (2014^[10]), which show lower GDP growth between 1952 and 2011 than the previous (official) estimates. Extrapolating backwards from this lower 2011 base using these lower growth rates leads to plausible historical income estimates for each alternative benchmark PPP (1990, 2011 and the multiple benchmark approach) – see Figure 2.3. The 2011 PPP benchmark gives a much lower level of GDP per capita due to the rapid increase in prices over the recent period, but never falls substantially below subsistence for earlier periods. The PWT approach leads to similar results as the 2011 benchmark for the most recent years, but its estimates for China are closer to the 1990 benchmark results for earlier years.

Figure 2.3. Historical series of GDP per capita for China using alternative benchmark PPPs

Values in 2011 USD



Note: The absolute line for extreme poverty line is based on the current World Bank poverty line of \$1.90/day in 2011 USD.

Source: Bolt and van Zanden (2020^[9]), "Maddison style estimates of the evolution of the world economy. A new 2020 update", *Maddison Project Working paper 15*.

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Looking more broadly into subsistence incomes, the original Maddison Project dataset includes 184 observations of GDP per capita below the subsistence level of USD 400 per year (out of 17 872 observations, i.e. 1% of the total). Most of these relate to countries in times of civil war such as Afghanistan, Liberia, Burundi and the Democratic Republic of Congo. When moving to the 2011 PPPs, the poverty line becomes USD 694, and the number of GDP per capita estimates below subsistence increases to 312 (1.8% of the total). Using the multiple benchmark method developed by PWT, the number of observations below subsistence increases even more, to 386 (2.6%), and this includes countries such as Peru during substantial parts of the 19th century, Egypt and Chile in 1820, and Korea during most of the period. Because of the high quality of the GDP series for some of those countries (the Peruvian historical

series, for example, is one of the best available), concerns arise about the quality of their earlier benchmarks, which may explain – in combination with the available time series of GDP per capita – these very low levels of GDP per capita. The main problem of the multiple benchmark method used by the PWT is that the historical GDP series are linked to the earliest available benchmark of the ICP (of 1960 or 1970 for example). This may, in view of the further development of the ICP Project, have been rather crude, therefore implying lower quality benchmarks and implausibly low historical estimates of GDP per capita for some countries.

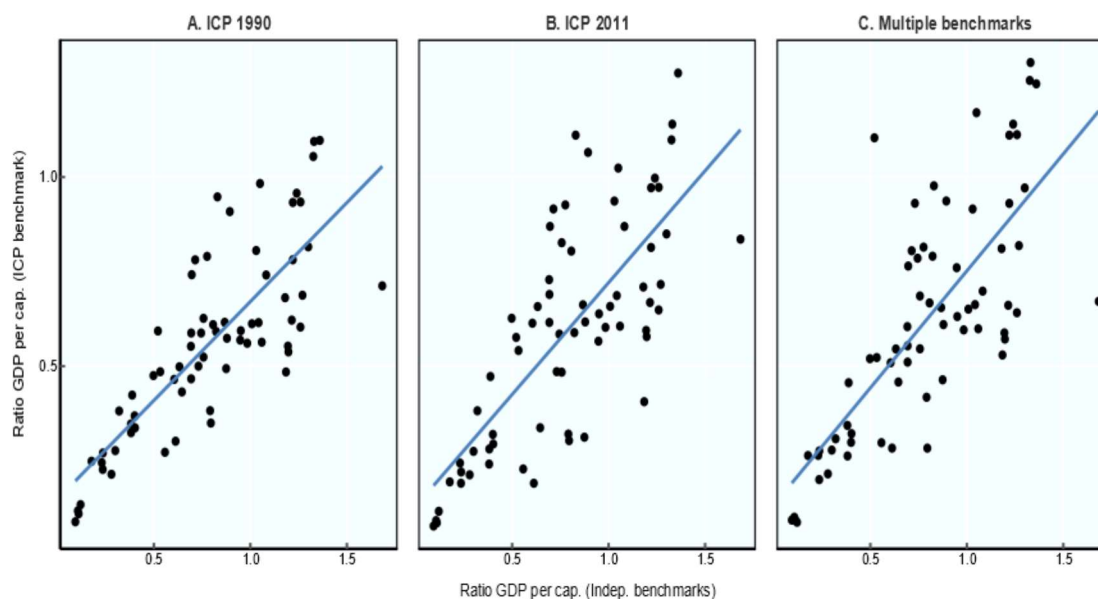
Analysing the accuracy of backward projections through comparisons with historical GDP benchmarks

Even though the effect of the new relative prices on the level of GDP per capita is, for some countries and regions, substantial, this does not necessarily mean that the view of past living standards provided by different methods completely changes, as that view depends largely on relative income levels, i.e. how well off certain countries were compared to other countries in the same year. So another way to assess how plausible the three approaches are is to calculate relative levels of GDP per capita for different countries for the years for which independent GDP benchmark estimates are also available. This comparison also addresses an often-heard criticism of the work by Maddison, i.e. that his dataset keeps relative and absolute levels of real GDP constant at the level of the base year 1990. In reality, prices change over time, and these changes in relative prices lead to biases in measured levels of GDP per capita; the longer the time period considered, and the larger the changes in relative prices, the more problematic an approach based on keeping prices constant would be. This criticism has resulted in various attempts to reconstruct the (implicit) PPPs for historical periods (Prados de la Escosura, 2000^[54]) or to use alternative proxies of the economic well-being of nations, such as real wages.

In this section we analyse the backward projections of the three approaches (i.e. making use of the 2011 PPP, the 1990 PPP and the multiple benchmark PPPs, respectively) to see which method results in the best “predictions” of relative income levels in the 19th and early 20th century, but also to find out how large are the biases of the Maddison approach. In other words, do the critics have a point, or do these changes in relative prices cancel out in the long run?

For this analysis, we collected all the independent historical comparisons of GDP per capita levels between sets of countries that are available in the literature. For all of these independent benchmarks, we calculated relative GDP per capita for the same countries and years from the time series using the three different methods. Figure 2.4 shows that the R^2 in panel A (1990 PPP benchmark) is 0.65, whereas the fit for both the 2011 PPP benchmarks (panel B) and multiple benchmarks (panel C) is much lower, with an R^2 of approximately 0.57. It appears that the 1990 benchmark produces better fit historical GDP estimates than the other two approaches.

Figure 2.4. Comparing GDP per capita estimates based on the three PPP approaches with independent benchmarks



Note: Points represent the ratio of GDP per capita of two countries measured using an independent benchmark and one of the ICP benchmarks (1990 (panel A), 2011 (Panel B), or multiple ICP benchmarks (Panel C)).

Source: Bolt and van Zanden (2020_[9]), "Maddison style estimates of the evolution of the world economy. A new 2020 update", *Maddison Project Working paper 15*.

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Additionally, we also gathered alternative estimates of relative levels of GDP per capita in the 19th and early 20th century that are based on an *econometric* (indirect) method used by Prados de la Escosura (2000_[54]). We compared these indirect estimates with our estimates of GDP per capita based on the three approaches described above, in a similar fashion as we did with the direct benchmarks. The results of these comparisons are very similar – see for details Bolt and van Zanden (2020_[9]). The 1990 PPPs and the multiple benchmarks are quite close and compare favorably to the results for the 2011 PPPs.

The conclusion is that simply moving from the 1990 to the 2011 PPPs benchmark does not improve GDP estimates for the historical period, probably due to the greater distance between 2011 and the historical year under review. The PWT approach, which uses all post-1950 benchmark estimates, does not suffer from this bias, but does result in a rather high share of countries with below-subsistence levels of GDP per capita over a prolonged period of time, which is problematic. The idea of a subsistence minimum is that people cannot survive if their income is below this threshold, so a country can fall below this minimum for one or two years (during a famine, for example) but not permanently or for long periods. An explanation of these results is that the PPP benchmarks are probably subject to two changes: both the quality of the PPPs and the coverage of the various ICP rounds are improving over time, but the distance from the "historical" period is increasing as well, resulting in more biases due to changes in relative prices. It follows that both a "perfect" but "distant" benchmark such as 2011, and the "imperfect" but "early" benchmarks used by the multiple benchmark method, have sizeable biases, and that the 1990 benchmark created by Maddison may well be the best compromise solution. It certainly produces the best results in terms of the two tests carried out in this chapter: first, it predicts historical benchmarks rather well (almost as well as the PWT approach) and, second, it does not result in a high share of countries with an implausibly low (below-subsistence) GDP per capita level. This assessment leads to the conclusion that the best way forward is to stick to the 1990 benchmark for the overall architecture of the Maddison dataset.

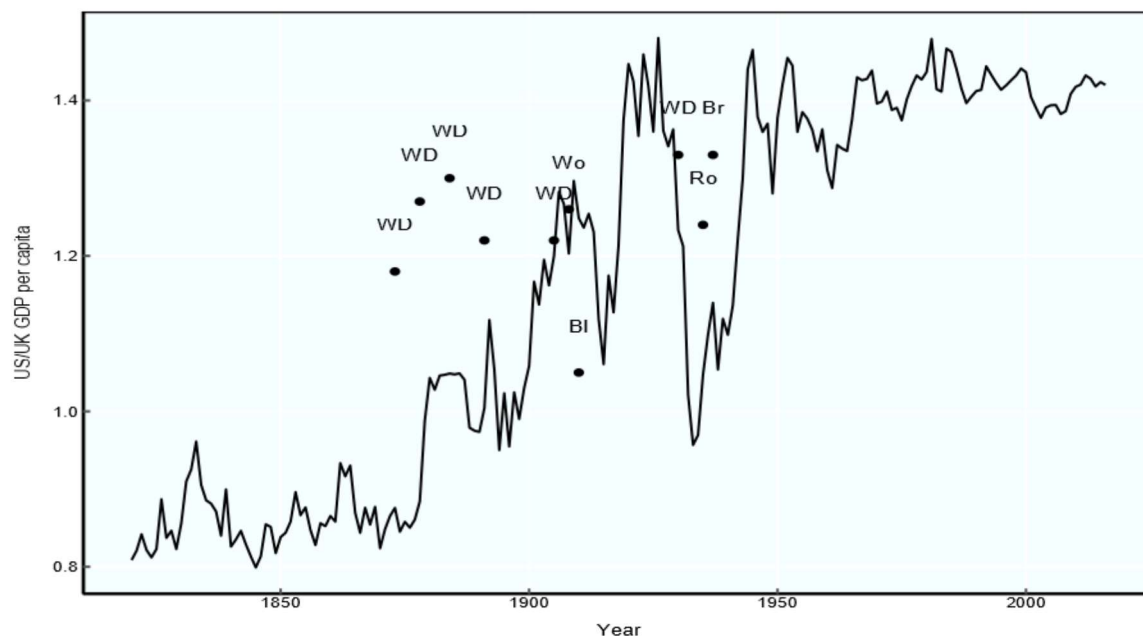
The dataset presented in this chapter, however, departs in a number of respects from the Maddison approach. There is, to begin with, no doubt that the 2011 PPPs and the related estimates of GDP per capita reflect the relative levels of GDP per capita in the world economy better than the combination of the 1990 benchmark and growth rates of GDP according to the national accounts. Hence, we adapted the growth rates of real GDP per capita in the period 1990-2011 to get a close fit between the two (1990 and 2011) benchmarks. Data on GDP growth after 2011 in the current dataset are based exclusively on the growth rates of GDP according to national accounts (but in the future this might be changed when new PPPs become available). A second change, i.e. developing a crude way to incorporate the available historical GDP benchmarks, is described below.

Incorporating important historical benchmarks of GDP per capita

Having collected all available GDP benchmarks (i.e. historical comparisons of GDP per capita between pairs of countries), it makes sense to use the information contained in them. We have therefore used the historical benchmark estimates to fine-tune the dataset for the pre-1940 period. When the quality of the benchmark was considered good, and the difference between the backward projected estimates based on the 1990 benchmarks was larger than 10%, we corrected the time series of GDP growth rates to fit the benchmark. It turns out that, when the Maddison 1990 benchmark is used, most historical benchmarks collected for this chapter do not show differences of more than 10% between the backward projections of the historical series, so the number of modifications is limited.

The most important correction concerns the US/UK comparison. The conventional picture, based on the original 1990 Maddison estimates, indicated that the US overtook the UK as the world leader in the early years of the 20th century. This was first criticised by Ward and Devereux (2003^[55]), who argued based on alternative measures of PPP-adjusted benchmarks between 1870 and 1930, that the United States led the United Kingdom in term of GDP per capita already in the 1870s, see Figure 2.5. This conclusion was criticised by Broadberry (2003^[56]). New evidence however also suggests that the overtaking by the United States indeed already happened in the 19th century (Lindert and Williamson, 2015^[57]). This is also confirmed by direct benchmark comparison of the income of both countries for the period 1907-09 (Woltjer, 2015^[58]). This shows that GDP per capita for the United States in those years was 26% higher than in the United Kingdom (Woltjer, 2015^[58]). We have used this benchmark to correct the GDP series of the two countries. Projecting this benchmark into the 19th century with the series of GDP per capita of both countries results in the two countries achieving parity in 1880, see Figure 2.5. This is close to Prados de la Escosura's conjecture based on his short-cut method (Prados de la Escosura, 2000^[54]) and even closer to the Lindert and Williamson (2015^[57]) results.

Figure 2.5. GDP per capita in the United States relative to the United Kingdom, 1850-1950



Note: WD: Ward and Devereux (2003); Wo: Woltjer (2015); BI: Broadberry and Irwin (2003); Ro: Rostas (1948); Br: Broadberry (2003).
 Source: Bolt and Van Zanden (2020^[9]), "Maddison style estimates of the evolution of the world economy. A new 2020 update", *Maddison Project Working paper 15*.

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Changing the US/UK ratio on the basis of the new research by Woltjer (2015^[58]) raises the question of which country's GDP estimates should be adapted. In the current PWT approach, the growth of GDP per capita in the United States is the anchor for the entire system. For the 19th century, however, it is more logical to take the United Kingdom as the anchor, because it was the productivity leader, and because most research focused on creating historical benchmarks takes the United Kingdom as the reference point. We have therefore adapted the US series for the period 1908-50 to fit the 1907-09 (Woltjer, 2015^[58]) benchmark. The reason for selecting this period is that there are doubts about the accuracy of price changes and deflators for this period, which was characterised by two big waves of inflation (during the two World Wars) and by large swings in relative prices and exchange rates (as documented in the detailed analysis by Stohr (2016^[38]) for Switzerland). Future research will have to assess whether this choice is justified.

Table 2.3. Main highlights of trends in GDP per capita, regional estimates

	Western Europe	Eastern Europe	Western Offshoots	Latin America and Caribbean	East Asia	South and Southeast Asia)	Middle East and North Africa	Sub-Saharan Africa	World
1820	2 307	818	2 513	953	1 089	929	974	800	1 174
1830	2 384	942							
1840	2 580	907							
1850	2 678	985	3 474	1 081	900	929	1 000	800	1 225
1860	3 034	1 358	4 214	1 588					
1870	3 301	1 575	4 647	1 319	989	850	1 165	800	1 498
1880	3 585	1 886	6 019						
1890	4 079	2 204	6 481	1 673		951			
1900	4 724	2 700	7 741	1 751	1 086	994	1 300	850	2 212
1910	5 135	2 283	9 355	2 194		1 143			
1920	4 884	1 343	9 741	2 331	1 160	1 117	900	950	2 241
1930	6 409	2 464	10 297	2 700	1 273	1 299	1 600		
1940	7 185	3 209	11 621	3 024	1 361	1 235	2 146	1 100	3 133
1950	7 263	4 082	14 773	3 713	1 122	1 070	2 393	1 323	3 351
1960	10 974	5 779	17 472	4 751	1 735	1 295	3 110	1 574	4 386
1970	16 161	8 241	23 210	6 286	3 042	1 546	4 801	1 958	5 952
1980	20 950	9 933	28 787	8 728	4 212	1 897	6 742	2 026	7 233
1990	25 440	10 344	35 619	8 132	6 121	2 574	6 435	1 801	8 222
2000	32 536	8 986	44 329	10 225	8 164	3 437	9 640	1 981	9 915
2010	37 318	17 021	48 090	13 453	12 853	5 367	16 716	3 156	13 179
2016	38 511	19 446	51 668	14 090	15 698	6 991	18 010	3 491	14 700


Note: All estimates expressed in 2011 USD.

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Table 2.4. Main highlights of trends in GDP per capita, 25 major countries

	GBR	NLD	FRA	DEU	ITA	ESP	SWE	RUS	POL	AUS	CAN	USA	ARG	BRA	MEX	KEN	NGR	ZAF	CHN	JPN	IND	IDN	THA
1820	3 306	3 006	1 809	1 572	2 665	1 600	1 415		818	826	1 441	2 674	1 591	867	1 007			1 188	1 070	1 317		827	909
1830	3 550	3 038	1 898		2 657		1 468		942	1 352	1 594	3 039										822	
1840	4 018	3 623	2 276		2 711		1 568		907	2 190	1 852	3 319						1 173				883	
1850	4 332	3 779	2 546	2 276	2 611	1 706	1 715		985	3 148	2 120	3 632	1 994	867	1 054			1 042	858	1 436	947	724	
1860	5 086	3 840	3 016	2 613	2 573	1 930	1 941		1 358	4 613	2 313	4 402	2 160	991	921			1 294				819	
1870	5 829	4 422	2 990	2 931	2 826	1 809	2 144		1 575	5 217	2 702	4 803	2 340	1 084	1 046			1 286	945	1 580	850	810	969
1880	5 997	4 666	3 379	3 174	2 796	2 520	2 359		1 886	6 830	2 895	6 256	2 557	1 058				2 294				1 041	
1890	6 845	5 078	3 787	3 870	2 974	2 463	2 606	1 380	2 204	7 106	3 790	6 665	3 851	1 084	1 568			1 830	964	1 854	931	1 030	1 250
1900	7 594	5 306	4 584	4 758	3 264	2 676	3 320	1 906	2 700	6 397	4 640	8 038	4 583	874	1 822			1 494	972	2 123	955	1 151	
1910	7 718	6 030	4 726	5 337	3 829	2 823	4 053	2 149	2 694	8 305	6 481	9 637	6 092	990	2 240			1 835		2 317	1 111	1 264	
1920	7 017	6 727	5 144	4 457	3 789	3 244	4 788	917	3 000	7 597	6 154	10 153	5 536	1 242	2 552					2 974	1 012	1 409	
1930	8 673	8 931	7 224	6 333	4 631	3 923	6 755	2 308	3 178	7 504	7 669	10 695	6 503	1 350	2 233			2 252	1 012	3 334	1 157	1 704	
1940	10 928	7 701	6 443	8 612	5 099	3 170	7 739	3 417		9 828	8 557	12 005	6 633	1 610	2 560			3 419		4 882	1 093	1 766	
1950	11 061	9 558	8 266	6 186	5 582	3 464	10 742	4 529	3 900	11 815	11 622	15 240	7 949	2 236	3 510	1 038	1 200	4 041	799	3 062	987	1 280	1 302
1960	13 780	13 209	11 792	12 282	9 430	5 037	13 849	6 288	5 125	14 013	13 952	18 057	8 861	3 398	4 723	1 157	1 307	4 847	1 057	6 354	1 200	1 613	1 718
1970	17 162	19 075	18 187	17 277	15 492	9 511	20 269	8 886	7 058	19 166	19 207	23 958	11 639	4 635	6 873	1 458	1 744	6 448	1 398	15 484	1 384	1 882	2 700
1980	20 612	23 438	23 537	22 497	20 959	14 008	23 809	10 245	9 149	22 972	25 784	29 611	13 080	8 249	9 929	1 675	2 080	6 998	1 930	21 404	1 495	2 981	4 071
1990	26 189	27 515	28 129	25 391	26 003	19 215	28 068	10 989	8 150	27 373	30 082	36 982	10 254	7 842	9 699	1 780	1 773	6 111	2 982	29 949	2 087	4 007	7 385
2000	31 946	37 900	33 410	33 367	32 717	26 995	34 203	8 194	12 732	36 603	36 943	45 886	14 369	9 834	12 613	1 915	2 145	7 583	4 730	33 211	2 753	5 384	9 627
2010	34 754	43 812	36 087	41 110	34 766	31 786	42 635	16 345	20 609	45 400	41 209	49 267	18 980	14 216	14 697	2 580	4 905	11 319	9 658	35 011	4 526	8 386	13 344
2016	37 334	45 600	37 124	44 689	33 419	30 110	44 659	18 635	24 838	48 845	43 745	53 015	18 875	13 873	16 133	3 169	5 360	12 1390	12 569	37 465	6 125	10 911	15 454

Note: All estimates expressed in 2011 USD.

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The world in 1820

The new estimates allow us to draw a more accurate picture of the world economy at about 1820, and also of the process of divergence in economic development before that year, of which we see the results as reflected in disparities in 1820 (). 1820 is the first year for which we can estimate levels of GDP per capita for all major regions in the world (but those for sub-Saharan Africa are still very weak). There were already sizable differences in GDP per capita between regions in 1820: the real GDP per capita in Western Europe and the Western Offshoots was three times that of Eastern Europe or sub-Saharan Africa, and the rest of the world was also quite close to this latter level. This gap, which is even larger when we compare the most advanced countries (the United Kingdom and the Netherlands) with the rest of the world, is (first and foremost) the result of the economic growth that preceded the Industrial Revolution in the North Sea region, where GDP per capita tripled between 1347 and 1820 due to a more or less consistent process of (slow) economic growth. On the other hand, the most advanced parts of the world in 1200 or even 1500 – China, India and the Middle East in particular – showed long-term stagnation and even decline in the centuries leading to the Industrial Revolution. In Asia, only Japan witnessed a process of slow GDP growth similar to that of Western Europe. In Latin America, real GDP increased from the 16th century onwards – mainly due to the dramatic decline of the population, but also thanks to the import of new crops and livestock – but some of these gains disappeared after 1750, when the population began to increase again. This early divergence in per capita GDP between Europe and Asia has been the topic of a fierce debate, the central question being whether the level of economic development in China (and India and Japan) before industrialisation was comparable to Western Europe (Pomeranz, 2002^[59]). New research by Bolt and van Zanden (2014^[48]), however, clearly indicates that GDP per capita in Western Europe was much higher than in the rest of the world already in 1820, and given the size of the difference, predates the Industrial Revolution.

At the same time, there existed in 1820 substantial differences in levels of GDP per capita within Western Europe itself. The richest country in 1820 was the United Kingdom with around USD 3 300 in 1820; the poorest country was Finland, with around USD 1 300 per capita. North America (with a GDP per capita of almost USD 2 700 in the United States) and the southern cone of Latin America (with GDP per capita of USD 1 500 in Argentina and USD 1 800 in Uruguay) came very close to the Western European average of USD 2 300 (or even surpassed it, as in the case of the United States). GDP per capita for Latin America as a whole, at around USD 650, was much lower. The other main southern hemisphere countries experienced GDP per capita levels that were clearly above subsistence: the average GDP per capita for the Cape Colony in 1820 was about USD 1 500; in Australia this was much lower, at around USD 800.

Developments since 1820

Over the past two centuries the world has witnessed a spectacular growth of GDP and production capacity. On a global scale, GDP per capita has risen 12.5-fold since 1820 (Table 2.3). The average level of global GDP per capita almost doubled in the 19th century (from USD 1 174 in 1820 to USD 2 212 in 1900). GDP growth then accelerated in the 20th century: the next doubling of per capita GDP took about 60 years (1900-60), and a similar doubling between 1960 and 2000 happened in (slightly less than) 40 years.

In the long run, all countries and world regions saw their levels of real GDP per capita rise, as Table 2.3 and Table 2.4 demonstrate. Comparable GDP data on Africa are so scarce that it is difficult to draw any general conclusions (the sub-Saharan Africa estimates for the 19th century presented in Table 2.1 relate only to South Africa and are therefore unrepresentative for the region as a whole). During the 20th century, and in particular after 1950, all parts of the world show real, sometimes accelerating GDP growth. The 1950s and 1960s were the years with the most rapid economic growth worldwide, mainly because many countries managed to catch up (or started to catch up) with the United States. After 1970, and to be more precise after 1973, economic growth often decelerated (see Table 2.5), which partly reflects the end of catching up for Western European countries, where US levels of productivity had been achieved. Declines

in material standards of living over longer time periods are exceptional for the post-1950 period; the most extreme case was the result of the dismantling of the centrally planned economies in the USSR and Eastern Europe in the early 1990s, causing GDP per capita in the former USSR to fall by about one-third between 1990 and 2000. But other regions also experienced disappointing developments during those years. Sub-Saharan Africa, for example, had its “lost decades” during the 1980s and 1990s, and the growth performance of Latin America was also quite poor during these first decades of “globalisation”.

East Asia, and to a lesser extent, South and Southeast Asia, were the most dynamic parts of the world economy since the 1960s, although even this part of the world knew exceptions; Japan, after catching up in the 1980s, switched to a very slow growth path in the 1990s (but still, in 2018, has a GDP per capita that is 20% higher than in 1990).

As described by Maddison (2003^[4]), world leadership in terms of GDP per capita and labour productivity has changed only a few times. The Netherlands was the productivity leader in the 17th and 18th century, until the United Kingdom took over world leadership after about 1780. The United Kingdom, in turn, was surpassed by the United States between 1870 and 1880, as discussed earlier, both in terms of productivity and GDP per capita. During this period, the United States became increasingly more productive compared to the rest of the world, including Europe. As a result, the Transatlantic productivity gap widened substantially between 1900 and 1950, and Western Europe started to catch up only after 1950. A gap in GDP per capita between the United States and Western Europe persisted, however, which is partly due to higher levels of labour force participation and working hours in the United States (see Chapter 3 on working hours).

Up to now, the focus of our attention has been the average GDP per capita of the world population. There is, however, another way of measuring global GDP growth, i.e. by estimating the average growth rate of GDP per capita experienced by the world’s population. In the first case (the series we have been discussing so far), countries’ GDP growth rates are weighted according to their share in global GDP. In the second series, the growth rates of GDP per capita are weighted according to the share of a country’s population in the world total. The latter series, in a way, measures the average rate of GDP growth experienced by the “average” world citizen. When rich countries grow more rapidly than poor countries, the GDP-weighted world series records faster growth simply because rich countries account for a large share of world GDP. Conversely, when poor countries grow more rapidly than rich countries, the population-weighted world series records faster GDP growth, because the majority of the world’s population still live in low-income countries.

Economic theory predicts that GDP growth is a cumulative process driven by people and ideas. One would, therefore, expect to observe an almost continuous acceleration of economic growth, as the number of people (and their ideas) grows continuously. This does not appear to be the case, however, when looking at global growth weighted by GDP (the second column in Table 2.5): in this case, GDP growth peaks in the “golden years” between 1950 and 1970, and strongly decelerates after 1970, to recover after 1990. The series weighted by population (the first column in Table 2.5) is much closer to theoretical expectations, with the most recent period also featuring the fastest GDP growth. The two series convey different perspectives on the development of global inequality between countries: initially, the rich countries grow more rapidly than the poor ones, resulting in an increase in income disparities between countries. But gradually the tables turn, and from the middle of the 20th century onwards poor countries start to catch up, with the population-weighted GDP series showing much more rapid growth than the GDP-based series.

Table 2.5. Growth of global GDP per capita, 1820-2010

	Weighted by population	Weighted by GDP	Difference
1820-1850	0.02	0.14	0.12
1850-1870	0.34	1.01	0.67
1870-1900	0.74	1.31	0.57
1900-1920	0.25	0.07	-0.19
1920-1940	1.27	1.69	0.42
1940-1950	-0.06	0.67	0.73
1950-1960	3.00	2.73	-0.27
1960-1970	3.53	3.10	-0.43
1970-1980	2.48	1.97	-0.51
1980-1990	2.10	1.29	-0.81
1990-2000	2.42	1.89	-0.53
2000-2010	4.19	2.89	-1.30

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Priorities for future research

There are two main priorities for future research on historical GDP. The first is producing more and better GDP estimates, most notably for China and Africa. In this chapter we have discussed and integrated the important work by Wu (2014^[10]) on charting Chinese economic development for the post-1950 period together with a series of recent estimates that document Chinese growth before the 20th century. An important region we know little about is Africa, especially prior to 1950. Nearly all available estimates start in 1950, and even those are sometimes of dubious quality. However, promising work is currently under way to produce the first GDP per capita estimates for Africa in the pre-1950 period (Broadberry and Gardner, 2019^[60]).

The second priority for future research is creating more historical benchmarks of relative income levels, as our understanding of comparative income levels becomes sparser as we move back further in time. This is particularly pressing in regions such as Africa and large parts of Asia, but there also important gaps for Latin America in the 19th century. More fine-grained information and more comparative studies are crucial to broadening and deepening such understanding.

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Notes

¹ "Domestic" refers to the fact that the estimates relate to what is happening within the borders of the country involved, whereas "national" would refer to the income or expenditure of the citizens of those countries.

² See the discussion of historical sources below for a more detailed explanation.

³ PPP estimates between benchmarks are interpolated; when no earlier or later ICP benchmark is available, the extrapolation method is used.

⁴ <http://www.rug.nl/research/ggdc/data/penn-world-table>.

⁵ <http://icp.worldbank.org/>.