Tjalling C. Koopmans Research Institute

Discussion Paper Series nr: 04-18

The Macro-dynamics of the Dutch Economy1800-1913

Jan Reijnders

Universiteit Utrecht

Utrecht School of Economics

Tjalling C. Koopmans Research Institute
Utrecht School of Economics
Utrecht University

Vredenburg 138
3511 BG Utrecht
The Netherlands
telephone +31 30 253 9800
fax +31 30 253 7373
website www.koopmansinstitute.uu.nl

The Tjalling C. Koopmans Institute is the research institute and research school of Utrecht School of Economics.
It was founded in 2003, and named after Professor Tjalling C. Koopmans, Dutch-born Nobel Prize laureate in economics of 1975.

In the discussion papers series the Koopmans Institute publishes results of ongoing research for early dissemination of research results, and to enhance discussion with colleagues.

Please send any comments and suggestions on the Koopmans institute, or this series to m.vandort@econ.uu.nl

ontwerp voorblad: WRIK Utrecht

How to reach the authors

Please direct all correspondence to the first author.

Jan Reijnders
Utrecht School of Economics
Utrecht University
Vredenburg 138
3511 BG Utrecht
The Netherlands
Phone: +31 30 2532011
+31 30 2539800
Fax: +31 30 2537373
Email: J.Reijnders@econ.uu.nl

Utrecht School of Economics
Tjalling C. Koopmans Research Institute
Discussion Paper Series 04-18

The Macro-dynamics of the Dutch Economy 1800-1913

Jan Reijnders

Utrecht School of Economics
Utrecht University

July 2004

Abstract
This paper presents a quantitative analysis of recently published Dutch national income statistics 1800-1913. An effort is made to identify Kondratieff waves in volume series relating to gross domestic product and expenditure. It is found that Kondratieff waves can be identified in most series. An interesting result is that the long waves in volume series appear to run contrary to the long waves in price series. This finding is at variance with the received view on long waves. It is argued that this typical result may be explained with reference to the so-called 'Keynes effect'.

Key Words
Trends, Long Waves, National Income Statistics, The Netherlands, Fourier Analysis.

JEL code
E32, E12

The Macro-dynamics of the Dutch Economy 1800-1913

1. Introduction

Dutch economic historians celebrated the start of the new millennium with the completion of the project 'Reconstruction of the National Accounts of the Netherlands', a detailed quantitative description of the growth of the Dutch economy during the nineteenth century (Smits, Horlings and van Zanden, 2000). The book was accompanied by an interpretative study focusing on the interrelations between the State, institutions and the structure of economic development (van Zanden and van Riel, 2000).

With the publication of the reconstructed national accounts for the period 1800-1913 we now have available a magnificent set of data[1] that creates the possibility of a comprehensive analysis of the development of the Dutch economy in this period. It now becomes possible to lay out the pattern of Dutch economic development from a macroeconomic perspective.

In the present paper I will limit the scope of the analysis of Dutch development by testing the hypothesis that the pattern of development exhibited in the reconstructed national accounts is characterized by the presence of so-called Kondratieff-waves, or long waves. By doing so I will try to achieve two goals. First I want to give a sequel to an earlier empirical study of the Kondratieff-phenomenon in the United Kingdom (Reijnders, 1992; Reijnders, 1990) and comply with a later call to widen the scope of the results of this type of analysis of the Kondratieff-phenomenon by extending it to other countries (Reijnders, 1998). Second I hope to instigate a periodization of the development of The Netherlands in the 19th century that is based on economic criteria. In this way I hope to contribute to the discussion of the development of Dutch economy of the 19th century especially on the following two 'classical' subjects of debate:

The first is the issue of the 'industrial revolution' in the Netherlands, where some represent the development of The Netherlands of the 19th century as the (gradual) transition of a backward, mainly agrarian economy to a modern industrial state, a transition which supposedly did not take place before the second half of the 19th century (after 1850, around 1870 or even after 1890: van Stuijvenberg, 1970; Jonge, 1968; Jonge, 1970; Jonker, 1996; Mokyr, 2000)). Others represent the development of the Dutch economy in the 19th century as the transition of the latter years of the first phase of the development of a modern economy (Vries and Woude, 1995) which temporarily exhibited little dynamism and was therefore surpassed first by Great Britain and later by Belgium and Germany. It only succeeded in catching up at a very late date. Still others finally interpret The Netherlands of the 19th century as an economy that admittedly deviated from the standard pattern of development but which nonetheless, by means of clever choices succeeded in remaining in the world's top league (Wintle, 2000).

The second is the issue of the 'derived business cycle', which supposes that the Dutch economy in the 19th century does not fulfill the basic conditions for exhibiting a cyclical pattern that is characteristic of a modern industrial mode of production. Fluctuations which nonetheless do occur under these conditions must be viewed as 'derived cycles', ebbs and flows which mimic endogenous cycles which are generated abroad (in Great Britain in this case Ridder, 1935, 13). This issue has recently been reiterated by Jacobs and Smits (Jacobs and Smits, 2001). A different opinion with respect to long cycles may be found in Wintle (Wintle, 2000: 239).

Assumptions regarding the composition of time series

With regard to the composition of time series the conventional assumption is adopted that economic time series are the sum of a number of elements where cyclical

---

[1] The subsequent analysis is based upon the data contained in (Smits, Horlings and van Zanden, 2000) and (Smits, Horlings and van Zanden, 1997), which are publicly available through the Historical Data Archive of the Dutch Academy of Sciences: (DHDA, 2000).

components are superimposed on an underlying trend[2]. Cyclical components can be distinguished according to their 'duration' or 'period'. In economic theory the following cyclical components are distinguished:

a. 'Kitchin' cycles with an average duration of 3-5 years;
b. 'Juglar' cycles with an average duration of 7-12 years;
c. 'Kuznets' cycles with an average duration of 15-25 years;
d. 'Kondratieff' cycles with an average duration of 40-60 years;
e. 'Hegemonial cycles' (Wallerstein, 1980; Kleinknecht, 1987; Simiand, 1932), 'Logistics' (Cameron, 1973), 'Life Cycles of Economic Development' (van Duijn, 1983; Forrester, 1973) or 'Systematic Long Run Movements' (Reijnders, 1990; Reijnders, 1992): wave-like movements of very long duration.

The mentioned cyclical components are superimposed upon a general tendency: the trend.

With this assumption regarding the composition of time series, the Kondratieff cycle is a so-called *hidden periodicity* that is covered with and masked by all other cycles to the extend that it must, so to speak, be 'distilled' out of the time series. To be able to do this, the time series under consideration must be split up into, at least, three domains:

1. The domain of short- and medium term cycles, comprising the 'Kitchin'-, 'Juglar- and 'Kuznets'-cycles;
2. The domain of the 'Kondratieff'-cycle
3. The domain of the trend, that apart from the 'standard'-trend also comprises the systematic long-run deviations from the standard-trend[3].

The necessity to extract the Kondratieff-cycle from a given series under the assumption of the simultaneous existence of several other cyclical components[4] (the domain of the short- and medium term cycles) as well as the trend and its systematic deviations (the domain of the trend) calls for a statistical method with special properties. It must be capable of estimating the contributions of several cyclical components simultaneously. Spectral analysis appears to be the appropriate method (Reijnders, 1990: 218 ff; Reijnders, 1992: 32 ff; Chatfield, 2004: 127 ff.; For an earlier application to Dutch historical data see: Bos et al., 1986).

Spectral analysis is based on the proposition that every time series of *n* observations can be approximated by the sum of an ordered set of *n/2* periodical functions. The amplitude of these periodical functions indicates the contribution of the given periodical component to the total variance of the time series under consideration. In this way it is possible to decompose a given time series into a number of individual contributions which are associated with specific periodical components (cycles) with different durations. Analogous to the way in which a prism can represent the color spectrum of white light (that is to project the different wave-lengths of light as separate color bands) it is possible to calculate the 'amplitude spectrum' of a given time series. The amplitude spectrum can be represented graphically by marking the sequence of cyclical components on the horizontal axis and the corresponding amplitudes on the vertical axis (for an example see figure 2 below). The amplitude is indicative of the explanatory power of a given component. In order not to exhaust the general reader with intricate technical details I limit myself here to a graphical illustration. For more details on the methods

---

[2] This position is analogous to Schumpeter's 'three cycle scheme' (Schumpeter, 1939). In this case, however, the catalogue of cycles is extended to cover the possibility of a greater number of cycles.

[3] There are long term fluctuations that cover such a long interval of time that they clearly belong to the domain of the trend. In my view, these long term fluctuations, which are sometimes called 'hegemonial cycles' or 'life cycles', are not strictly periodic phenomena. For this reason I prefer to designate them systematic deviations from the 'standard'-trend. The definition of the 'standard'-trend will be given below.

[4] The earlier mentioned catalogue of cycle types is only an overview of the types that have identified by different authors in the course of time. This does not mean to say that every type will actually be present in the Dutch time series for the nineteenth century. Since we do not have *apriori* knowledge of the composition of the Dutch times series we have to take account of the possibility that they do exist simultaneously..

applied, see appendix 1 below.

2. Application to price series

Figure 1 depicts the development of the price deflator of GDP[5] which exhibits a wavelike pattern that is very similar to the patterns in the English, French and American price series that formed Kondratieff's point of departure (Kondratieff, 1926: 577 ff.). Kondratieff considered this an indication of a long cycle with a rising phase from the end of the 1780s to 1810-1817, a declining phase 1810-1817 to 1844-1851, another rising phase 1844-1851 to 1870-1875, another declining phase 1870-1875 to 1890-1896 and a new rising phase 1890-1896 to 1914-1920 (Kondratieff, 1926: 590). According to my approximation (see below) of this movement made visible through the dotted line in figure 1, the periodization would be: Up until 1814, down until 1842, up until 1869, down until 1894 and then up again.

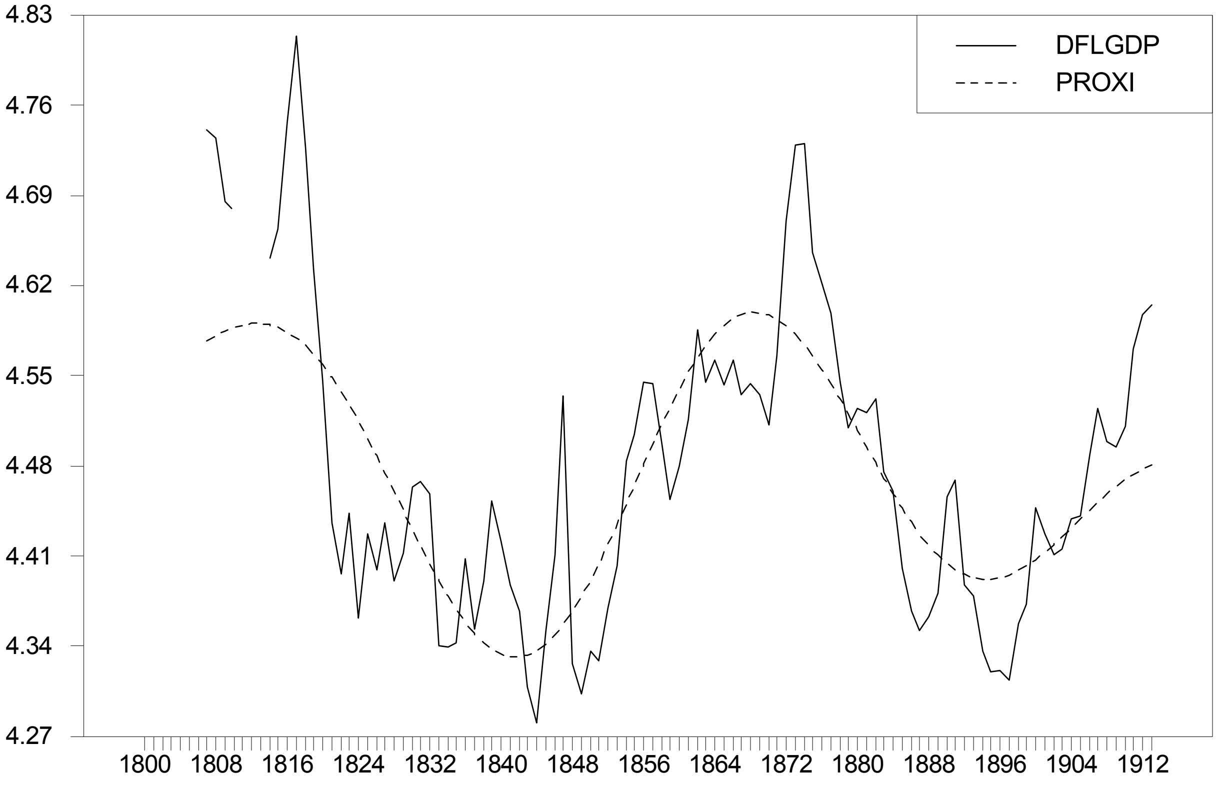

Figure 1 *Price deflator of GDP and a proxy of the Kondratieff-wave.*

The price deflator is a good example to illustrate the characteristics of the present method of determining the importance of various cycle types of the above mentioned catalogue of cycle types. Figure 1 gives an impression of the structure of the time series in question, which appears to consist of a (weak) trend, a long cycle of the Kondratieff-type and at least two kinds of shorter cycles (most likely of the Juglar- and Kitchin-type). To measure the importance of the various cycle types I propose to decompose the total variance of the time series into the simultaneous contributions of several periodical components (cycles) that may be present in the series. This is done by calculating the 'amplitude spectrum' of the series. The amplitude spectrum of the GDP price deflator is depicted in figure 2.

---

5 Source: (Smits, Horlings and van Zanden, 2000: table I.5, 228-230)

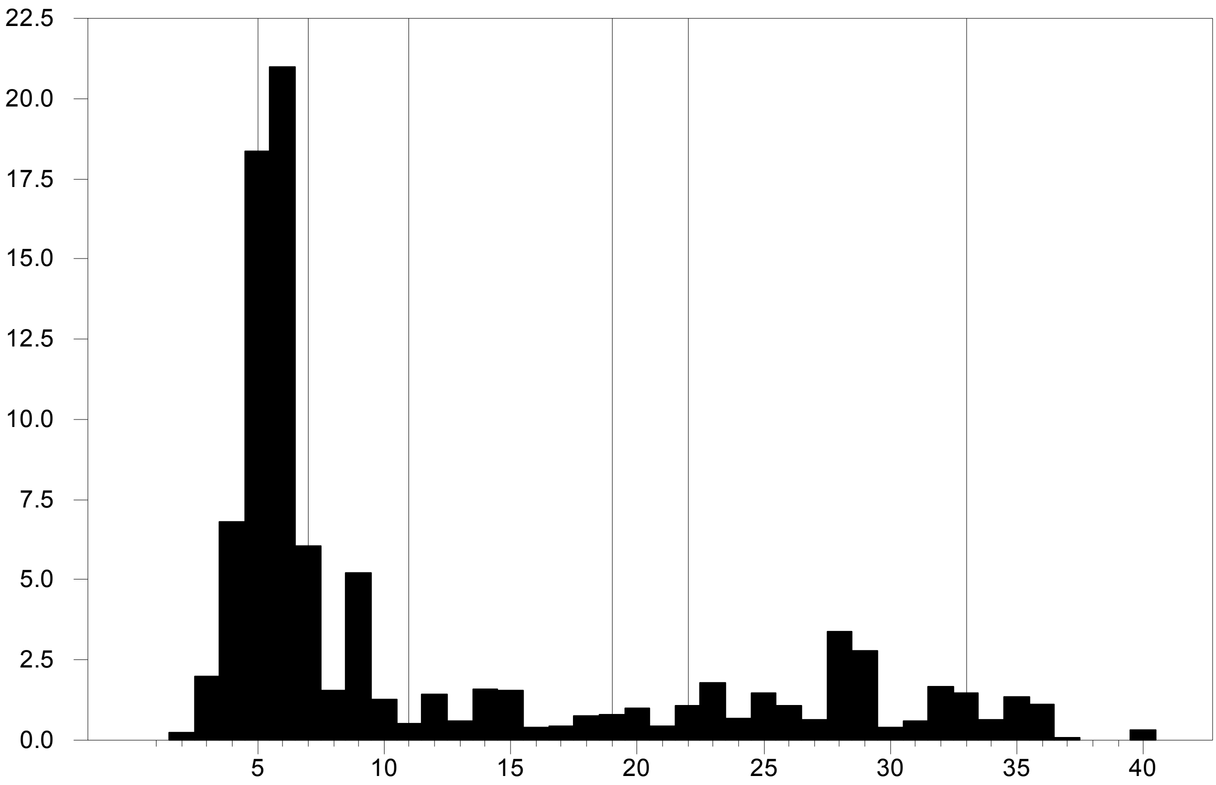

Figure 2 *Amplitude spectrum of the price deflator of GDP (1-4 Trend-domain, 5-7 Kondratieff-domain, 11-19 Kuznets-domain, 22-33 Juglar domain).*

The horizontal axis contains the different cycles[6] arranged according to duration. The longest cycles come to the left. The more to the right, the shorter the cycle in question. The various cycles can be grouped together in domains. The Kondratieff domain, for example, contains all cycles with a duration between 40 and 60 years (i.e. components 5, 6 and 7). The vertical axis measures the amplitude (relative contribution to total variance explained) of the periodical components given on the horizontal axis. From the graph it is clear that the three highest peaks are located in the Kondratieff domain. This establishes that the Kondratieff domain has the highest explanatory value in this case. Total explanatory value of the Kondratieff-domain is the sum of the explanatory value of the frequencies 5, 6 and 7. It is 38,99% in this case, indicating that the Kondratieff domain explains 38.99% of the total variance of the trend deviations of the GDP-deflator. The corresponding values for the other domains are: 8.22% for the Kuznets, 18.94% for the Juglar and 4.73% for the Kitchin domain. These figures and the visual impression from figure 1 establish that the Kondratieff cycle is an important element in the explanation of the variability of the price index.

The amplitude spectrum can be directly used as a device to approximate the general tendencies of the series in question. By adding the power concentrated in the lower frequency domains and adding it to the implicit 'standard trend' (a smooth exponential curve) one obtains the smooth pattern traced by the variable PROXI, the dotted line in figure 1.

On the basis of the foregoing one can establish that the Kondratieff-cycle is an essential element of the structure of the GDP-deflator. This inevitably leads to the conclusion that in one way or the other the Kondratieff cycle is connected with the development of the Dutch economy in the nineteenth century. The importance of this conclusion is, however, limited by the fact that the GDP-deflator is a price series and it is

[6] The notion of a sequence of numbered cycles is used here solely for the sake of simplicity. Stricktly speaking, the x-axis contains frequencies (that is inverses of average cycle durations).

well known that the Kondratieff-cycle is not controversial with respect to price indicators, or more general, with respect to trendless series or series which only have a weak trend (Reijnders, 1992). The 'acid-test' regarding the existence of Kondratieffs has to be taken in the class of series with a strong trend, that is in volume series or value series that have a price- as well as a volume component. It appears to be obvious to directly apply the earlier demonstrated spectral analysis to volume series. But before doing so, two problems have to be coped with.

3. Application to volume series: Gross Domestic Product

Complications with trending series

In his analysis, Kondratieff distinguishes between trendless series (price series and monetary series)[7] and trending series (Kondratieff, 1926; Kondratieff, 1928). He uses different statistical methods to study each of them. Kondratieff subdivides the trending series into what he calls 'mix ed series', that is value series containing a price- and volume element and 'volume series', that is series that directly measure a physical volume or index series in constant prices. With the trending series two complications arise. One that has to do with the fact that the 'mixed series' are compounds and another that has to with the presence of a trend and fluctuations that logically belong to the domain of the trend.

The complication with the 'mixed series' is that interference may occur between patterns in the price- and in the volume component. For this reason it is advisable to forgo the analysis of mixed series in the present context (see the appendix on statistical method).

The complication with the trending series is twofold. First there is the 'leakage'-problem, that is that the power contained in the trend domain leaks away into the domain of cycles which considerably blurs the spectrum. Second there is the problem that the trend is not a monotonous movement in one direction. There are long run accelerations and decelerations in the pace of growth, which actually belong to the domain of the trend. To prevent the trend and the mentioned long run accelerations and decelerations in the pace of growth to disturb the analysis of shorter cyclical patterns, a trend correction is applied. With this so-called P3-trend correction the 'standard trend' as well as the 'systematic deviations from the standard trend' are removed from the series before spectral analysis is applied (see the appendix on methods for more details on the P3 trend elimination procedure).

Analysis of Gross Domestic Product

After having established that it does not make sense to analyze 'mixed series' we can now direct our attention to the analysis of volume series. The first and foremost candidate is of course Gross Domestic Product in constant prices[8].

The P3-trend of GDP

As has been said, spectral analysis is preceded by P3-trend correction[9]. The estimated shape of the P3-trend which is used for the correction represents the underlying pattern of growth in the very long run. In this case the shape of this P3-trend reveals a number

---

[7] Characterising price series as 'trendless' seems rather odd from our current perspective. This does, however, not apply to the perspective of the beginning of the 20th century: the (negative) inclination of the price deflator in figure 1 does not significantly differ from zero.

[8] Gross Domestic Product in prices of 1913. Source (Smits, Horlings and van Zanden, 2000: table A.1: 109-111, table I.5: 228-230)

[9] In short, P3-trend correction entails least squares estimation of the of the P3-trend function given in footnote 37 to the data series and determination of the relative deviations from it. These relative deviations from the P3-trend are subsequently subjected to spectral analysis.

of very interesting features that deserve attention before the quest for Kondratieffs continues.

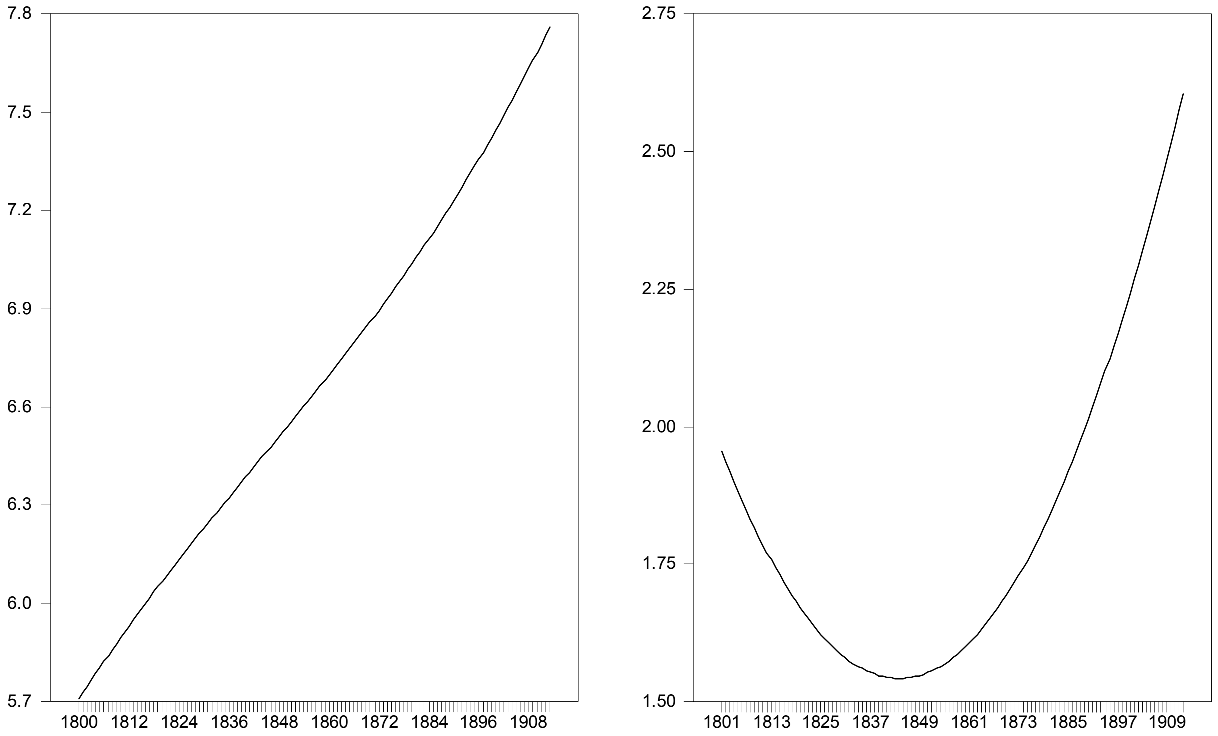

Figure 3 *Shape of the (logarithm of) the implicit P3-trend (left panel) and the course of the corresponding implicit growth rate (right panel).*

The left panel of figure 3 displays the logarithm of the implicit P3-trend. Its striking feature is that it exhibits an inverse S-shape (degressive increase in the beginning and a progressive increase at the end of the time interval) with an inflection point in 1844. The location of this inflection point is clearly marked in the right panel of figure 3 which depicts the implicit growth-rate of the P3-trend. The growth rate is positive during the whole interval but steadily decreases from a starting level around 1.8% in the beginning of the century to a minimum level of about 1.5% in 1844 to rise again to 2.6% towards the end of the period considered. The presence of the inflection point in 1844 signifies that the middle of the century forms a kind of watershed in the pattern of development of the Dutch economy. As such there is nothing new in this for economic historians. There is a kind of consensus that things took a favorable turn somewhere in the middle of the century. The issue is, however, what was the character of Dutch economic development before and after this turn. In this respect the inverse S-shape of the P3-trend is of the utmost importance. In mainstream economic theory the idea is that at a certain stage of its development the pattern of growth of an economic system takes the form of an S-shaped life cycle curve. At the start of this life cycle, growth rates are high. In the final phase, when the saturation level is reached, the growth rates taper off. If applied to the implied shape of the trend, such a curve turns its convex side to the axis of time whereas in its final phase it turns its concave side towards the axis of time. From figure 7 (in appendix 1) it appears that British industry did exhibit this pattern. The Dutch pattern of development clearly deviates from this. The Dutch P3-trend turns its concave side to the time axis in the first half of the century whereas it just turns its convex side to the time axis in the second part of the century. If the image of an S-shaped life cycle is an adequate representation of the tendencies of development of an economic system, the conclusion must be that the development of the Dutch economy manifests itself in two shapes which belong tot different life cycles: as the final, declining, phase of an old life cycle of development in the first half of the century and as the initial, rising, phase of a new life cycle of development. I will return to this issue in the final section of this paper.

Amplitude spectrum

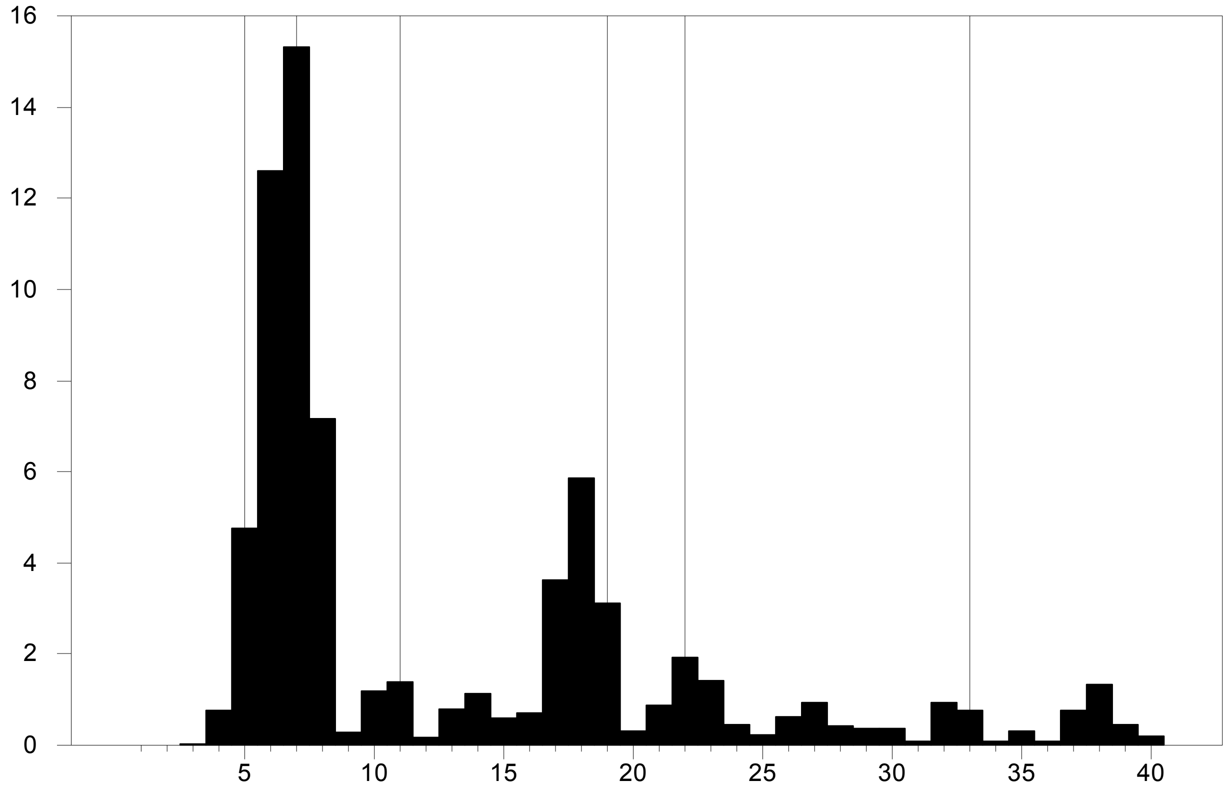

Figure 4 *Amplitudespectrum GDP (constant prices) after P3-correction (1-4 Trend-domain, 5-7 Kondratieff-domain, 11-19 Kuznets-domain, 22-33 Juglar domain).*

Let us now turn to the analyis of the residuals that remain after P3-correction. The amplitude spectrum of GDP is depicted in figure 4. It is apparent from the figure that also in this case there is a clear concentration of power in the Kondratieff-domain. It explains 32.72% of residual variance, whereas the Kuznets-domain explains 17.33%, the Juglar-domain 8.41% and the Kitchin-domain 11.41%. Consequently the Kondratieff wave must be clearly visible. This is illustrated in figure 5, which contains the residual after P3-correction and the corresponding approximation of the Kondratieff-wave. Analogous to the price series, the Kondratieff wave is apparent in this case. It has a minimum around 1815, a maximum in 1838, a minimum in 1863, and another maximum in 1888. The pattern is similar to the pattern in the price series but it runs in the opposite direction.

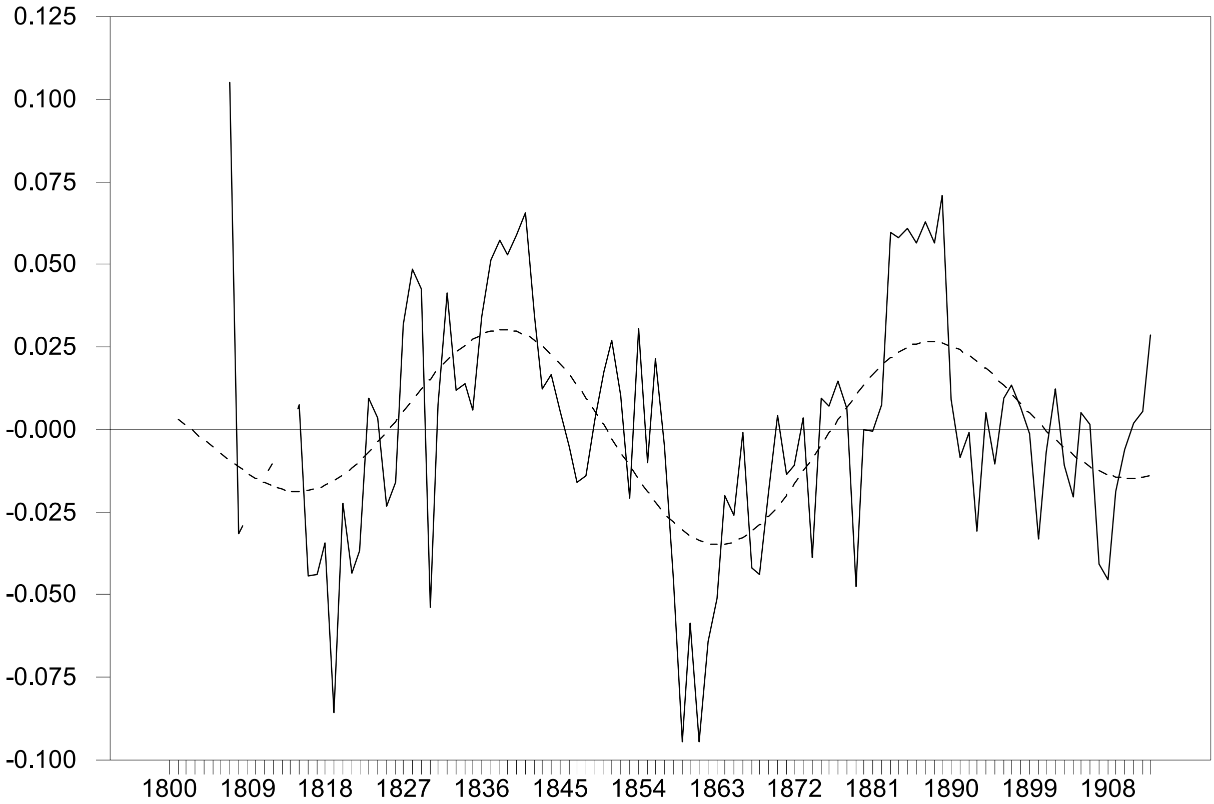

Figure 5 *Trend deviations GDP (constant prices) and proxy of the GDP-Kondratieff .*

This result is very interesting, not only because it establishes the existence of a Kondratieff wave in the volume of GDP, but also - or may be even particularly so - because this volume-Kondratieff runs counter to the price-Kondratieff. This result contradicts the conventional view that price- and volume cycles are consonant (that is that they tend to run in the same direction). An acceleration of volumes as a rule generates an upward pressure on prices whereas a deceleration of volumes slows down price increase. If this 'stylized fact' of conventional business cycle theory has general validity, we must conclude that the Dutch Kondratieff-wave has an a-typical path of development. It is improbable that Dutch economic development does not obey the economic laws that obviously govern the rest of the world. There is, however, a possibility that in view of its level of development and its degree of integration, the Dutch economy of the 19th century did not have the structure necessary for an endogenous[10] business-cycle. From this point of view, the nineteenth century Netherlands are only an economy in a nutshell that rocks and rolls on the waves that are generated by the world economy. The waves are forced upon it externally and the economy must find a way to maintain its internal stability amidst a rough environment. This could be done by applying opposite lock, by countering foreign price rises by cutting back production and vice versa. The fluctuations in Dutch price and volume levels would in this case be the expression of, what Ridder in his analysis of the Dutch short business cycles 1848-1860 has called, 'derived' cycles (Ridder, 1935)[11].

---

[10] An *endogenous* cycle is internally generated by the economic system proper. Conversely, an *exogenous* cycle is considered to be the adaptation process following an external impulse to the system (a natural disaster or a major war)

[11] Similar results regarding shorter cycles in the nineteenth century are reported in a recent study by Jacobs and Smit (Jacobs and Smits, 2001). It is interesting that Wintle (between the lines) draws the opposite conclusions with regard to the Kondratieff movement (Wintle, 2000: 239).

4. Analysis of various volume indicators

It would be premature to draw far reaching conclusions with regard to the 'derived' cycles at this point. It is important first to check whether the observed phenomenon is merely an incident or that it occurs on a wider scale. To check this, a greater number of volume indicators is analyzed. With this analysis there are three central questions:

1. Does the P3-trend of the indicator concerned have the typical inverse S-shape or not?
2. Does the indicator concerned contain a Kondratieff wave or not?
3. Is this Kondratieff consonant with the price-Kondratieff or not?

The basis for such an such an analysis is laid in the previous section. Analogous to the application to the development of the volume of GDP, P3-trend correction followed by spectral analysis is applied to the remaining volume indicators. Subsequently various categories of expenditure (private consumption, private capital formation, public consumption, public capital formation), exports and imports, output of various sectors (agriculture, fisheries, manufacturing and services), factor inputs (labor and capital) as well as factor productivities and factor rewards are put to the test. The results of these analyses are summarized in table 1.

Table 1: Summary of main findings

Variable*	Explained variance per domain					Kondratieffs turning points					Trend	
	Kondratieff	Kuznets	Juglar	Kitchin	P	T	P	T	P	TL	K	IP
Price deflator GDP	38,99	8,22	18,94	4,73	1814	1842	1869	1894	..	5		
GDP constant prices	32.72	17,33	8,41	11,41	..	1816	1839	1864	1889		-	1844
Private consumption	56.05	6,79	5,47	6,09	..	1811	1835	1860	1886	-2	e	
Private fixed cap. form.	33,03	9,22	10,47	7,61	..	1807	1830	1855	1880	-8	e	
Public consumption	7,22	7,84	17,73	21,17							-	1851
Public fixed cap. form.	7,63	17,54	12,67	10,96							+	1865
Exports goods	46.26	9,12	11,3	7.34	1806	1832	1859	1886	..	-5	+	1860
Exports services	76,7	39,5	6,18	11,65					..		-	1865
Imports goods	22,92	10,7	3,67	10,03	1810	1836	1864	1891		0	+	1838
Imports services	8,24	37,33	8,25	13,69							-	1841
Industrial production	63,8	6,01	4	4,65	..	1815	1839	1864	1889	1	-	1841
Services production	3,35	14,66	13,28	26,98							-	1852
Agricultural production	6,81	10,26	17,08	19,99							-	1886
Fisheries	14,07	17,05	18,94	16,7	1803	1833	1863	1892	..		e	
Labor input	46,05	24,11	2	2,22	..	1819	1846	1873	1899	8	-	1849
Labor productivity	33,16	15,42	10,71	11.59	..	1814	1837	1862	1888	-1	-	1846
Real wage	57,42	8,69	12,16	3,63	..	1815	1840	1866	1892	2	e	
Capital stock	75,63	6,62	1,05	0,25	..	1815	1839	1864	1890	1	-	1873
Capital productivity	10,32	16,74	15,87	17,16							-	1887
Real capital reward	12,53	18,53	14, 91	2078	..	1810	1832	1856	1881	-6	d	1858
P.M.**												
Interest	5639	10,46	7,38	4,39	1824	1850	1875	1900	..	11	-	1873
Manufacturing share	56,44	10,03	3,48	5,07		1812	1836	1861	1887	-2	e	
Unemployment %	38,29	17,65	5,28	7,89		1824	1849	1874	1899	11	-	1874
T	Trough											
P	Peak											

Table 1: Summary of main findings					
Variable*	**Explained variance per domain**		**Kondratieffs turning points**		**Trend**
TL	Average time lag				
K	Kind of trend (- = reversed S-shape, + = S-shape, e = exponential, d = decreasing)				
IP	Inflection point				
*	Source: Smits, Horlings and van Zanden, 2000; Smits, Horlings and van Zanden, 1997; Albers, 1998 Also see DHDA, 2000				
**	The Kondratieff's in the share of manufacturing in domestic output, the development of the rate of interest and the unemployment rate will be dealt with below.				

From the table it can de concluded that the pattern of long term development of the Dutch economy in the period 1800-1913 is in the majority of cases characterized by the simultaneous presence of long cycles of the Kondratieff type and a systematic long run movement (SLRM) in the trend-domain. The Kondratieff cycle clearly manifests itself in 15 out of the 22 series analyzed. This includes of course the price series but most importantly it is also typical of a number of volume series including GDP in constant prices, the volume of private expenditure (private consumption, private fixed capital formation), the volume of exports and imports of goods, factor inputs (labor as well as capital) factor rewards and labor productivity. From the seven series which do not contain a significant Kondratieff, two relate to public expenditure (consumption and capital formation), three on the services sector (service output, exports of services, imports of services), one on the output of the agricultural sector and finally one on capital productivity.

The foregoing justifies the conclusion that the development of the Dutch economy in the period 1800-1913 is characterized by the presence of a prominent Kondratieff wave[12]. In a general sense the present analysis confirms the results of a comparable study of Kondratieff dynamics in the English economy (Reijnders, 1990; Reijnders, 1992). There is, however, an important difference between Kondratieff dynamics in the Dutch and the English economy in that the English price and volume Kondratieffs are consonant (develop in step), whereas the Dutch price and volume Kondratieffs run in opposite directions. This typical feature requires a separate explanation that will be developed subsequently.

According to the overview in table 1, the results may be classified in accordance with two aspects. The first is the trend aspect wherein three main groups can be distinguished:

- A group with an inverse S-shape
- A group with a regular S-shape
- A group with a (quasi) exponential shape

The second is the aspect of the Kondratieff waves wherein two groups can be distinguished:

- A group characterized by the presence of Kondratieffs. It can be further subdivided into:
    - The sub-group where the Kondratieff is consonant with the price-Kondratieff.
    - The sub-group where the Kondratieff runs in the opposite direction of the price-Kondratieff
- A group where the existence of Kondratieffs can not be established.

The arrangement of results according to the two mentioned aspects is depicted in table 2 below. Columns represent the trend aspect and the rows the Kondratieff aspect (series running in consonance with the price-Kondratieff are in italics).

[12] The conclusions with regard to the existence of Kondratieffs raise the question whether the present results are the direct or indirect consequence of the methods applied, especially the P3 trend correction. To prevent erroneous conclusions in this respect, an alternative test of the Kondratieff hypothesis, which does not rely on prior trend elimination, is presented in appendix 2. The results of the alternative test (spline regression) corroborates the present conclusions and demonstrate the robustness of the Kondratieffs identified here (see appendix 2).

Table 2: Kondratieff- versus trend-aspect				
Kondratieff		Trend shape		
		S-shape	Inverse S-shape	Exponential
+		*Exports goods*		
+		*Imports goods*		
+				*Fisheries*
+				Private investment
+				Private consumption
+				Real wages
				Share manufacture
+			GDP volume	
+			Industrial production	
+			Labor input	
+			Labor productivity	
+			Capital stock	
			Real capital reward*	
			Interest rate	
+			Unemployment %	
-		Public. Investment		
-			Public consumption	
-			Output services	
			Agricultural production	
-			Exports services	
-			Imports services	
			Capital productivity	

From the table two important characteristics can be derived. First it appears that the majority of series is characterized by an inverse S-shaped trend. Second it appears that the majority of volume-Kondratieffs run in the opposite direction of the price-Kondratieff.

It is striking that the regular S-shape is particularly characteristic of series relating to international trade. Obviously these series follow the pace and tendency set by the leading economies of the time, particularly England of which we have seen that it is typified by a regular S-shaped trend. Conversely, the indicators relating to domestic development are practically all characterized by an inverse S-shaped trend. Comparing this pattern to the regular S-shaped pattern that is typical of the development of British industry, would lead to the conclusion that this is the manifestation of a 'hegemonial cycle'(Kleinknecht, 1987; Wallerstein, 1980; Simiand, 1932), a matter of 'crowding out' in the international market. The accelerations of the English economy go at the expense of a relative deceleration of the growth of Continental economies such as the Dutch. The last mentioned only get leeway for their acceleration of growth once the growth of the English economy loses its momentum. The problem with this interpretation is that with the crowding out hypothesis one would expect that especially exports suffered from the hegemony of the English industry. This does not happen to Dutch exports. It is not that Dutch domestic production in the first half of the century stagnates because of a stagnation of goods exports and expands in the second half of the century because of an expansion of goods exports. Rather, domestic production stagnates (expands) in spite of (or may be because of) the expansion (contraction) of goods exports. There need not be crowding out in quantitative terms which expresses itself in a relative decrease of production. It may also be a matter of crowding out in a qualitative sense. In this case the Netherlands would be forced to change its export mix in such a way that it has to resort to less productive activities. In this vein, under the pressure of the English hegemony, the Netherlands would have specialized in a product mix with lower value added whereas it used the ellbow room that was created by the decline of the British dominance to switch to a product mix with higher value added. The fact that the trend in labor productivity is also characterized by the typical inverse S-shape is also indicative of this. The implied change in the product mix is also visible in the development of the share of industrial production in total domestic product[13]. The trend in the share decreases until 1848 to increase thereafter (the P3-growth rate increases from -0.47% in the beginning to 0.76% at the end of the period). On the assumption that the manufacturing sector represents a higher productivity level[14] than the other sectors, productivity growth slows down before 1848 when the share of manufacturing decreases, to accelerate after 1848 when the share of manufacturing goes up.

If one looks at the concordance between prices and volumes in the Kondratieff domain, it stands out that the international trade-Kondratieffs (which are volume series) run in step with the price-Kondratieffs whereas the majority of the domestic volume series run in the opposite direction of the price-Kondratieffs. This observation contradicts conventional wisdom with respect to the relation between macroeconomic variables:

1. In conventional business cycle theory the point of departure is that price- and volume cycles develop in step. The higher level of activity during the boom phase of the cycle puts pressure on factor markets, which leads to an upward pressure on factor rewards, which is translated into a rising price level. *Mutatis mutandis*, the reverse takes place during the depression phase of the cycle.
2. In the conventional theory of a small open economy, the point of departure is that an exogenous increase in the level of international trade, gives an impulse to the domestic economy which translates into an increase in the level of economic activity.

The observed 'anti cyclicity' in the Kondratieff domain, which is the counterpart of the earlier observed reverse movements in the trend domain, requires an explanation. With regard to the first point, one has to appreciate the fact that the hypothesis of consonance between price- en volume movements presupposes that the country in question indeed generates an endogenous cycle. The issue is, however, whether the structure of the Dutch economy of the 19th century was such that it can be considered capable of generating a business cycle of its own. After all an endogenous cycle makes demands on the level of development of industry, the magnitude of the share of industrial production in total domestic production, the degree of integration within the economy and the level of development of the banking system. It is doubtful whether the Netherlands met these requirements at this stage (Brugmans, 1950: 76 ff.; Brugmans, 1961: 272; Ridder, 1935: 10 ff.). Under the circumstances the odd situation occurs that the Netherlands is confronted with cyclical fluctuations which it cannot have generated on its own. Accordingly the cause of the fluctuations must be found outside the Netherlands. The fluctuations present an exogenous phenomenon mirroring cycles generated by higher developed foreign economies. De Ridder designates this phenomenon as 'derived cycles'. He assumes that the original impulse for these movements is generated by England (Ridder, 1935: 13).

Defining the Dutch Kondratieffs as 'derived cycles' does, however, not explain the inverse relationship between prices en volumes. It does, however, present the beginning of an explanation to which I will turn subsequently.

Before going into this it is necessary to dwell upon the second puzzle, the fact that domestic volume cycles develop in the opposite direction of the international cycles. After

---

[13] Share of value added of industry in gross domestic product (current prices). Source: (Smits, Horlings and van Zanden, 2000)

[14] See footnote 15.

all in the standard textbooks, exports are normally interpreted as an external impulse which stimulates domestic production. The implicit assumption is that aggregate output variables are defined in terms of one homogeneous standard good (Blanchard, 2000). In reality, however, goods are heterogeneous. Particularly so in case of international goods trade. Taking into account that international trade develops along the lines of comparative advantage, one must take account of the fact that increase in international trade involves a reallocation of productive activity. This implies a change in the structure of production. Well, if the Netherlands is exposed to an expansion of international trade, and if it has a comparative advantage in the area of non-industrial production, the expansion of international trade translates for the Dutch economy into a change of the structure of production in favor of non-industrial goods. If one assumes that non-industrial production is characterized by a lower absolute level of productivity[15], that is lower value added per volume unit of factors of production, a change in the structure of production will lead to a decrease of macroeconomic productivity. This in turn will slow down economic growth given the limited availability of productive resources.

On the basis of the foregoing it appears that various pieces of the puzzle start falling into place. The contours of the solution of the existence of the Dutch 'anti cycles' can be outlined as follows:

1. If the Dutch Kondratieff cycle of the 19th century Netherlands is a derived - exogenously generated - cycle, where fluctuations so to speak are 'imported' from abroad, it is conceivable that price- and volume cycles run in opposite directions.
2. If exogenous movements in exports are translated into a reallocation of production between different sectors, it is conceivable that an increase in exports results in a lowering of macroeconomic productivity.
3. If the decrease of macroeconomic productivity takes place in an environment wherein an expansion of production comes across the limited availability of one or more (material or financial) productive resources, it is conceivable that the growth of domestic production slows down.

We are near the solution. There is only one missing link. The Dutch 'anti cycle' can be explained if the development of the Dutch economy in the 19th century was factor constrained in one way or the other. This factor constraint must be such that it interacts with the international cycle in such a way that its effect is strong in the rising phase of the international cycle whereas it is mitigated in the declining phase of the international cycle. Bottlenecks of this kind can occur in the area of labor supply or the supply of capital (both in real and financial terms).

Let us consider labor supply first. As we have seen before, the P3-trend as well as the Kondratieff in employment (labor input) move in step with those of GDP. If labor supply would be a bottleneck, an increase in employment would have resulted in a lower unemployment rate before the Kondratieff turning point is reached. Accordingly, the unemployment rate could answer the question whether labor supply was a bottleneck or not. If the usual method is applied to the unemployment rate [16] it turns out that the P3-trend rises until 1845. After that there is a drop in the level which lasts until 1905. After that a new rise sets in. The inflection point is in 1875. The unemployment rate exhibits a clear Kondratieff, which explains 38.29% of the residual variance. The unemployment-Kondratieff has a maximum at the start of the period, a minimum around 1824, a maximum in 1849 and a new minimum in 1875. Accordingly the unemployment-Kondratieff has the characteristic inverse path be it that it has an considerable time lag relative to the GDP-Kondratieff. This implies that unemployment rises towards the end of the GDP-Kondratieff and keeps on rising after the upper turning point. This inevitably

[15] In this case, of course, the relevant productivity measure is 'total factor productivity', that is output per unit of combined factors of production (labour, capital and land): (Solow, 1957; Blanchard, 2000, 246-47).

[16] Source: (Smits, Horlings and van Zanden, 2000: table C.2, 118-20).

leads to the conclusion that the turning point in the GDP-Kondratieff can not be explained by a bottleneck in the area of labor supply[17]

Where the factor capital is concerned, the consensus is that real capital is a reproducible factor of production that can only form a bottleneck in the short run. Because here we are concerned with the long run only, it would be inconsistent to look for a bottleneck in the sphere of real capital. The sphere of financial capital, the monetary sphere[18] is more promising in this respect. Around 1780 a process started where the Netherlands lost their leading position in trade and banking. The demise of the Netherlands requires a long an painful process of adjustment. For many observants, these adjustment problems and the concomitant conservatism of bankers formed the onset of a protracted period of economic stagnation. This is their principal explanation of the belated industrialization of the Netherlands (Mokyr, 1974: 377; Mokyr, 1976: 147-8; See also: Jonker, 1997: 94). Until the end of the 1840-s the Dutch monetary system hobbled on the basis of a double standard (gold and silver). This was - in an environment of lacking confidence in the stability of the system and with deficient support of paper currency issued by the Dutch Circulation Bank and a strong region-oriented system of cashier's paper - mainly characterized by a high degree of rigidity. The return of confidence had to await the reconstruction of the Government debt, the abolishment of bi-metalism and the establishment of the silver standard towards the end of the 1840s. Thanks to its role as (co-)director of the earlier mentioned reorganizations the 'Nederlandse Bank' strengthened its position as the national circulation bank. Under the leadership of the 'Nederlandse Bank' the rigidities that characterized the monetary system in the first phase where gradually removed in the second half of the century. The resulting upward shift of the monetary 'ceiling' created some ellbow room for the process of growth although it must be noted that the rules of every metal based monetary system (a silver standard until 1873, a gold standard thereafter) has the property that the money supply is very inelastic (Visser and Goor, 1997: 38). From the point of view of the money supply, the first half of the 19th century seems to have been characterized by a phase of considerable rigidity of money supply ((compare van Zanden and van Riel, 2000: 201 ff. and 265 ff.)). This might explain the degressivity of trend growth in the first half of the century. The higher degree of upward flexibility of the monetary system might then explain the progressivity of trend growth in the second half of the century. The general lack of flexibility that is characteristic of all metal standards might explain why the monetary sphere can nonetheless act as a bottleneck in the Kondratieff domain.

The identification of the monetary sphere as an impediment to development is especially interesting because it may give a clue to the understanding of the Dutch 'counter cycle' in the period considered. The explanation may be found the so-called 'Keynes effect', the wealth effect in the money market that occurs as the consequence of a change in the price level (Snowdon, Vane and Wynarczyk, 1994: 71; Morgan, 1982: 39). According to Keynes there is a connection between the realm of goods and the realm of money wherein the interest rate acts as a transmission mechanism. A change in the realm of money, for instance an increase in the real money supply translates into a fall in the rate of interest. The fall of the interest rate acts as a stimulus to expenditures (consumption as well as investment), which leads to an increase of the level of production and employment. Because the real money supply equals nominal money supply divided by the price level ($M_{rs} = M_s/P$), given the nominal money supply, there is a negative correlation between the price level and the level of economic activity. Provided

---

[17] A similar point of view is put forward by (Wintle, 2000: 86).

[18] The point of departure is that the monetary sphere is the product of two quantities: the monetary base (which traditionally was determined by the reserves of precious metals, but presently mainly by central bank money, so-called 'high powered money') and the money multiplier (the multiplicative factor that determines the magnitude of credit). The magnitude of the money multiplier depends on the efficiency of the banking system. Given the efficiency of the banking system, the money multiplier is constant and accordingly the dimension of the monetary sphere is completely determined by the magnitude of the monetary base.

that the nominal money supply is inelastic, the inverse price- volume relationship may be explained on the basis of the 'Keynes effect'[19].

The assumption regarding the inelasticity of nominal money supply is a crucial one which is not undisputed. Various authors among which Mokyr claim that the belated industrialization of the Netherlands is consequence of the fact that the Dutch capital market was incapable of funding the emerging industry (Mokyr, 1974: 377; Mokyr, 1976: 147 ff.). This position has recently been challenged by a number of authors. As far as the first part of the century is concerned, Jonker claims that there is no indication of a bottleneck in the supply of funds to finance trade and industry (Jonker, 1996: 274 ff.). Wintle is even more determined in rejecting the hypothesis of 'capital starvation' (Wintle, 2000: 96-98, 101, 108). Van Zanden and van Riel endorse Jonker's position but add some major qualifications. In their view it is true that there is sufficient supply of financial funds but at the demand side the government lays claims to these funds to a degree that private investment is completely crowded out (van Zanden and van Riel, 2000: 196-199). The common property of all cited views is that they concentrate on what could be de called the 'efficiency of the banking system'. In other words, the arguments relate to factors determining the magnitude of the money multiplier[20]. This is only part of the story. As I said before, the dimension of the monetary sphere does not only depend on the magnitude of the money multiplier (the efficiency of the banking system) but also on the magnitude of the monetary base. This is why, even in case of the very efficient banking sector postulated by Wintle, a monetary scarcity can occur if the monetary base is restricted.

Due to a lack of data, the dimension of the monetary base or the magnitude of nominal money supply can not be determined directly. There is, however, a possibility to test the monetary scarcity hypothesis in an indirect way. Because changes in the money market are transmitted through the interest rate mechanism, the last mentioned can be used as an indicator of the situation in the monetary sphere. Application of the usual method to the development of the rate of interest[21] in the period 1800-1913 results in a P3-trend that exhibits a rising tendency up to 1840 (the advent of the reconstruction of state finance and the monetary system) and a declining tendency up to 1907. The rate of interest exhibits a prominent Kondratieff explaining 56.39% of total variance[22]. The interest-Kondratieff has a minimum in the beginning of the period, a maximum in 1824, a minimum in 1850, and another maximum in 1900.

Comparison of the timing of the interest rate-Kondratieff with that of the price-Kondratieff leads to the conclusion that the peaks and troughs of the price-Kondratieff more or less coincide with the inflection points of the interest rate-Kondratieff. This implies that the interest rate goes up as long as the price level exceeds its average level whereas the interest rate goes down as long as the price level is below average. This confirms the hypothesis that above average price levels make the economy touch the

---

[19] In a certain sense, the present explanation on the basis of the 'Keynes effect' is a variation on Tugan Baranowsky's 'loanable funds'-theory of the business cycle that is also propounded by Kondratieff as an explanation of the mechanism of the Kondratieff wave (Kondratieff, 1928; Tugan-Baranowsky, 1901). The essential difference, however, is that Kondratieff and Tugan Baranowsky's assumed consonance between price- and volume movements, whereas here we are talking about inverse price- and volume movements.

[20] See footnote 18.

[21] The nominal long term interest rate on the private market in the province of Groningen is used as a proxy. Source: (Albers, 1998: table A-169). The widely used yield on Government bonds is not suitable in this case. The deplorable state of Dutch public finances in this period required the payment of high risk premiums, which heavily distort the yield series.

[22] The observed Kondratieff fluctuations prove Wintle to be in the wrong: 'The final nail in the coffin of the capital starvation thesis, alongside the plentiful supply of funds and excellent financial institutions, is the persistently cheap price of that financial capital in the Netherlands.' He bolstered his contention by stating: "Interest rates [...] had fallen to as low as 3 percent in 1790, and at the end of the long nineteenth century in 1910 they were still only around the 3.5 per cent mark.". As if time stood still between 1790 and 1910!

ceiling determined by the magnitude of the money supply, whereas below average price levels alleviate the monetary tension.

On the basis of the foregoing, the Dutch 'derived counter cyclicity' may be explained as follows: the expansion phase of an externally generated world cycle drags the Dutch economy along through the volume of its international trade. This positive impulse is, however, transformed into a negative influence from the Dutch perspective because it is accompanied by an increase of the general price level. Given the rigidity, or later the inelasticity of the Dutch monetary system, this rising price level translates through the Keynes effect in a retardation of the volume growth of the Dutch economy. This retardation is accompanied by a reshuffling of productive resources in such a way that the most productive sectors (manufacturing) lag behind whereas the less productive sectors expand. This reshuffling can be traced back to a restructuring process where foreign countries have a comparative advantage with regard to industrial production whereas the Dutch economy in view of its comparative advantage has to fall back on non-industrial activities. The effect of this reshuffling process can be observed in the fluctuations in the share of industry in domestic production, which as we have seen before, runs almost exactly in step with the domestic volume-Kondratieff and in counter phase to the international volume Kondratieff[23].

5. Conclusion Considering the results so far, the present analysis sheds a new light on the ontology of the Kondratieff wave and of the 'derived cycle' in its domain. In conclusion I want to give some thoughts on a periodization of the development of the Dutch economy which is based on macroeconomic criteria. In the foregoing it appeared that the long term pattern of development of the Dutch economy is composed of an inverse S-shaped trend and a Kondratieff wave which is superimposed upon it. If the growth rate[24] of GDP is taken as a measure, the long term pattern emerges as the image represented in figure 6.

From the point of view of the longest run, one can distinguish the period before and after 1844: a phase of stagnating trend growth followed by a phase of accelerating trend growth. This succession of a stagnating and an accelerating rate of growth produces the typical pattern of an inverse S-shape suggesting that there is a kind of watershed in economic development around the middle of the century. On the basis of the conventional assumption that the normal pattern of development follows a regular S-shape, the first half of the century appears as the declining phase (the final part of the S-shape) of the life cycle of the old system, whereas the second half of the century appears as the pioneering phase (the first part of another S-shape) of a new system: 'modern'economic growth. At first sight this state of affairs seems to be consistent with the view that the Netherlands had a 'take off', the transition from a backward agrarian society to a modern industrial economy (Jonge, 1968; van Stuijvenberg, 1970). In view of the actual course of the growth rate this interpretation is however incorrect. In the first place because the first half of the century did not witness stagnation in the sense of an absolute decline or the occurrence of a nearly stationary state (van Stuijvenberg, 1970). The expression 'stagnation' does not fit the fact that in this period the average growth rate remains relatively high in spite of the systematic decline in the pace of growth. It rather is a matter of relative stagnation in the sense that the high growth rate of the beginning of the century gradually declines in the first part of the century[25].

---

23 Note that he present explanation of the Dutch 'derived counter cycle' is complementary to van Zanden and van Riel's explanation of the 'reverse' development of the Dutch economy during the deceleration of growth in the middle of the 19th century (van Zanden and van Riel, 2000: 240 ff.).

24 In interpreting figure 6 one must be aware of the fact that there is a phase difference between a representation in growth rates and in levels. The extremal points in the growth rate series correspond to the inflections points in the levels and the inflection points in the growth rate series correspond to extremal points in the levels.

25 Compare: (Mokyr, 1974; Mokyr, 1976).

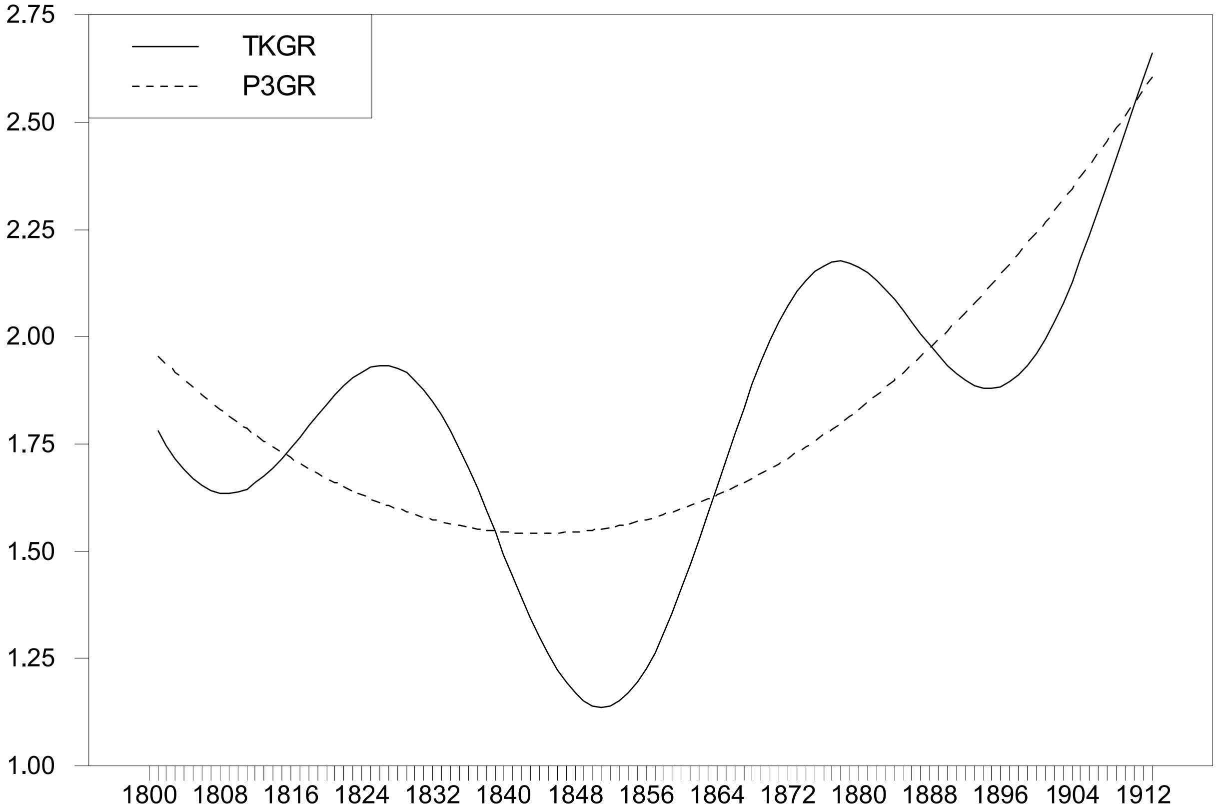

Figure 6 *Development of trend growth (P3G) and the growht rate of trend plus kondratieff (TKG) in GDP (volume).*

In the second place there was no 'take off'in the sense that the economy in a very short time jumps to a structurally higher level of growth. It was rather a matter of slowly catching up, a process where the Dutch economy, after a period of relative stagnation, struggled back to the original trend level of growth. It was not a backward country that suddenly leaped into the modern era but rather the gradual development of a system that after a temporary setback had found its way back up again. Accordingly there emerges an image of the character of Dutch economic development in the 19th century that is consistent with the representation of van Zanden, van Riel and others (van Zanden and van Riel, 2000; Smits, 1995; Horlings, 1995). It is only consistent with Griffith' representation as far as the acceleration of growth in the second half of the century is concerned but it differs with respect to his representation of the first half of the century. His idea of 'balanced growth' does not fit very well the systematic decline of the growth rate that is visible in figure 6 (Griffiths, 1979).

The U-curve in the growth rate which marks the watershed in 1844 belongs to the domain of the trend and represents the basic pattern of Dutch economic development in the nineteenth century. The basic pattern is however accentuated by the superimposition of the movements representing the Kondratieff domain. On the basis of this a more refined periodization can be obtained wherein both the extremal points of the Kondratieff movement and its points of intersection[26] with the U-curve are significant. The period of the 'Batavian Republic'[27] and the annexation by the France was characterized by growth rates below the trend level. Although growth rates were low,

[26] The points of intersection with the U-curve of course correspond to the inflection points of the Kondratieff.

[27] After the Patriot revolution of 1795, the name of the Dutch Republic was changed to 'Batavian Republic'. It lasted until 1806 (Israel, 1995: 1122 ff.).

they were rising so that the trend level is surpassed just after the accession of King Willem I. The upward movement lasts until 1828, the eve of the Belgian uprising. After that a decrease of the growth rate sets in which lasts until 1851. It is important to consider the points of intersection of 1815/16 and 1838/39 which indicate that the growth rate exceeded the trend rate during nearly the whole reign of King Willem I. It was not before the financial crisis of 1839 and the abdication of Willem I that the growth rate dropped below the trend level to reach its low point at the end of the period of reconstruction of public finance and the liberalization of trade, which largely covers the reign of King Willem II. The constitutional revision of 1848 and the launching of Thorbecke, the frontman of the liberals who took on is first ministerial office in 1849, more or less marks the lower turning point in the development of the growth rate. The following period witnesses a strong recovery of the growth rate such that the trend level is matched again in 1862/63. In the interval between the points of intersection of 1838/39 and 1862/63, which roughly coincides with the period that has been termed the ' Liberal offensive' or 'Liberalization' (van Zanden and van Riel, 2000: 209 ff.; Wintle, 2000: 146), the growth rate was below the trend rate. The first period between 1838/39 and 1851 can be considered a period of reconstruction which inevitably precedes the phase of modernization that is put into effect in the time between 1852 and 1862/63. Catching up with trend growth (which in the meantime has risen itself) creates the point of departure for the process of 'modern' economic growth in which "the enlargement of the internal market and its accelerated integration gave a strong impetus to growth" (van Zanden and van Riel, 2000: 377). Again, the growth rate is raised above the trend level throughout the continuation of the upswing that lasts until 1975, during which according van Zanden and van Riel the first of two "spurts of the growth of industry" takes place (van Zanden and van Riel, 2000: 241, 377 ff.). The ensuing downswing between 1875 and 1899 coincides with Chandler's "second industrial revolution" (Chandler, 1990) wherein a fundamental reorientation of production technology takes place and wherein after a likewise fundamental transformation of the institutional structure of industry (van Zanden and van Riel, 2000: 380) the time is ripe for a second "spurt of the growth of industry", the - in the eyes of de Jonge - real 'take off' of Dutch industry.

The present, on macroeconomic criteria based, periodization of the development of the Dutch economy contained in figure 6 quite accurately follows Van Zanden and van Riel's periodization which is mainly based on historiographical criteria. The present analysis adds something to it. On the one hand it accords on the general level with the time pattern contained in Van Zanden and van Riel's periodization. On the other hand it creates a link between the general level of economic development and the specific pattern in which it manifests itself in concrete macroeconomic categories. It reveals the structure of its interrelations. This might create the possibility to reconstruct the 'mechanism' of economic development in the period under consideration. The combination of such an insight in the dynamics of the economy proper with an insight in the dynamics of the institutional setting within which it develops, leads to a better understanding of what really happened. As far as the understanding of Dutch economic development in the nineteenth century is concerned there is a world to win when the richness of Dutch economic historiography is combined with the theoretical background of the economics of the Kondratieff phenomenon that was the focal point of this paper.

Appendix 1: Methods

Spectral analysis is based on the proposition that every time series of *n* observations can be approximated by the sum of an ordered set of *n/2* periodical functions. The amplitude of these periodical functions indicates the contribution of the given periodical component to the total variance of the time series under consideration. In this way it is possible to decompose a given time series into a number of individual contributions which are associated with specific periodical components (cycles) with different durations. To be able to determine the importance of the various cycle types, the total variance of the time series is decomposed into the simultaneous contributions of the various periodical components (cycles) present in the series. This is obtained by calculating the amplitude spectrum of the series.[28] The amplitude spectrum of the GDP deflator is depicted in figure 2 in the main text[29]. The vertical axis measures the amplitudes (the relative contributions to the total variance of the series[30]) of the periodical components that are represented on the horizontal axis. The cycle length of each component equals 256 divided by the component number (1..128) minus one[31]. The cycle lengths of components 5, 6 and 7 equal 256/4=64.0 years, 256/5=51.2 years and 256/6=42.67 years. Consequently they belong to the domain of the Kondratieff wave. In a similar fashion the domains of the trend (components 1- 4), the Kuznets cycle (components 11-19) and the Kitchin cycle (components 51-87) can be defined. The various domains are distinguished in the figure by vertical lines.

From the amplitude spectrum of figure 2 can be deduced that the Kondratieff domain explains 38,99% of the variance[32] of the trend deviations of the GDP deflator. The corresponding figures for the other domains are: 8.22% for the Kuznets domain, 18.94% for the Juglar domain and 4.73% for the Kitchin domain. These figures and the visual impression of figure 1 (main text) indicate that the Kondratieff is a crucial element in the explanation of the variability of the GDP price deflator.

The amplitude spectrum is not only useful for determining the relative explanatory powers of a certain cycle type. It can also be directly used as a device to approximate the general tendencies of the series in question. By summing the power concentrated in

---

28 The method is a simplified version of the spectral analytic test that has been used in (Reijnders, 1990: chapter 7, 218 ff.). It consists of a trend correction procedure followed by the determination of an unsmoothed amplitude spectrum by means of Fourier transformation. The amplitude spectrum is also used as an instrument to generate an approximation of the long run pattern. It acts as a low pass filter that only leaves the low frequency components (long waves) intact and removes all high frequency components (short run movements).

29 The amplitude spectrum is equivalent with the Fourier transform of the series. In the present application, the amplitude spectrum is determined after prior elimination of a log linear trend component (the 'standard trend'. See footnote 33).

30 According to Parseval's theorem (Chatfield, 1989: 110) the amplitudes of the set of periodical components add up to equal the total variance of the series. To make the amplitude spectra comparable, each spectrum is scaled such that the amplitudes add up to 100.

31 To avoid leakage from the data window the data series are padded with zeros up to 256. The number 256 (the 8th power of 2) is selected because it enables the use of a more efficient algorithm for Fast Fourier Transformation. Another advantage of this procedure is that all data are measured on the same grid of frequencies, irrespective of the original series length.

32 The significance of the percentages of variance explained can be assessed by contrasting them with the expected percentages of variance explained (power) of the corresponding components in the theoretical spectrum of a 'white noice' process (Chatfield, 1989: 121). The power of a white noice process is 0,78% per component. The corresponding upper limit of the 99% confidence interval is 4.14% per component. Since the Kondratieff domain takes up three components, its power needs to be at least 3 x 4.14% = 12.42% in order to be considered significant. On the basis of this it can be concluded that the Konratieff domain represents a significant power in this case.

The upper limit of the 99% confidence interval of 12.42% of the variance explained for the Kondratieff domain is used as a benchmark for all amplitude spectra considered in this paper.

the lower frequency domains and adding it to the implicit 'standard trend'[33] one obtains the smooth pattern traced by the variable PROXI (the dotted line in figure 1).

Complications with mixed- and volume series
Mixed series and interference
To establish the existence of long waves, Kondratieff required that such waves must be discernable in all series representing economic development. These are price series, pure volume series as well as 'mixed' series, that have both a price- and a volume component (i.e. value series). The problem with the last mentioned series is that both the price- and the volume component may have a cyclical pattern of its own. If this is so the analysis has to take account of the possibility of interference between the two patterns. The effect of this interference critically depends upon the presence of time lags between the cyclical patterns in the price- and volume component (see also: (Reijnders, 1990: 96-116)). In the extreme case where the time lag is zero, the amplitude of the cycle in the 'mixed' series will be large because the amplitude in the price component is multiplied by the amplitude of the volume component. This is the case which Kondratieff had in mind (Kondratieff, 1926: 585). However, at the other extreme there is the possibility that the time lag is equal to B, half the duration of the cycle. In that case both cycles run in the exact counter phase. As a consequence of this they may compensate or even completely wipe each other out. Between these two extremes the two cycles will interfere to the effect that the apparent amplitude of the series is reduced and the peaks in the spectrum are shifted because the power of the two cycles is dispersed over various frequency domains[34]. Because there is no *apriori* knowledge of the time lags and amplitudes involved, one cannot exclude the possibility that the earlier mentioned interaction effects do occur. To avoid the ambiguities involved it makes sense not to follow Kondratieff's advice at this point and to skip the analysis of mixed series and immediately proceed with the analysis of volume series, as is done in the main text of this paper.

Systematic deviations from the 'standard' trend
A preliminary analysis of the development of the volume of GDP makes clear that after the elimination of the 'standard' trend still considerable power is left in the trend domain. This might be an indication of the presence of so-called 'systematic long run movements' (long term changes in the pace of growth that I will subsequently designate SLRM). The presence of such movements creates the so-called problem of 'perspectivistic distortion', that occurs with Reijnders' analysis of English time series covering the period 1700-1985 and which he tries to solve by 'standardizing the series in a certain fashion (Reijnders,

---

[33] The implicit 'standard trend'is a smooth exponential curve characterised by a constant 'standard'growth rate that is obtained by ordinary least squares of the logarithm of the data against time. It is used to identify 'waves', that is accelerations and deceleration of the growth rate, that emerge as deviations from the 'standard trend' (see (Reijnders, 1990: 154 e.v.)).

[34] What happens can be illustrated with a simple example. Suppose we have identical waves in a price and a volume series, the only difference being that one has a time lag J relative to the other. The corresponding value series V then is:

$$W = (1 + \cos(t))(1 + \cos(t + \tau))$$

$$= 1 + [(1 + \cos(\tau))\cos(t) - \sin(\tau)\sin(t)] + \{\cos(\tau))\cos^2(t) - \sin(\tau)\sin(t)\cos(t)\}$$

$$= 1 + [(1 + \cos(\tau))\cos(t) - \sin(\tau)\sin(t)] + \{\frac{\cos(\tau)}{2}\cos(2t) - \frac{\sin(\tau)}{2}\sin(2t)\}$$

In the part between square brackets the sinus and cosinus functions interact to produce alternations in the amplitude, phase and apparent periodicity of the resulting cycle. The peculiar effect on periodicity is most obvious in the part between braces which produces a wave at a double frequency (that is with half the duration) of the original wave. This explains the apparent dispersion of power in the amplitude spectrum of the value series.

1984; Reijnders, 1990: 120 ff.; Reijnders, 1992: 15 ff.). Such a solution is however beyond the scope of the present analysis. But even apart from the problem of perspectivistic distortion, the presence of (traces of) systematic long run movements entails the possibility that the amplitude spectrum is distorted by the presence of a powerful component in the trend domain that clutters the lower frequency domains. In this case it will be very difficult or even impossible to distinguish between the trend domain and the Kondratieff domain and there may even be a spill-over into the other domains. In this case something must be done about it.

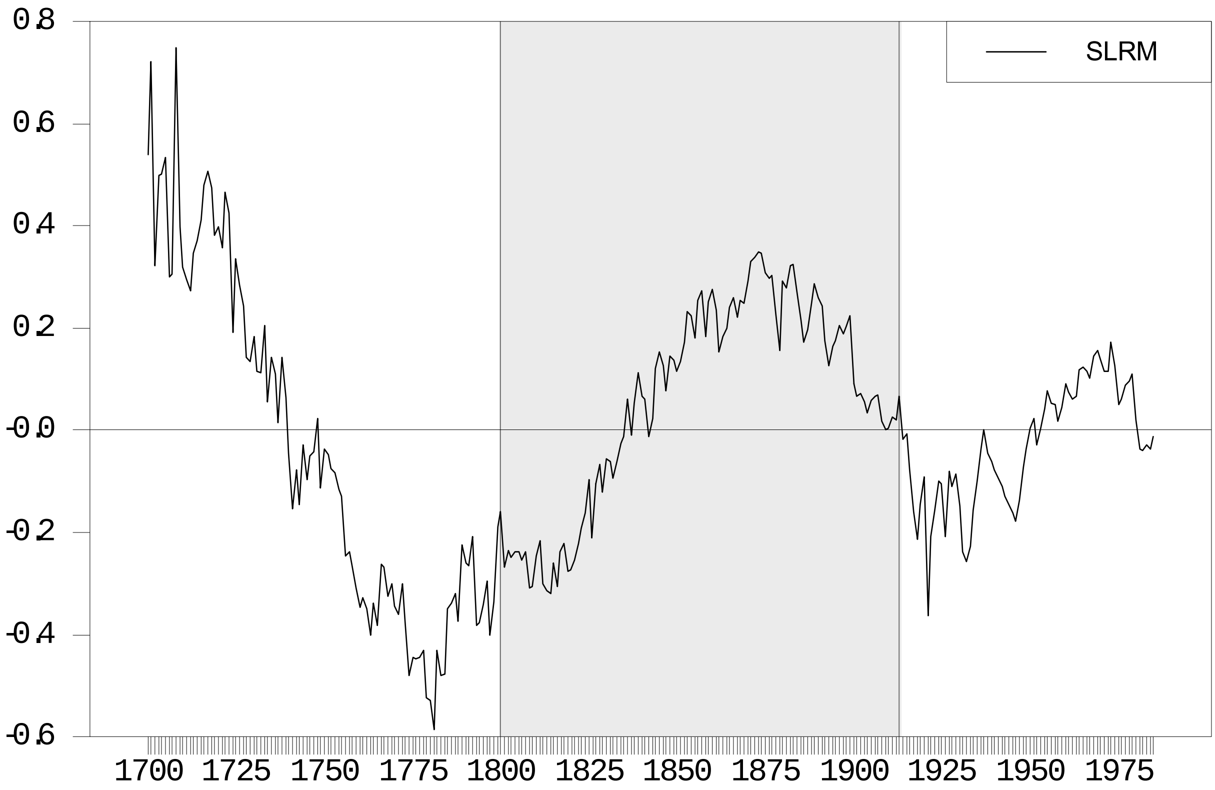

Figure 7 *Systematic long run movement in British industry (SLRM=deviations from log-linear 'standard trend'). Source: Reijnders 1990, 143.*

To come to grips with this phenomenon it is worth while to have a closer look at one of the known Systematic Long Run Movements. Figure 7, gives an example of the SLRM that applies to the British case. The figure depicts deviations from a 'standard'-trend for the interval 1700-1985 and reveals a systematic long run movement that declines until 1780, rises until 1875, declines until 1925, and rises almost until the end of the interval. Since the systematic long run movements are deviations from a log linear trend, the 'full'-trend, which comprises the standard trend and the systematic long run movement will have turns and twists around 1780, 1875 and 1925.[35] It is conceivable that the Dutch economy is characterized by similar twists. In this case we must envision the possibility that the Dutch SLRM takes a shape similar[36] to the parabolic shape between the two grid-

35 The movements of the 'full'-trend bear a strong resemblance to the tendencies of the trend in British data as measured by Crafts, Leybourne and Mills on the basis of a Kalman filtering procedure (Crafts, Leybourne and Mills, 1990, pp. 455) .

36 The shape may be similar but need not be identical. It is conceivable that the Dutch SLRM is an U-shaped parabola, whereas the British one is N-shaped, indicating that the Dutch growth accelerates where British growth recedes.

lines at 1800 and 1913. To capture this effect I propose to apply a correction to the standard trend which takes the shape of a parabola of the third degree.[37] I will designate it the P3 'full'-trend correction and accordingly call the corresponding 'full trend' the P3-trend .

Summing up

In short, the method applied consists of the following steps:

1. The P3-trend is fitted by ordinary least squares and subsequently eliminated from the data to produce standardized trend deviations.
2. The trend deviations are padded with zeros (up to 256) and subsequently Fourier transformed to produce the amplitude spectrum. The spectrum is scaled such that the amplitudes sum up to 100. The explanatory power and significance of the Kondratieff domain is assessed by adding up the relative contributions of frequencies 5, 6, and 7.
3. The path of the Kondratieff is reconstructed by an inverse Fourier transformation of the lowest frequencies (1 to 7) of the amplitude spectrum to produce an approximation (PROXI). This approximation is used to determine the Kondratieff turning points.

---

[37] A 3rd-degree parabola has 3 roots and 2 inflection points. Accordingly it is suitable to describe an S-shape, a U-shape or a straight line. The implicit formula for 'full'-trend (the corrected 'standard'-trend) is:

$$T_{Ft} = A(1+g)^{(a+bt+ct2+dt3)}$$

where g (=constant) is the growth rate of the 'standard'-trend. The exponent ($a+bt+ct^2+dt^3$) represents the SLRM

Appendix 2: Spline Regression

Earlier it was pointed out that the Kondratieffs identified in the previous sections come as a a 'package deal' together with the P3-trend so that the Kondratieffs can be said to be a by-product of the trend elimination procedure. Because Kondratieffs are essential to the argument, it is necessary to test their robustness by checking the present findings against an alternative method that does not require prior trend elimination. This can be obtained by using the Kondratieff turning points as benchmarks (knots) in a spline regression[38]. In this way one can test whether the turning points correspond to structural breaks in the original data series. The coefficients of the spline segments measure the change in slope relative to the slope of the previous segment. If the spline regression is applied to the log of the original series, the slope coefficients signify changes in the average segment growth rate. A structural break can be said to occur if the slope coefficient (S_i) changes sign. Since there are two Kondratieffs per series, three structural breaks have to be identified. The test requires that the S_i ($i>1$)[39]change sign for every subsequent segment and that all S_i ($i>0$) significantly differ from zero.

The results are given in table 3. In most cases the Kondratieff turning points correspond to structural breaks. Consequently the hypothesis holds that Kondratieffs can be identified without prior trend elimination.This leads to the conclusion that the Kondratieffs are robust and can be identified without requiring prior trend elimination.

Table 3: Spline regression. Slope coefficients S2-S4

Series	Coefficient S2	t-value	Coefficient S3	t-value	Coefficient S4	t-value	result
Price deflator GDP	0,0213	9,36	0,0194	900	0,0186	6,29	**
GDP (volume)	-0.01	-7,95	0,0089	9,82	-0,0003	-0,28	*
Private consumption	-0.01	-6.2	0,0195	17,09	-0,0055	4,84	**
Private fixed cap. form.	-0.012	-3,22	0,0228	8,99	-0,0041	1,82	*
Export goods	0.0742	15,85	-0,0459	-13.6	0,0204	5,67	**
Import goods	0.0183	3,92	-0,0235	-6.9	0,0156	3,64	**
Industrial production	-0.04	-15,61	0,0427	18,96	-0,0208	8,35	**
Fisheries output	0,0409	4.1	-0,0348	-4,59	0,0437	4,16	**
Labour input	0	-17,04	0,0041	14,22	0,0016	3,17	---
Labour productivity	-0.01	-6,45	0,0089	8,81	-0,0019	1.8	*
Real wage	-0.013	-5,79	0,0306	16,46	-0,0218	9.39	**
Capital stock	0	1.14	0,0116	34,73	0,0022	5,71	---
Capital productivity	-0.01	-1,49	0,0137	3,47	-0,0159	-4,63	*
Rate of interest	0.009	10,92	-0,0099	-11,86	0.012	8	**
Proportion ind. prod.	-0.027	-11,38	0,0274	15,57	-0,0151	-8.3	**
Unemployment %	-0.039	-13,89	0.028	9,76	-0,0247	-5.1	**

[38] See for instance (Reati, 1990, 86ff.). For the principles of spline regression see for instance (Green, 1993; Poirier, 1976)

[39] S_0 and S_1 give the general tendency of the series. The slope changes for the first time at the first knot, that is between S_1 and S_2. For this reason the sign of S_2 is not important for the test, the only requirement is that it significantly differs from zero.

References

Albers, R. M. (1998). *Machinery Investment and Economic Growth: The Dynamics of Dutch Development 1800-1913*. Groningen: Rijksuniversiteit Groningen.

Blanchard, O. (2000). *Macroeconomics* (2 ed.). Upper Saddle River: Prentice Hall International.

Brugmans, I. J. (1950). *Welvaart en historie; tien studiën*. 's-Gravenhage: Martinus Nijhoff.

Brugmans, I. J. (1961). *Paardenkracht en Mensenmacht. Sociaal-economische geschiedenis van Nederland, 1795-1940*. 's-Gravenhage: Martinus Nijhoff.

Cameron, R. (1973). The Logistics of European Economic Growth: A Note on Historical Periodization. *Journal of European Economic History, 2*, 145-148.

Chandler, A. D. (1990). *Scale and Scope*. Cambridge.

Crafts, N. F. R., Leybourne, S. J., & Mills, T. C. (1990). Measurement of Trend Growth in European Industrial Output before 1914: Methodological Issues and New Estimates. *Explorations in Economic History, 27*, 442-467.

DHDA. (2000). *Dutch National Accounts, 1800-1913*. Dutch Academy of Sciences, http://nationalaccounts.niwi.knaw.nl/.

Forrester, N. B. (1973). *The Life Cycle of Economic Development*. Cambridge Massachusetts: MIT Press.

Green, W. H. (1993). *Econometric Analysis* (2 ed.). Englewood Cliffs: Prentice Hall.

Griffiths, R. T. (1979). *Industrial Retardation in the Netherlands, 1830-1850*. 's-Gravenhage: Martinus Nijhoff.

Horlings, E. (1995). *The economic development of the Dutch service sector 1800-1850: trade and transport in a premodern economy*. Amsterdam.

Israel, J. I. (1995). *The Dutch Republic. Its Rise, Greatness and Fall 1477-1806*. Oxford: Oxford University Press.

Jacobs, J., & Smits, J.-P. (2001). Conjunctuurbewegingen in Nederland gedurende de negentiende eeuw met een internationale vergelijking. *Neha jaarboek voor economische, bedrijfs en techniekgeschiedenis, 64*, 178-199.

Jonge, J. A. d. (1968). *De industrialisatie in Nederland tussen 1850 en 1914* (Academisch proefschrift Amsterdam ed.). Amsterdam: Scheltema en Holkema.

Jonge, J. A. d. (1970). De industriële ontwikkeling van Nederland tussen 1850-1914 gezien in het licht van enkele facetten van de theorie van Rostow. In P. W. Klein (Ed.), *Van stapelmarkt tot welvaartsstaat* (pp. 75-93). Rotterdam: Universitaire Pers Rotterdam.

Jonker, J. P. B. (1996). *Merchants, Bankers, Middlemen. The Amsterdam Money Market during the first half of the 19th Century*. Amsterdam: NEHA.

Jonker, J. P. B. (1997). The alternative road to modernity: banking and currency, 1814-1914. In M. t. Hart & J. Jonker & J. L. v. Zanden (Eds.), *A financial history of The Netherlands* (pp. i-xv, 1-232). Cambridge: Cambridge University Press.

Kleinknecht, A. (1987). *Innovation Patterns in Crisis and Prosperity: Schumpeter's Long Cycle Reconsidered*. London: MacMillan.

Kondratieff, N. D. (1926). Die langen Wellen der Konjunktur. *Archiv für Sozialwissenschaft und Politik, 56*, 573-610.

Kondratieff, N. D. (1928). Die Preisdynamik der industriellen und landwirtschaftlichen Waren. *Archiv für Sozialwissenschaft und Sozialpolitik, 60*, 1-86.

Mokyr, J. (1974). The Industrial Revolution in the Low Countries in the First Half of the Nineteenth Century: A Comparative Case Study. *Hournal of Economic History, XXXIV*(2), 365-391.

Mokyr, J. (1976). *Industrialization in the Low Countries, 1795-1850*. New Haven and London: Yale University Press.

Mokyr, J. (2000). The industrial revolution in the Netherlands: Why did it not happen? *De Economist, 148*(4), 503-520.

Morgan, B. (1982). *Monetarists and Keynesians: their contribution tot Monetary Theory*. London and Basingstoke: MacMillan Press.

Poirier, D. J. (1976). *The Econometrics of Structural Change*. Amsterdam: North-Holland.

Reati, A. (1990). *Taux de profit et accumulation du capital dans l'onde longue de l'apres guerre.* Bruxelles: Université de Bruxelles.

Reijnders, J. P. G. (1984). Perspectivistic distortion. A note on the approximation of trends and trend-cycles. *Social Science Information, 23*, 411-426.
Reijnders, J. P. G. (1990). *Long Waves in Economic Development*. Aldershot UK, Brookfield USA: Edward Elgar.
Reijnders, J. P. G. (1992). Between Trends and Trade Cycles: Kondratieff Long Waves Revisited. In A. Kleinknecht & I. Wallerstein & E. Mandel (Eds.), *New Findings in Long Wave Research*. London: MacMillan.
Reijnders, J. P. G. (1998). Lange Wellen auf den zweiten Blick. In H. Thomas & L. A. Nefiodow (Eds.), *Kondratieffs Zyklen der Wirtschaft* (pp. 309-316). Herford: BusseSeewald.
Ridder, J. (1935). *Een conjunctuur-analyse van Nederland, 1848-1860*. Amsterdam: H.J. Paris.
Schumpeter, J. A. (1939). *Business Cycles: A Theoretical, Historical and Statistical Analysis of the Capitalist Process*. New York: McGraw Hill.
Simiand, F. (1932). *Les fluctuations économiques a la longue période et la crise mondiale*. Paris: Alcan.
Smits, J.-P. (1995). *Economische groei en structuurveranderingen in de Nederlandse dienstensector, 1850-1913*. Amsterdam.
Smits, J. P., Horlings, E., & van Zanden, J. L. (1997). *The Measurement of Gross National Product and its Components. The Netherlands 1800-1913* (Research Memorandum no. 1). Utrecht: N.W. Posthumus Institute / Utrecht University.
Smits, J. P., Horlings, E., & van Zanden, J. L. (2000). *Dutch GNP and its components, 1800-1913*. Groningen: Groningen Growth and Development Centre.
Snowdon, B., Vane, H., & Wynarczyk, P. (1994). *A Modern Guide to Macroeconomics*. Aldershot: Edward Elgar.
Solow, R. M. (1957). Technical change and the aggregate production function. *Review of economics and statistics, 39*(4), 312-320.
Tugan-Baranowsky, M. (1901). *Studien zur Theorie und Geschichte der Handelskrisen in England*. Jena: Fisher.
van Duijn, J. J. (1983). *The Long Wave of Economic Life*. London: Allen and Unwin.
van Stuijvenberg, J. H. (1970). Economische groei in Nederland in de negentiende eeuw: een terreinverkenning. In P. W. Klein (Ed.), *Van stapelmarkt tot welvaartsstaat* (pp. 52-74). Rotterdam: Universitaire Pers Rotterdam.
van Zanden, J. L., & van Riel, A. (2000). *Nederland 1780-1914. Staat, instituties en economische ontwikkeling*. Amsterdam: Uitgeverij Balans.
Visser, H., & Goor, L. v. (1997). *Inleiding tot het geld- en bankwezen* (4 ed.). Schoonhoven: Academic service.
Vries, J. d., & Woude, A. v. d. (1995). *Nederland 1500-1815*. Amsterdam: Uitgeverij Balans.
Wallerstein, I. (1980). *The Modern World System* (Vol. II). New York: Academic Press.
Wintle, M. (2000). *An Economic and Social History of the Netherlands 1800-1920*. Cambridge: Cambridge University Press.