Industrial output and labour productivity in the Netherlands, 1913-1929

Jong, Herman de; Albers, Ronald

Industrial Output and Labour Productivity in the Netherlands, 1913-1929: Some Neglected Issues

Research Memorandum 574 (GD-13)

Herman de Jong and Ronald Albers

October 1994

Memorandum from
Institute of Economic Research*
Faculty of Economics
University of Groningen
P.O. Box 800
9700 AV Groningen - The Netherlands
tel. 31-50-633741
fax. 31-50-637337

* Research memoranda of the Groningen Growth and Development Centre are published as a sub-series of the memorandum series of the Institute of Economic Research.

INDUSTRIAL OUTPUT AND LABOUR PRODUCTIVITY IN THE NETHERLANDS, 1913-1929: SOME NEGLECTED ISSUES*

H.J. de Jong & R.M. Albers

1. Introduction

The purpose of this study is to make a quantitative assessment of the development of manufacturing in a period which was crucially important for Dutch industry. This is an abridged version of the more comprehensive Dutch text, which will appear in the 1994 issue of the *NEHA-Jaarboek*. We here emphasize the quantitative results of our research, leaving out many details and references set out in the historiography.

World War I is in many ways regarded as marking the end of the nineteenth century, a statement which is particularly appropriate for The Netherlands. The First World War has been a watershed in Dutch historiography. Most economic historical studies of The Netherlands either take the 1920's as a starting point, or end at the eve of World War I. The lack of quantitative studies on a period which in many respects can be considered a major turning-point in Dutch economic development is striking. This can partly be attributed to a lack of quantitative data. The first industrial census was carried out in 1913. However, key economic figures gathered by the Dutch bureau of statistics (CBS) only are available on an annual basis from 1921 onwards. As far as industrial production is concerned, the series solely pertain to some industries. The coverage of the industrial production surveys was extended to the whole of industry only after World War II. In our opinion, however, it is not so much the lack of detail which is the gravest shortcoming in current historiography. A consistent long term perspective is the most urgent requirement. We try to shed some light on the developments in this crucially important period, without claiming to provide a comprehensive survey.

According to recent estimates Dutch GNP increased at an annual rate of 3.6% between 1913 and 1929. This compares favourably to annual growth rates of 1.2%, 0.7%, and 3.1% in Germany, the UK, and the USA over the same period.[1] More striking still is the relatively rapid growth of domestic product per hour worked on a macro level. According to Maddison the growth rate for The Netherlands was 2.7% annually, compared to 1.4%, 1.5%, and 2.4% for Germany, the UK, and the USA, respectively.[2] This makes the Dutch experience a potentially interesting case for international comparisons. In the present contribution, however, we focus on production and productivity in manufacturing industry, and its impact on the economic development of The Netherlands between 1913 and 1929. We try to identify some of the driving forces behind industrial development and to place them in a long-term perspective. Our calculations are all based on published sources (most important of which are the censuses of production). It goes without saying that our analysis is conducted from the supply side. This paper is arranged as follows. First, we give a brief review of the development of Dutch industry between 1913 and 1929. We then present our calculations of

---

* We are grateful to Jan Luurs for his assistance with statistics and graphs. This paper is based on research sponsored by the Foundation for Economic, Social, and Spatial Sciences (ESR), which is part of the Netherlands Organization for Scientific Research (NWO).

1 C.A. van Bochove & T.A. Huitker, *Main national accounting series, 1900-1986*. CBS NA-017 (1987), 9.

2 A. Maddison, *Dynamic forces in capitalist development: a long-run comparative view* (Oxford/New York, 1991), 212-214. Maddison's figures for The Netherlands are based on Van Bochove & Huitker, 'National accounting'.

value added and labour productivity and briefly discuss the results. In our empirical work we restrict the analysis to a number of industries, representing about a fifth of total manufacturing industry, for which we have consistent data. Finally, we proceed to focus on two determinants of output and productivity which have, in our opinion, played a crucial role in the development of Dutch industry during and after World War I: the cut back in hours worked accompanied by a substantial real wage increase, and the rapid electrification.

2. A brief description of the development of Dutch industry between 1913 and 1929

At the eve of the First World War, The Netherlands had witnessed a decade or so of rapid economic growth, with booming investment. Manufacturing industry was rapidly expanding, but in the small open economy of The Netherlands the services sector was most prominent. In manufacturing small and medium-sized firms were dominant. Many industries relied on imports for their supplies of raw materials. Therefore, the outbreak of the war and the subsequent decrease in foreign trade posed grave problems, especially for those industries which were wholly dependant on imports. Overseas trade was most seriously affected. The Dutch tried to secure large stocks of primary materials. Government and firms cooperated to set up a system of distribution and price controls.[3] The distribution of coal was of vital importance to the economy. Despite a dramatic rise in the supply of domestic coal fuel shortages were a major problem until 1920. Distribution was also extended to the most important foodstuffs. Coupled with rigid price-controls this meant the rise in nominal wages could be limited, although real wages dropped dramatically because other prices increased rapidly.

It is difficult to give a balanced account of the development of Dutch manufacturing during the first World War, since circumstances could vary dramatically between industries. In general, after serious disruption in the first months following the outbreak of the war industry adapted rather quickly to the changing conditions. Adverse circumstances did by no means cripple Dutch industry, although, it must again be stressed, differences between various industries could be very important. In the first years of the war there was no widespread shortage of raw materials. The virtual cessation of trade in numerous products meant that foreign competition was ruled out in many industries. This was of course a powerful stimulus for import substitution. This resulted in changes in the composition and structure of the secondary sector and the establishment of many new industries (such as rubber). These structural changes had a very significant long term impact. Until 1916 industrial output, prices for industrial products, and employment all showed a marked increase. Because of low real wages and a relatively low interest rate profits were excessively high. Consequently investment did also boom, resulting in a sharp increase in production capacity (table 1).[5]

---

3 H.A.R. Smidt, 'De regulering van de Nederlandse export van landbouwprodukten naar Duitsland tijdens Eerste Wereldoorlog', *Economisch- en Sociaal-Historisch Jaarboek* 54 (1991) 102-133.

4 Good contemporary introductions to the economic history of The Netherlands in World War I in English are: *The Netherlands and the World War* Volume I, II (New Haven, 1928) and B.F. Moore, *Economic aspects of the commerce and industry of the Netherlands, 1912-1918* (Washington 1919).

5 These calculations have a large margin of error, since they were based on rough estimates of production of machinery plus net imports of capital goods.

Table 1 Gross investment in fixed assets, excluding buildings 1913-1919.

	1913	1914	1915	1916	1917	1918	1919
Gross investment (mln *f*) (current prices)	185	174	160	223	185	257	498
Gross investment (mln *f*) (constant prices of 1913)	185	177	167	201	110	93	136
Index of investment in constant prices (1913=100)	100	96	90	109	59	50	74

Sources: *Nederlandsche volkshuishouding, 1914-1918*, 5, 23; *Ongevallenstatistiek*, 1913; *Statistiek van voortbrenging en verbruik*, 1913.
Deflation by a price index consisting of engineering wages (weight 0.4) and iron prices (weight 0.6).

Shortages of raw materials and machinery and spare parts from abroad probably limited the growth of the industrial capital stock. High investment in industry was partly the result of a shift in the policies of banks and private investors. With many of the more traditional investments abroad becoming increasingly insecure, funds were diverted to the industrial sector. The turning point came in 1917. Because of the increasingly sharp trade restrictions from both the Allied and the Central powers Dutch foreign trade came to a virtual standstill. Stocks ran out, profits plummeted and in 1918 production in many industries decreased sharply or even came to a total standstill.

The first six years after World War I show an unstable picture with large cyclical fluctuations in industrial output. The year 1919 witnessed an unbalanced recovery of industrial production and foreign trade. Until the fall of 1920 optimism about future developments prevailed: industrial production and investment rose, accompanied by a sharp increase in prices and nominal wages. Because of simultaneous reductions in the number of hours worked real hourly wages increased fast. The recession of the early 1920's revealed many inherent weaknesses of Dutch manufacturing industry. In general, from late 1920 until 1923 prices were under pressure without affecting levels of real output to the same extent. The recession primarily squeezed profits. The tendency of decreasing industrial output prices continued throughout the 1920's. The period 1924-1929 is referred to in the literature as one of slow progress without an overt urge for expansion and without high expectations.[6] The literature emphasizes the need for firms to cut back costs and raise labour productivity in this period in order to remain profitable.

6 See for instance: A. De Graaff, *De industrie*. De Nederlandse volkshuishouding tussen twee wereldoorlogen 8 (Utrecht, 1951); F.A.G. Keesing, *De conjuncturele ontwikkeling van Nederland en de evolutie van de economische overheidspolitiek 1918-1939* (Reprint: Nijmegen, 1978), and: R.T Griffiths & J.L. van Zanden, *Economische geschiedenis van Nederland in de 20e eeuw* (Utrecht, 1989).

3. Development of value added

Our estimates of gross output and value added in some branches of industry are based on the official production censuses published by the CBS. Coverage is almost complete for 1913 and 1916. The 1919 census covers only certain branches of industry. From 1921 onwards the censuses provide annual data on a number of important industries. Because of problems with the coverage and reliability of the census data and their comparability over time, we selected a sample comprising 12 major branches of manufacturing industry for our analysis. For these 12 industries consistent, relatively reliable and comparable figures are available.[7] Table 2 presents our calculations of gross value added in current prices. Since we have no estimates of capital consumption there is no corresponding estimate of net value added. Therefore, all our calculations refer to gross value added.

Table 2 Nominal value added in 12 branches of industry (million guilders).

Branch of industry	1913	1921	1929
Potato flour	3,4	8,0	10,0
Cocoa	8,8	20,6	21,1
Cotton	26,2	74,5	85,0
Margarine	5,6	3,2	7,0
Flour	2,4	8,3	11,1
Paper	4,4	9,3	21,1
Rubber	0,5	3,3	3,9
Shipbuilding	23,2	100,3	67,6
Shoes	4,3	21,6	22,0
Knitted goods	2,2	7,0	8,4
Wool	10,8	30,4	24,7
Soap	2,0	10,0	11,2
Total	93,7	296,5	293,1

Source: *Statistieken van voortbrenging en verbruik*, 1913-1929

The most recent estimate of total value added in Dutch manufacturing for 1921 is 1,452 million guilders.[8] The industries in our sample represent an estimated 20% of industrial value added and about 22% of employment in 1921.[9] Our sample is dominated by two very large industries: cotton manufacturing and shipbuilding. These two make up 58% of value added and 55% of employment within the sample.

7 Annex 1 ("bijlage 1") in the Dutch version discusses more comprehensively the issue of reliability and comparibility of the census data.

8 H.J. de Jong & R.B.M. Oude Vrielink, 'Produktie en arbeidsproduktiviteit in de voedingsmiddelenindustrie 1918-1939', *Economisch- en Sociaal-Historisch Jaarboek* 56 (1993) 289-339, 292.

9 *Ongevallenstatistiek betreffende de kalenderjaren 1920-1921* (Amsterdam, 1930), 99.

The development of nominal value added is to a large degree determined by price fluctuations. For instance, the general volume of output actually increased between 1921 and 1929, despite a drop in value added at current prices. To calculate real value added we computed industry-specific unit value ratios from the census data for the most important inputs and outputs. The unit value ratios we used to deflate nominal value added are weighted Fisher type indices. The final index (1913=100) was computed by splicing series with base years 1913, 1921, and 1925. We use single deflation, since double deflation in many instances yields highly volatile results. The period we cover exhibits large and divergent price fluctuations for inputs and outputs. Under these conditions double deflation tends to magnify fluctuations.[10] We therefore adopted single deflation with output unit value ratios. The tables in annex 2 presents value added at current prices, unit value ratios, and real value added for industries in our sample. Table 3 reports weighted (by share of value added) and unweighted growth rates of real value added.[11]

Table 3 Growth rates of real value added in 12 branches of industry (annual compound growth rate).

Branch of industry	1913-1921	1921-1929	1913-1929
Potato flour	-4,3	10,5	2,8
Cocoa	10,7	1,5	6,0
Cotton	4,8	5,6	5,2
Margarine	2,4	5,9	4,1
Flour	6,1	10,7	8,4
Paper	-1,9	18,3	7,7
Rubber	16,5	9,2	12,6
Shipbuilding	10,2	1,0	5,5
Shoes	9,2	6,5	7,8
Knitted goods	1,0	10,7	6,0
Woo	5,2	1,2	3,2
Soap	11,6	5,4	8,4
Total			
Weighted average	6,3	4,9	5,3
Unweighted average	6,0	7,2	6,4

Source: *Statistieken van voortbrenging en verbruik*, 1913-1929.

In our opinion the unweighted figures are to be preferred to the weighted growth rates since the latter are dominated by the cotton and shipbuilding industries. We again emphasize that we do not regard our figures representative for the whole secondary sector. Real value added in the 12 branches of industry showed a growth of 5.0 to 6.3% annually between 1913 and

10 H.H. van Ark, *International comparisons of output and productivity* (Groningen, 1993), 38-41.

11 With the exception of the potato flour and margarine industries, for which we could only calculate physical output, due to no consistent prices being available.

1929. This is high compared to yearly GDP growth of 3.6%.[12] The growth of value added in agriculture amounted to only 2.1% per annum.[13] A second characteristic is the divergence in growth patterns of various industries over time. Performance during World War I was to a large degree determined by the availability of raw materials and the development of relative prices. Those industries which substituted for imports showed a particularly fast growth during the war, often followed by a subsequent decline as trade restrictions were lifted. The rubber industry is a good example. The twenties generally show very rapid growth of industrial production. The unweighted growth rate for our sample is 7,2% from 1921 to 1929. This is in line with recent estimates of industrial output in the twenties, which suggest an annual growth rate of 6 to 7%.[14] The weighted growth rate is lower, however, in particular because of the stagnation in shipbuilding. In general, those branches of industry which performed best during the first World War witnessed a relative decline during the twenties.

4. Labour productivity

Our estimates of labour productivity are based on the computations of value added. From 1919 onwards value added by branch of industry could be matched with figures on labour input from the census (*Produktiestatistiek*) itself. Unfortunately, the census does not provide labour input for 1913 and 1916. For these years we had to resort to using a different source which registrates man years by branch of industry: the statistics of industrial accidents (*Ongevallenstatistiek*). The relative movements in employment according to the *Ongevallenstatistiek* were linked to the number of employees registered in the production census in 1919, 1920, or 1921. Despite minor differences in registration between the two sources it proved possible to match them and splice index numbers of labour input in 1919/1921. The classification for the industries in our sample in the *Ongevallenstatistiek* remained very much the same over the relevant period. Also, the relative movements in the number of employees registered by the two sources showed a very close correlation during the 1920's. We therefore conclude that the *Ongevallenstatistiek* may be used to extrapolate *relative* movements in the number of employees.[15]

The sources discussed so far only register days worked. We rearranged the information to calculate labour input in terms of hours worked. In the period we examined allowance for hours worked make a crucial difference, since there was a very considerable reduction in the length of the working week between 1913 and 1929. This is a characteristic of many Western European countries in the same period. If we do not adjust the calculations of labour productivity for variations in the length of the working week we seriously underestimate the gains in productivity. The number of hours worked per person first declined gradually between 1910 and 1920. In the course of 1920 a very significant further reduction occurred as a result of the effectuation of the 8-hour working day. In reaction to the depression of the

12 Maddison, *Dynamic forces*, 214.

13 M. Knibbe, *Agriculture in the Netherlands 1851-1950. Production and institutional change* (Amsterdam, 1993), 292.

14 J.J. Seegers, 'Produktie en concurrentievermogen van de Nederlandse industrie in het Interbellum', *Economisch- en Sociaal-Historisch Jaarboek* 50 (1987) 186-211, 194.

15 The matching of the two sources is discussed in more detail in the Dutch annex 1 ("bijlage 1").

of hours worked differed between industries. Table 4 charts the development of the average number of hours worked by branch of industry.[16]

Table 4 Average number of hours worked per day by branch of industry, 1913-1923.

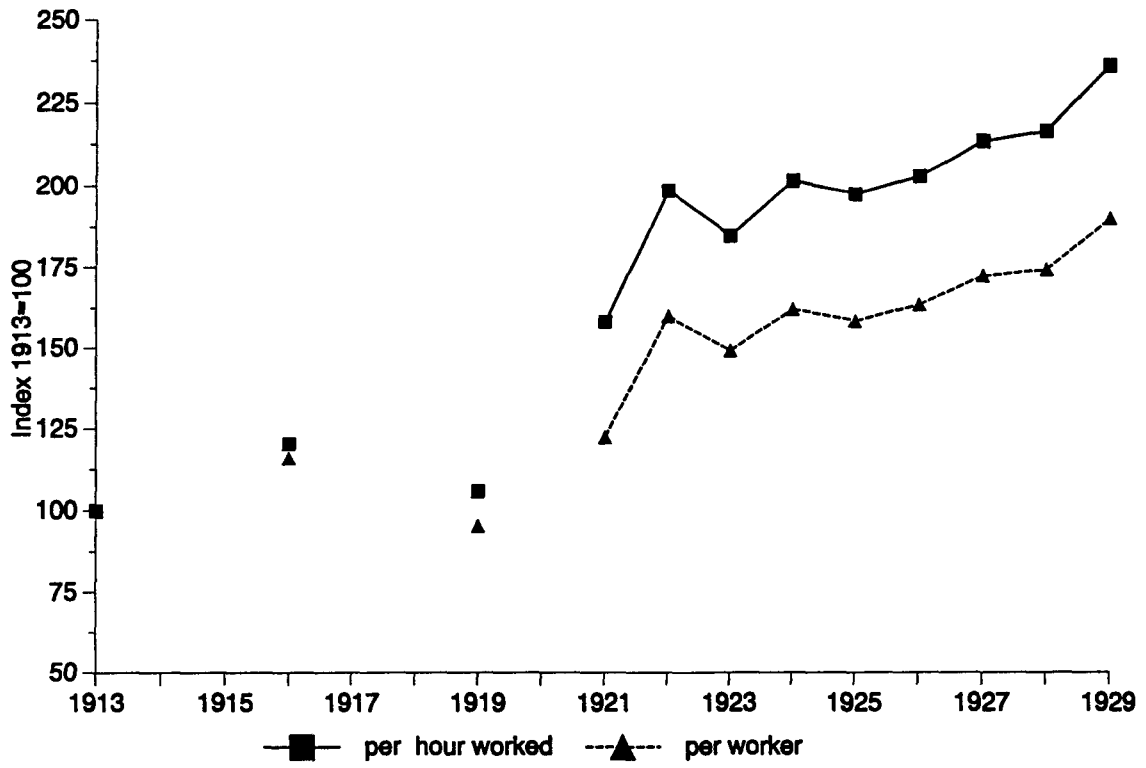
	1913	1916	1919	1921	1922
Potato flour	11	10	8	8	8
Cocoa	10	9,5	10	7,5	8
Cotton	10	9,25	9,25	8	8,5
Margarine	10	9,5	9,5	7,5	8
Flour	10,5	10,5	10,3	7,5	8
Paper	11	10,3	9,8	8	8
Rubber	10	10	9	8	8
Shipbuilding	10,5	10,8	9	8,5	8,5
Shoes	10	10	9	8	8
Knitted goods	11	10	10	8	8,5
Wol	10	9,25	9,25	8	8,5
Soap	10,25	9,75	9	7,5	8

Source: see text

We adopted two alternative ways to calculate an index of labour productivity in terms of value added per unit of labour input: first, labour productivity (value added) per worker; second, labour productivity per hour worked. Graph 1 plots the development of average real labour productivity per hour for the 12 industries in our sample. The tables in annex 1 and the graphs in annex 2 give a more detailed account of our figures by branch of industry.

16 Figures derived from: *Centraal verslag der Arbeidsinspectie in het in het Koninkrijk der Nederlanden over 1911* (z.p. ('s-Gravenhage), 1912), 251-258; F.J.C. van der Schalk, *De wiskundig statistische analyse van de arbeidsproductiviteit*, (Haarlem, 1938), and: A.F. Heerma van Voss, *Kosten van arbeidstijdverkorting. De achturendag in de jaren twintig* (Unpublished PhD-thesis Universitity of Utrecht, 1991), 117, 468.

Graph 1 Index of unweighted real labour productivity per worker and per hour worked in 12 industries, 1913-1929. Source: see text.

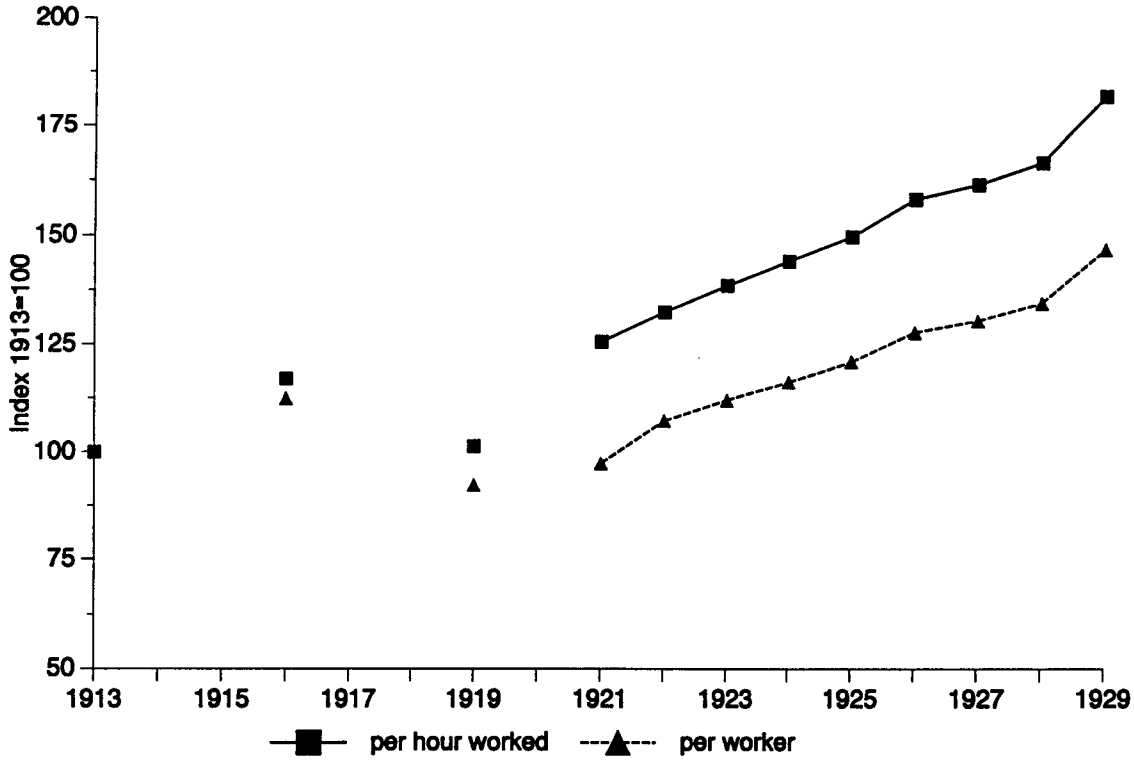


Clearly, labour productivity per hour grows much faster than productivity per worker. The large increase in the difference between 1919 and 1921 is mainly due to our recalculation allowing for the effects of the shortened working week. At first sight the jump in productivity per hour may seem implausibly high, whereas the much more limited increase in productivity per worker looks more credible. However, the very considerable increase in labour productivity per hour is not an artefact of the data. The scope of our figures for 1919 is more limited than for other years, which creates a larger margin of error. More importantly, the picture is distorted because of cyclical fluctuations: 1919 and 1921 are at opposite ends in the business-cycle. Furthermore, value added itself shows a large increase in various industries between 1919 and 1921, which leaves open the possibility of a substantial gain in labour productivity.

To check our estimates of the development of labour productivity in terms of value added we also calculated indices of physical labour productivity, which is a more conservative measure. The computation of physical productivity was based on quantities of physical output (potato flour, margarine, flour, paper, shipbuilding, and shoes) or the consumption of raw materials (cocoa, cotton, rubber, wool, and soap).[17] The trend in physical labour productivity may shed some light on the plausibility of a jump in real labour productivity per hour around 1920. Graph 2 displays the overall development of physical labour productivity.

17 Based on the sources mentioned above and: CBS, 'Indexcijfers van de productie per arbeider', *De Nederlandsche Conjunctuur* (november 1936) 16-18.

Graph 2 Index of unweighted physical labour productivity per worker and per hour worked (excluding shipbuilding), 1913-1929. Source: see text.



Interestingly enough, physical productivity per worker shows a very low relative level in 1921, whereas the development of physical productivity per hour (allowing for the changing length of the working week) is in line with an average productivity gain of 3% per annum. This supports our opinion that the jump in productivity per hour in terms of value added is not a figment of the data.

A comparison of graphs 1 and 2 makes clear that the growth of physical labour productivity is consistently below the development of value added per unit of labour. How can this be explained? In our opinion the divergence between real and physical labour productivity indicates changes in the production structure. A higher efficiency in the use of raw materials is not reflected in estimates of productivity if production is estimated from raw material consumption using fixed technical coefficients. However, if we measure output directly (value added or quantities) the gain in productivity is observed. Growth in physical productivity is generally caused by higher efficiency, for instance the processing of more inputs per unit of labour. The difference between the growth rates of physical productivity and real productivity signifies structural changes in production processes and supply and demand patterns. In general there was a considerable shift towards products with higher value added in The Netherlands over the first World War. The changes in the basket of goods produced is reflected in a higher growth of real value added compared to output in physical units. This observation reinforces the plausibility of a rapid increase in real labour productivity per hour.

Table 5 shows the development of labour productivity per hour worked by branch of industry. Both cross-sectional and cross-time differences can be seen to be substantial.

Table 5 Growth rates of real and physical labour productivity per hour (annual compound growth rate).

Growth rates of real labour productivity per hour by branch of industry

Branch of industry	1913-1921	1921-1929	1913-1929
Potato flour	-1,3	8,5	3,5
Cocoa	11,4	2,0	6,6
Cotton	8,6	1,1	4,8
Margarine	-2,5	8,5	2,9
Flour	5,0	12,2	8,5
Paper	-0,3	12,9	6,1
Rubber	2,0	10,1	6,0
Shipbuilding	9,3	-0,2	4,4
Shoes	8,8	4,1	6,4
Knitted goods	2,2	6,3	4,2
Wool	6,8	-1,3	2,7
Soap	12,0	3,1	7,5
Total unweighted real productivity	5,2	5,6	5,3
Total unweighted physical productivity	3,0	4,1	

Source: *Statistieken van voortbrenging en verbruik*, 1913-1929. *Ongevallenstatistiek*, 1913-1921.

An important general conclusion is that for 7 branches of industry the rise in productivity from 1913 to 1921 was higher than the rise in real value added. This means that labour input in terms of total number of hours worked had actually fallen over the period. The most important explanation for this phenomenon is the shorter working week.[18] Around 1920 the substantial decrease in hours worked was not fully compensated for by a rise in the number of workers employed. The considerable reduction in hours worked in 1920 raises the question of productivity offsets. In general, a productivity increase accompanies shorter hours, an argument which already figures in contemporary discussions. There is a also a rich literature on the subject. For Dutch industry around 1920 estimates of the productivity effects of a shorter working week range between 41.5% and 71% on aggregate.[19] These figures may not be very accurate. It is clear, however, that these productivity effects have played a major role in the growth of labour productivity per hour.

A puzzle which remains is that the most profound decrease in total labour input occurred in the food processing industries, in particular in the cocoa, margarine and flour

18 Already during the war many firms suffered from a shortage of skilled labour due to mobilisation.

19 Heerma van Voss, *Arbeidstijdverkorting*, 141. P.J. Verdoorn, *Arbeidsduur en welvaartspeil* (Leiden, 1947), 165, 242. Verdoorn's figures are based on: Van der Schalk, *Arbeidsproductiviteit*.

industries. According to Van der Schalk the effects of shorter hours on productivity in these industries were limited because of the high capital intensities. However, Van der Schalk based his calculations on physical indicators, not taking into account the effects of rapid mechanization and mergers.

To sum up, real and physical labour productivity levels per hour worked for 1913, 1916 and 1921 can be reconciled with a consistent trend growth. On the other hand, productivity levels in 1919 are inordinately low, which is supposedly due to the adverse circumstances at the end of the war. Our methodology does not enable us to precisely distinguish the various driving forces behind the development of labour productivity. We measure the net result of a number of influences. Around 1920 cyclical effects, shifts in production structure, and the effects of a reduction in hours worked probably all pointed in the same direction.

With reference to our calculations of labour productivity one should bear in mind that the figures we present here only pertain to a subset of manufacturing industry. We could not include figures on many important 'new industries' in chemicals, electrical engineering and metalworking. Thus our figures do not precisely mirror developments in the whole of manufacturing. In the remainder of this paper we will focus on two complementary determinants of labour productivity which have hitherto received little attention in the Dutch literature. In the first place we will deal with the effects of an increase in the real cost of labour. In the second place we will pay attention to the significance of mechanization, in particular electrification.

5. Real wages and labour productivity

Many industries benefitted from a decline in real wages during the first World War and from a sharp increase of prices at the end of the war. From 1918/1919 onwards real wages increased continuously until 1922, when the real wage level had risen 31% compared to 1913. The wage increases of 1919 and the first half of 1920 probably did not pose too many problems. Wages still lagged behind the growth in value added and firms had sizable financial reserves. However, as prices sharply fell in the summer of 1920 the prospects of manufacturing industry rapidly deteriorated. The reduction of the length of the working week in 1920 coincided with a rapid increase in real weekly wages (due to falling prices). What were the effects on real daily and hourly wages?

Nominal weekly wages remained the same as hours were reduced. Hourly nominal wages therefore increased by the same amount as the length of the working week was reduced. In 1920 the average reduction in hours worked amounted to approximately 10%. In the industries in our sample the average working week was reduced by 23% between 1913 and 1921. This is considerably more than the 13% reduction in Great-Britain over the same period.[20] By contrast, the index of daily real wages (on the basis of 1913=100) increased from 84 to 128 between 1918 to 1921.[21] Information on hourly wages is more scarce. We estimated an increase of the index of real hourly wages from 83 in 1918 to 154 in 1921

20 S.N. Broadberry, 'The emergence of mass unemployment: explaining macroeconomic trends in Britain during the trans-World War I period', *The Economic History Review* 43 (1990) 271-282, 276.

21 P. Schrage, E. Nijhof & P. Wielsma, 'Inkomensontwikkeling van werkenden en werklozen in Nederland, 1913-1939', *Tijdschrift voor Sociale Geschiedenis* 15 (1989) 347-394, 380-384.

(1913=100).[22]

To assess the effects of the development of real wage for firms we computed real product wages (real wage costs per unit of production). To this end we deflated nominal wages with an index of wholesale prices, for the moment without taking productivity increases into account.[23] The index of the real product wage (1913=100) demonstrates the following pattern: 52 in 1918; 154 in 1921, and 172 in 1922. Without laying too much emphasis on the accuracy of the figures it is clear that the increase in wage costs was very considerable. Firms had to come to terms with this rise in labour costs as they sought ways to compensate for the decline in labour input due to the reduction in hours worked. Firms were forced to take rapid action as prices and profits continued to decline during 1921 whereas real wages were still on the rise. It proved not possible to completely pass on higher labour costs to prices.

Did the reduction in hours worked and the accompanying rise in real wages constitute a major supply shock, as has been argued for the United Kingdom and Germany?[24] If so, were the consequences felt throughout the 1920's? The answer to a large extent depends on the development of labour productivity. It is obvious that there was a distributional shift towards labour in the first years after the war. But how large was the productivity offset to the fall in hours worked? Real value added per worker in our sample of industry rose by an estimated 47% from 1919 to 1921. Firms reacted to the reduction in hours worked by lessening slack and changing the structure of production and sales. The result was that marginal labour was not replaced. Verdoorn brought forward a theoretical explanation for the very rapid changes during 1920 and beyond. High profits until 1920 meant firms were not forced to increase efficiency. According to Verdoorn the period 1917-1920 is characterized by labour hoarding in anticipation of even better times ahead.[25] Drastically lower expectations together with the reduction in hours worked led to a rapid adjustment, which resulted in a sharp increase in labour productivity. The indices of labour productivity and real hourly wages (on the basis of 1913=100) for 1921 are 156,3 and 154,0 respectively. Hence, in the short term the productivity offsets were substantial. The impact of the supply shock around 1920 was probably not as dramatic as in the United Kingdom. However, productivity gains were not sufficient to fully compensate the continuing rise in real wages and the fall in profits in subsequent years. This resulted in a tendency to substitute capital for labour during the 1920's. The continuing rise in labour productivity throughout the period under study should partly be ascribed to the direct influence of mechanization, in particular electrification. It is to this issue we turn next.

---

22 Based on figures from: Schrage, Nijhof & Wielsma, 'Inkomensontwikkeling', 354-355; Verdoorn, *Arbeidsduur*, 261, and H.W. Methorst, 'The cost of living, prices, and wages' in: *The Netherlands and the World War* Volume II (New Haven, 1928) 303-361, 337, 341.

23 Wholesale prices from: CBS, *Zestig jaren statistiek in tijdreeksen* (Zeist, 1959), 122.

24 In particular J.A. Dowie, '1919-20 is in need of attention', *The Economic History Review* 23 (1975) 429-450, 441. See also: S.N. Broadberry & A. Ritschl, *Real wages, productivity and unemployment in Britain and Germany during the 1920's* Münchner Wirtschafstswissenschaftliche Beiträge 92-26 (1992), 1.

25 Verdoorn, *Arbeidsduur*, 247.

6. Capital intensity, electrification and productivity

Gains in labour productivity can for a large part be accounted for by a rise in capital intensity,[26] accompanied by structural change. Production capacity in the secondary sector was substantially expanded during the first years of World War I, in 1919/1920, and from the middle of the twenties until the great depression. However, trends in investment and employment did not closely match the development of the capital stock. Investment boomed in the period 1913-1916 and again in 1919/1920. In both cases this was accompanied by a significant rise in the number of workers in many industries. However, employment lagged behind the growth of production capacity in industry after the recession of the early 1920's. In our opinion we should distinguish two periods. The first is World War I proper, the second the 1920's, with the crucial years immediately after the war serving as a watershed.

The first World War did not witness large scale substitution of capital for labour in Dutch industry. Up to and including 1916 all factors of production were increased simultaneously. Subsequent years were characterized by labour hoarding and the inability to reap the benefits of large scale investment in previous years. In the 1920's firms had to improve their prospects by cutting costs, utilizing economies of scale, and raising labour productivity since prices were continuously under pressure. Profits were modest which limited investment opportunities.[27] Nevertheless the expansion of production capacity in manufacturing industry continued. Employment in manufacturing industry failed to follow suit. In the literature the 1920's stand out as a period with an acceleration in mechanization and rationalization.[28] These at first sight conflicting observations can be reconciled by stressing the importance of substitution of capital for labour in this period. In our opinion the shock associated with the sudden increase in real wage costs around 1920 played a crucial role. The long term effects extended well into the 1920's.

In order to examine the contribution of mechanization to the development of labour productivity in manufacturing industry we have to study it in more detail. It is difficult to exactly trace the progress of mechanization in the secondary sector. Figures about investment and capital stocks by branch of industry do not exist for the period we study. The growth of the capital stock by branch of industry can be approximated by horsepower statistics.[29] Total horsepower capacity is subdivided into electrical and non-electric motors. The inclusion of electrical motors complicates the applicability of total horsepower capacity as a measure of power capacity used in production. One should distinguish primary electric motors, which are powered by purchased electricity, from secondary electric motors, which are operated by electricity within the firm. All electric motors drive production machines but to gauge the

---

26 This does not, of course, entail a rise in capital productivity.

27 Griffiths & Van Zanden, *Economische Geschiedenis*, 112. J. Tinbergen, 'Kapitaalvorming en conjunctuur in Nederland, 1880-1930', *De Nederlandsche Conjunctuur* (maart 1932) 8-16.

28 Keesing, *Conjuncturele ontwikkeling*, 81-82. In the literature the terms rationaliztion and mechanization are often used as if they were freely interchangable. We opt for a clear distinction. We define rationalization as higher efficiency in the production process which reduces costs, and as a rule raises joint factor productivity. We reserve the concept of mechanization for substitution of capital for labour in a more narrow sense. Mechanization raises labour productivity but need not be accompanied by an increase in joint factor productivity.

29 R. Minami, *Power revolution in the industrialization of Japan: 1885-1940* (Tokyo, 1987), 7.

development of production capacity one should include only primary motive power.[30] We use primary horsepower capacity per worker as an approximate measure of capital intensity.[31] Primary horsepower per worker in all industries which the production censuses encompasses grew at an annual rate of 2.6% between 1921 and 1929.[32] Table 6 presents the development of capital intensity in the paper industry and in shipbuilding.

Table 6 Development of power capacity in the paper industry and in shipbuilding, 1904-1929.

	1904	1919	1921	1929
PAPER INDUSTRY				
Horsepower non-electric motors (index 1921=100)	22	78	100	108
Horsepower secondary electric motors (index 1921=100)	5*	82	100	129
Horsepower primary electric motors (index 1921=100)		162	100	302
Primary power (HP) per worker	2,4	9,8	13,6	11,5
Electric power (HP) per worker	0,5	8,6	8,7	9,0
SHIPBUILDING				
Horsepower non-electric motors (index 1921=100)	38	-	100	93
Horsepower secondary electric motors (index 1921=100)	30*	-	100	92
Horsepower primary electric motors (index 1921=100)		-	100	213
Primary power (HP) per worker	0,7	-	1,7	2,7
Electric power (HP) per worker	0,3	-	1,5	2,6

* The basic data do not permit to distinguish primary and secondary electric motors in 1904

Sources: 1904: *Ongevallenstatistiek*
1919-1929: *Statistiek van voortbrenging en verbruik*

30 S. Sonenblum, 'Electrification and productivity growth in manufacturing', in: S.H. Schurr e.a., *Electricity in the American economy* (New York, 1990) 277-324, 288. M. Saitzew, *Die Motorenstatistik. Ihre Methode und ihre Ergebnisse* (Zürich, 1918), 7-8.

31 R.B. Du Boff, 'Electrification and capital productivity: a suggested approach', *Review of Economics and Statistics* 38 (1966) 426-431, 428; A.G. Woolf, *Energy and technology in American manufacturing: 1900-1929* (PhD-thesis Ann Arbor, 1980), 75.

32 'Enkele kenmerken van de ontwikkeling der Nederlandsche nijverheid sedert 1921', *Maandschrift van het C.B.S.* (september 1936) 1333-1337, 1336. Tinbergen, 'Kapitaalvorming en conjunctuur', 16. See *Ongevallenstatistiek* 1904 for the only pre-1919 power statistics for individual branches of industry.

The rapid growth of capital intensity over the trans-World War I period is striking. Unfortunately, this development cannot be reconstructed on an annual basis. A second important feature is the rapid electrification, which already made significant progress in the decade before 1914. Mechanization progressed throughout the 1920's, albeit not at a similar pace in every class of industry. Electric power per worker increased more rapidly than total horse power, whereas primary electric power comprised a larger and larger share.[33] The shift towards primary electric motors also implied a shift of generating capacity from firms towards electric utilities. This tendency was particularly strong in smaller firms because of diseconomies of scale in the generation of electricity.[34]

We emphasize the key role of electrification in understanding the relation between mechanization and the growth of labour productivity. We follow American literature in stressing that electrification strongly boosted productivity growth and lowered energy intensity in manufacturing industry, albeit with a certain lag.[35] For the United States the period 1910-1920 is regarded as an important divide. The rising trend in both the consumption of energy per unit of GDP and the capital labour ratio was reversed.[36] A similar break in the relation between energy and output around World War I has been suggested for some European countries, among them The Netherlands.[37] We draw a parallel between the United States and The Netherlands with regard to electrification and labour productivity.

The consumption of energy per unit of labour in manufacturing rose at an annual average of 3.8% between 1921 and 1929.[38] This indicates substitution of capital for labour. However, energy consumption per horsepower and per unit of output remained more or less constant, which implies higher efficiency in the generation and transmission of energy. These efficiency gains were connected in particular with the increasing importance of electric power in manufacturing. Table 7 illustrates the development of electric power in the secondary sector between 1904 and 1930.[39]

---

33 Shipbuilding had an extraordinarily large degree of electrification in 1904. In contrast, only 1% of total horsepower in the cotton industry consisted of electric motors in 1904.

34 Woolf, *Energy and technology*, 47-48.

35 S. Sonenblum, 'Electrification and productivity growth', 277-324; P.A David, 'The dynamo and the computer: an historical perspective on the modern productivity paradox', *American Economic Review* 80 (1990) 355-361.

36 S. Schurr & B.C. Netschert, *Energy in the American economy. An economic study of its history and prospects* (Baltimore, 1960), 157-167. S. Sonenblum & S. Schurr, 'Electricity use and energy conservation' in: Schurr e.a., *Electricity in the American economy* 325-339, 325-326. Du Boff, 'Electrification and capital productivity', 426.

37 B.P.A Gales, 'Mijnbouw', in: H.W. Lintsen, M.S.C. Bakker, E. Homburg e.a. (eds.), *Geschiedenis van de techniek in Nederland. De wording van een moderne samenleving 1800-1890* IV (Zutphen, 1993) 13-35, 14.

38 Energy consumption calculated for 21 branches of manufacturing industry for which there is a production census. Figures from: De Graaff, *Industrie*, 20-23, 29. Conversion coefficients for electricity from: B. Etemad & J. Luciani, *World energy production 1800-1985* (Genève, 1991), XXXV (linear interpolation between 1920 and 1931).

39 In the United States the share of primary and secondary electric motors in total power capacity increased from 10% in 1903 to 64% in 1929. Schurr e.a., *Electricity in the American economy*, 394. In The United Kingdom these shares were 10% in 1907 10% and 49% in 1924. I.C.R. Byatt, *The British electrical industry, 1875-1914* (Oxford, 1979), 74-76.

Table 7 Total power capacity in industry (horsepower) by type of engine, 1904-1930.

	Non-electric power capacity (*1000 HP)	Capacity of secondary electric motors (*1000 HP)	Capacity of primary electric motors (*1000 HP)	Share of electric motors in total power capacity
1904	212	17*		8,1%
1912	389	86	50	25,8%
1930	2.370	1.553	961	51,5%

Sources: 1904: *Ongevallenstatistiek* (1904).
1912: *Staatscommissie electrische kracht*, 42-45.
1930: *Bedrijfstelling 1930* deel III, 76-77.

* Primary and secondary electric motors

Note: Power capacity in electric utilities has been excluded

Electric power capacity increased at a much faster rate than total horsepower: mechanization meant first and foremost electrification. The significance of electrification is disguised if only the development of total power capacity is taken into account. Griffiths and Van Zanden, for instance, conclude from the slow growth of total horsepower per worker in manufacturing that capital does little to explain the gains in labour productivity.[40] However, they fail to distinguish between electric and non-electric motive power. In this way, they disregard the capital saving bias of electrification, which enabled production to grow at a much faster rate than capital inputs.[41] Technological progress embodied by electrification made it possible to use capital, labour, and energy more efficiently. New methods of power transmission and distribution often reduced the cost of equipping plant.[42] The effects on labour productivity were profound.[43] The strong capital saving bias of electrification thus may help to explain the comparatively low level of investment in the 1920's. The same point has been made for Great Britain, where investment also seemed paradoxically low compared with the growth of production during the twenties.[44]

40 Griffiths & Van Zanden, *Economische geschiedenis*, 118.
41 Sonenblum, 'Electrification and productivity growth', 298.
42 W.D. Devine Jr., 'Electrified mechanical drive: the historical power distribution revolution' in: Schurr e.a., *Electricity in the American economy* 21-42, 30, 36-38; David, 'Dynamo and computer', 358.
43 Minami, *Power revolution*, chapters 8-13 provides excellent material on the level of individual industries.
44 R.C.O. Matthews, C.H. Feinstein & J.C. Odling-Smee, *British economic growth, 1856-1973* (Oxford, 1982), 382-385.

7. Conclusions

The trans-World War I period has shown significant changes in the development of manufacturing industry in The Netherlands. In our opinion the period immediately after the war deserves thorough investigation since many profound changes with long term structural effects occurred in the aftermath of the First World War. From a sample of twelve industries we infer a marked acceleration in labour productivity in Dutch manufacturing. We emphasize two possible explanations. First, a drastic reduction in hours worked accompanied by a shock in real wage costs around 1920. In our view this sparked off substitution of capital for labour, which was an important characteristic of Dutch manufacturing in the 1920's. Second, in contrast with the historiography, we state that investment, electrification in particular, did contribute prominently to the growth in labour productivity. A trend towards mechanization had already set in before World War I. The capital saving tendencies associated with electrification were of particular importance. This enabled a reduction in non-labour costs which partly compensated for the rise in real wages. These preliminary conclusions cannot be more than a first attempt to emphasize factors that were underrated in previous accounts. This needs to be followed up by more detailed research on the level of individual industries.

Annex 1: Real value added, labour input, real labour productivity, and unit value ratios by branch of industry. Sources: *Produktiestatistiek, Ongevallenstatistiek.*

Cocoa 1913-1929

1	2	3	4	5	6	7	8
Year	Number of companies in census	Value of inputs mln. gld.	Value of gross output mln. gld.	Output unit value ratio 1913=100	Index of labour input 1913=100	Index of real value added 1913=100	Index of labour productivity 1913=100
1913	35	26.9	35.7	100.0	100.0	100.0	100.0
1914							
1915							
1916	37	31.6	42.7	134.7	97.6	93.3	95.6
1917							
1918							
1919	49	52.2	83.8	223.1	118.1	160.7	136.1
1920							
1921	50	34.7	55.2	103.4	95.4	226.1	236.9
1922	50	32.4	53.3	93.5	91.4	254.9	278.9
1923	51	32.1	50.8	80.8	85.3	263.2	308.5
1924	49	34.1	53.7	76.0	92.6	292.7	316.2
1925	48	40.2	60.0	92.4	98.7	243.2	246.3
1926	46	41.4	60.8	96.8	93.0	228.6	245.8
1927	46	44.4	62.5	121.1	85.1	169.3	198.9
1928	43	49.2	67.1	110.7	87.7	183.2	208.9
1929	44	45.0	66.1	94.4	91.4	253.9	277.9

Cotton 1913-1929

1	2	3	4	5	6	7	8
Year	Number of companies in census	Value of inputs mln. gld.	Value of gross output mln. gld.	Output unit value ratio 1913=100	Index of labour input 1913=100	Index of real value added 1913=100	Index of labour productivity 1913=100
1913	82	75.1	101.3	100.0	100.0	100.0	100.0
1914							
1915							
1916	90	101.2	140.2	130.4	93.3	122.1	130.9
1917							
1918							
1919							
1920							
1921	92	125.2	199.6	195.0	75.0	129.6	172.9
1922	100	132.7	213.1	184.6	84.8	148.0	174.5
1923	101	130.8	194.1	201.2	82.2	106.8	129.9
1924	100	131.5	190.6	220.5	88.4	91.0	102.9
1925	103	176.0	255.6	197.0	92.0	137.1	149.0
1926	106	138.3	210.3	147.7	96.9	165.6	170.9
1927	110	136.2	224.1	135.9	102.5	219.7	214.3
1928	105	157.8	245.4	150.0	105.3	198.2	188.2
1929	105	160.0	245.0	143.6	106.3	201.1	189.2

Flour 1913-1929

1	2	3	4	5	6	7	8
Year	Number of companies in census	Value of inputs mln. gld.	Value of gross output mln. gld.	Output unit value ratio 1913=100	Index of labour input 1913=100	Index of real value added 1913=100	Index of labour productivity 1913=100
1913	15	31	33.4	100.0	100.0	100.0	100.0
1914							
1915							
1916	16	91.7	98.6	160.8	127.3	180.7	142.0
1917							
1918							
1919							
1920	31	178.7	192.5	354.9	124.2	163.5	131.6
1921	25	129.5	137.7	218.4	108.4	160.0	147.6
1922	22	89.4	98.4	151.0	115.2	251.8	218.5
1923	22	81.9	91.6	138.3	108.3	295.7	273.1
1924	24	96.8	113.1	151.2	106.5	456.1	428.3
1925	20	112.1	124.9	180.5	105.1	301.0	286.5
1926	19	99.0	108.7	169.9	97.5	240.3	246.5
1927	20	93.8	104.8	161.2	94.6	288.2	304.5
1928	23	89.3	101.6	148.5	99.7	352.1	353.0
1929	19	84.9	96.0	130.1	97.9	361.6	369.5

Paper 1913-1929

1	2	3	4	5	6	7	8
Year	Number of companies in census	Value of inputs mln. gld.	Value of gros output mln. gld.	Output unit value ratio 1913=100	Index of labour input 1913=100	Index of real value added 1913=100	Index of labour productivity 1913=100
1913	30	11.1	15.4	100.0	100.0	100.0	100.0
1914							
1915							
1916	32	18.9	27.8	191.9	95.1	106.3	111.8
1917							
1918							
1919	23	23.4	36	354.4	98.4	81.6	82.9
1920							
1921	22	20.1	29.4	250.8	87.8	85.6	97.5
1922	23	15.0	28.3	181.0	90.7	169.8	187.2
1923	24	15.3	27.3	170.8	92.1	161.1	175.0
1924	24	16.6	30.2	161.1	96.9	194.3	200.6
1925	25	18.5	35.3	164.7	101.2	234.0	231.2
1926	26	19.4	38.3	165.8	106.0	261.0	246.2
1927	25	20.5	38.9	154.8	110.3	273.0	247.4
1928	26	21.9	42.2	149.8	120.4	311.0	258.3
1929	26	23.7	44.8	148.2	127.2	328.1	258.0

Shipbuilding 1913-1929

1	2	3	4	5	6	7	8
Year	Number of companies in census	Value of inputs mln. gld.	Value of gross output mln. gld.	Output unit value ratio 1913=100	Index of labour input 1913=100	Index of labour productivity 1913=100	
1913					94.7	72.8[1]	76.9
1914							
1915							
1916	202	21.4[2]	44.5	100.0	100.0	100.0	100.0
1917							
1918							
1919							
1920	112	98.3	196.2	381.1	120.5	111.1	92.2
1921	108	96.7	203.8	273.4	101.1	158.6	156.8
1922	92	70.5	188.2	253.1	71.2	188.4	264.5
1923	98	39.5	96.9	265.7	60.4	87.4	144.7
1924	102	48.3	104.7	226.0	74.0	101.1	136.7
1925	99	51.1	124.2	164.0	85.0	180.4	213.0
1926	103	59.3	122.9	192.2	87.6	133.9	152.8
1927	103	69.8	139.3	191.5	94.8	146.0	154.0
1928	107	84.6	164.5	191.0	103.4	169.6	164.0
1929	119	83.3	150.9	159.6	112.0	171.7	153.3

[1] Production in 1913 calculated from physical indicators provided by Van der Schalk, *Arbeidsproduktiviteit*, bijlage II, 8-9.
[2] Intermediate inputs in 1916 estimated by the ratio to gross output in 1920 and 1921.

Shoes 1913-1929

1	2	3	4	5	6	7	8
Year	Number of companies in census	Value of inputs mln. gld.	Value of gross output mln. gld.	Output unit value ratio 1913=100	Index of labour input 1913=100	Index of real value added 1913=100	Index of labour productivity 1913=100
1913	345	9.6	13.8	100.0	100.0	100.0	100.0
1914							
1915							
1916							
1917	645	34.4	47.1	225.3	126.2	133.3	105.6
1918							
1919	504	35.9	53.3	375.8	94.2	109.0	115.7
1920							
1921	186	16.6	38.3	251.0	103.3	202.9	196.4
1922	163	11.4	27.0	207.9	70.5	176.6	250.5
1923	170	10.7	22.6	167.0	83.4	167.8	201.3
1924	202	16.2	33.8	154.2	107.4	268.7	250.2
1925	195	15.7	32.7	153.1	104.7	260.8	249.1
1926	204	17.2	36.3	151.9	111.7	295.0	264.1
1927	200	18.9	38.3	150.7	116.6	302.8	259.6
1928	209	23.4	44.1	156.1	124.9	312.7	250.3
1929	203	21.5	43.5	153.6	123.7	336.1	271.8

Knitted goods 1913-1929

1	2	3	4	5	6	7	8
Year	Number of companies in census	Value of inputs mln. gld.	Value of gross output mln. gld.	Output unit value ratio 1913=100	Index of labour input 1913=100	Index of real value added 1913=100	Index of labour productivity 1913=100
1913	19	3.5	5.7		83.0		83.7[1]
1914							
1915							
1916	19	7.2	11.4		99.4		91.1[1]
1917							
1918							
1919							
1920							
1921	29	5.6	12.7	100.0	100.0	100.0	100.0
1922	30	7.3	16.2	75.2	124.1	168.9	136.1
1923	27	5.1	10.5	61.6	97.9	123.7	126.4
1924	24	6.9	12.5	61.1	103.2	130.1	126.1
1925	25	7.0	12.7	59.7	103.5	135.9	131.3
1926	25	6.7	12.8	55.6	112.9	157.2	139.3
1927	27	7.1	14.6	49.3	128.6	215.5	167.6
1928	28	8.6	16.4	51.7	137.8	211.8	153.7
1929	28	9.1	17.5	49.9	146.8	239.0	162.8

[1] Calculated from physical indicators

Wool 1913-1929

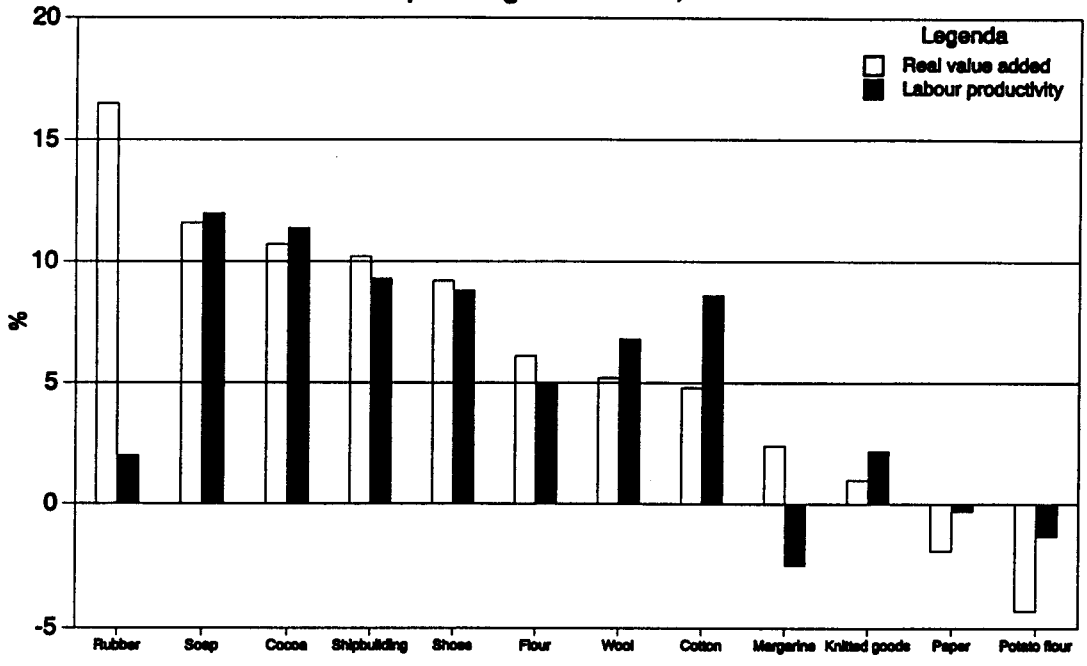
1	2	3	4	5	6	7	8
Year	Number of companies in census	Value of inputs mln. gld.	Value of gross output mln gld.	Output unit value ratio 1913=100	Index of labour input 1913=100	Index of real value added 1913=100	Index of labour productivity 1913=100
1913	72	17.8	28.6	100.0	100.0	100.0	100.0
1914							
1915							
1916	74	34.9	63.4	142.9	112.0	184.4	164.6
1917							
1918							
1919							
1920							
1921	82	30.8	56.2	188.2	88.4	149.5	169.2
1922	84	30.2	57.6	172.0	97.9	176.4	180.2
1923	82	30.1	52.2	170.7	93.2	143.5	154.0
1924	82	39.3	60.8	183.4	97.8	130.1	133.0
1925	82	35.1	55.6	192.7	93.7	118.1	126.1
1926	82	33.1	54.9	171.8	95.8	140.4	146.5
1927	80	39.4	64.4	170.3	102.3	162.9	159.2
1928	77	44.3	69.6	181.7	106.0	154.5	145.8
1929	78	44.1	68.8	166.5	107.9	164.9	152.8

Soap 1913-1929

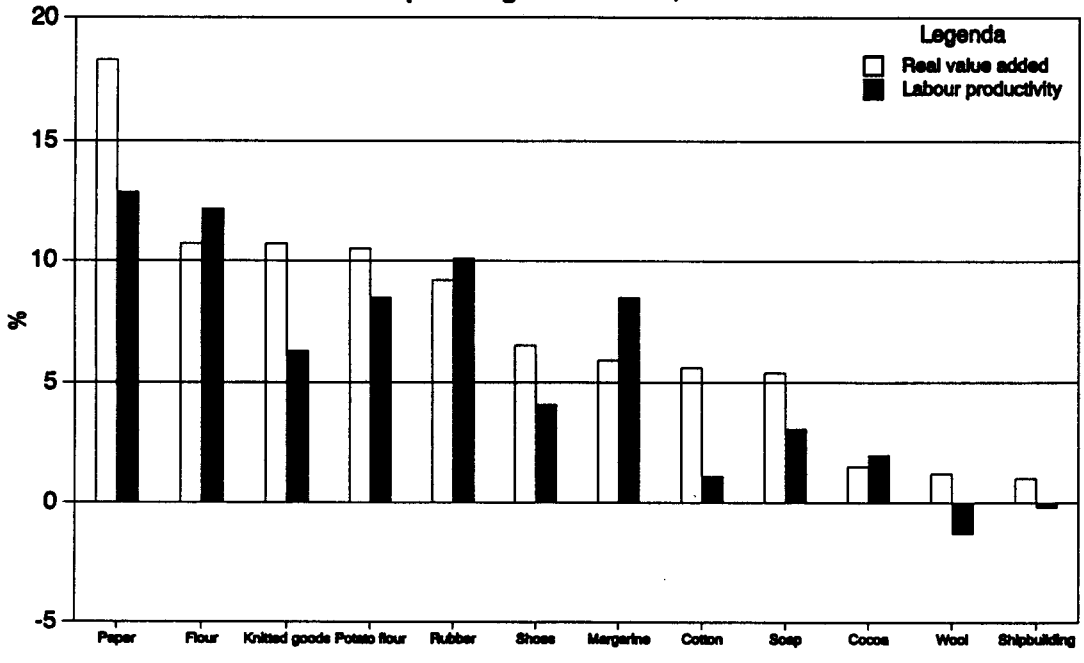
1	2	3	4	5	6	7	8
Year	Number of companies in census	Value of inputs mln. gld.	Value of gross output mln. gld.	Output unit value ratio 1913=100	Index of labour input 1913=100	Index of real value added 1913=100	Index of labour productivity 1913=100
1913	58	8.5	10.5	100.0	100.0	100.0	100.0
1914							
1915	66	15.6	21.1	140.3	97.3	195.9	201.3
1916							
1917							
1918							
1919	60	23.2	32.6	318.6	105.0	148.5	141.4
1920							
1921	61	16.9	26.9	208.1	96.9	240.0	247.8
1922	63	16.7	27.2	190.1	100.2	276.6	276.1
1923	58	18.4	28.3	183.9	101.1	269.4	266.4
1924	56	19.0	28.8	181.4	101.0	269.2	266.5
1925	58	20.2	30.4	186.0	106.2	274.2	258.1
1926	63	20.0	31.1	172.2	107.6	325.8	302.8
1927	61	20.7	31.8	159.2	112.4	350.6	312.0
1928	62	20.7	31.9	152.2	116.2	367.8	316.6
1929	62	20.5	31.7	153.2	115.9	366.1	316.0

Annex 2: **Growth rates of real value added and real labour productivity per hour worked in 12 branches of industry**

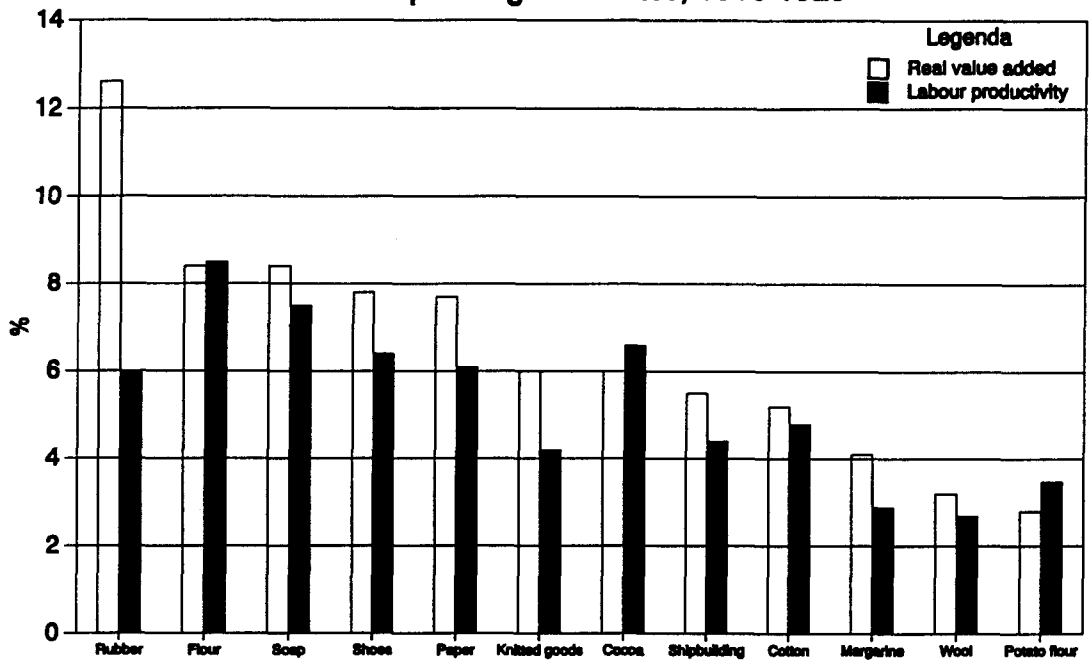
Real value added and labour productivity per hour in 12 branches of industry
Annual compound growth rates, 1913-1921



Real value added and labour productivity per hour in 12 branches of industry
Annual compound growth rates, 1921-1929



Real value added and labour productivity per hour in 12 branches of industry
Annual compound growth rates, 1913-1929



References

'Enkele kenmerken van de ontwikkeling der Nederlandsche nijverheid sedert 1921', *Maandschrift van het C.B.S.* (september 1936) 1333-1337.

Ark, H.H. van, *International comparisons of output and productivity* (Groningen, 1993), 38-41.

Bochove, C.A. van, & T.A. Huitker, *Main national accounting series, 1900-1986.* CBS NA-017 (1987).

Broadberry, S.N., 'The emergence of mass unemployment: explaining macroeconomic trends in Britain during the trans-World War I period', *The Economic History Review* 43 (1990) 271-282.

Broadberry, S.N., & A. Ritschl, *Real wages, productivity and unemployment in Britain and Germany during the 1920's* Münchner Wirtschafstswissenschaftliche Beiträge 92-26 (1992).

Byatt, I.C.R., *The British electrical industry, 1875-1914* (Oxford, 1979).

CBS, *Statistiek van de voortbrenging en het verbruik der Nederlandse nijverheid in 1913 en 1916.* Bijdragen tot de statistiek van Nederland. Nieuwe volgreeks No. 292. ('s-Gravenhage, 1920).

CBS, *Statistiek van de voortbrenging en het verbruik van een aantal takken der Nederlandsche nijverheid in 1919.* Bijdragen tot de statistiek van Nederland. Nieuwe volgreeks No. 322. ('s-Gravenhage, 1921).

CBS, *Maandschrift van het C.B.S.* various issues [1921-1931].

CBS, 'Indexcijfers van de productie per arbeider', *De Nederlandsche Conjunctuur* (november 1936) 16-18.

CBS, *Zestig jaren statistiek in tijdreeksen* (Zeist, 1959).

Centraal verslag der Arbeidsinspectie in het in het Koninkrijk der Nederlanden over 1911 (s.l. ('s-Gravenhage), 1912).

David, P.A., 'The dynamo and the computer: an historical perspective on the modern productivity paradox', *American Economic Review* 80 (1990) 355-361.

De Graaff, A., *De industrie.* De Nederlandse volkshuishouding tussen twee wereldoorlogen 8 (Utrecht, 1951).

Devine Jr., W.D., 'Electrified mechanical drive: the historical power distribution revolution' in: S.H. Schurr e.a., *Electricity in the American economy* (New York, 1990) 21-42.

Dowie, J.A., '1919-20 is in need of attention', *The Economic History Review* 23 (1975) 429-450.

Du Boff, R.B. du, 'Electrification and capital productivity: a suggested approach', *Review of Economics and Statistics* 38 (1966) 426-431.

Etemad, B., & J. Luciani, *World energy production 1800-1985* (Genève, 1991).

Gales, B.P.A., 'Mijnbouw', in: H.W. Lintsen, M.S.C. Bakker, E. Homburg e.a. (eds.), *Geschiedenis van de techniek in Nederland. De wording van een moderne samenleving 1800-1890* IV (Zutphen, 1993) 13-35.

Griffiths, R.T., & J.L. van Zanden, *Economische geschiedenis van Nederland in de 20e eeuw* (Utrecht, 1989).

Heerma van Voss, A.F., *Kosten van arbeidstijdverkorting. De achturendag in de jaren twintig* (Unpublished PhD-thesis Universitity of Utrecht, 1991).

Jong, H.J. de, & R.B.M. Oude Vrielink, 'Produktie en arbeidsproduktiviteit in de voedings-middelenindustrie 1918-1939', *Economisch- en Sociaal-Historisch Jaarboek* 56 (1993) 289-339.

Keesing, F.A.G., *De conjuncturele ontwikkeling van Nederland en de evolutie van de economische overheidspolitiek 1918-1939* (Reprint: Nijmegen, 1978).

Knibbe, M., *Agriculture in the Netherlands 1851-1950. Production and institutional change* (Amsterdam, 1993).
Maddison, A., *Dynamic forces in capitalist development: a long-run comparative view* (Oxford/New York, 1991).
Matthews, R.C.O., C.H. Feinstein & J.C. Odling-Smee, *British economic growth, 1856-1973* (Oxford, 1982).
Methorst, H.W., 'The cost of living, prices, and wages' in: *The Netherlands and the World War* Volume II (New Haven, 1928) 303-361.
Minami, R., *Power revolution in the industrialization of Japan: 1885-1940* (Tokyo, 1987).
Moore, B.F., *Economic aspects of the commerce and industry of the Netherlands, 1912-1918* (Washington 1919).
Ongevallenstatistiek betreffende de kalenderjaren [1903-1929] (Amsterdam, 1904-1930).
Saitzew, M., *Die Motorenstatistik. Ihre Methode und ihre Ergebnisse* (Zürich, 1918).
Schalk, F.J.C. van der, *De wiskundig statistische analyse van de arbeidsproductiviteit*, (Haarlem, 1938).
Schrage, P., E. Nijhof & P. Wielsma, 'Inkomensontwikkeling van werkenden en werklozen in Nederland, 1913-1939', *Tijdschrift voor Sociale Geschiedenis* 15 (1989) 347-394.
Schurr, S., & B.C. Netschert, *Energy in the American economy. An economic study of its history and prospects* (Baltimore, 1960).
Seegers, J.J., 'Produktie en concurrentievermogen van de Nederlandse industrie in het Interbellum', *Economisch- en Sociaal-Historisch Jaarboek* 50 (1987) 186-211.
Smidt, H.A.R., 'De regulering van de Nederlandse export van landbouwprodukten naar Duitsland tijdens de Eerste Wereldoorlog', *Economisch- en Sociaal-Historisch Jaarboek* 54 (1991) 102-133.
Sonenblum, S., 'Electrification and productivity growth in manufacturing', in: S.H. Schurr e.a., *Electricity in the American economy* (New York, 1990) 277-324.
Sonenblum, S., & S. Schurr, 'Electricity use and energy conservation' in: S.H. Schurr e.a., *Electricity in the American economy* (New York, 1990) 325-339.
The Netherlands and the World War Volume I, II (New Haven, 1928).
Tinbergen, J., 'Kapitaalvorming en conjunctuur in Nederland, 1880-1930', *De Nederlandsche Conjunctuur* (maart 1932) 8-16.
Verdoorn, P.J., *Arbeidsduur en welvaartspeil* (Leiden, 1947).
Woolf, A.G., *Energy and technology in American manufacturing: 1900-1929* (PhD-thesis Ann Arbor, 1980).

Papers issued in the sub-series of the Groningen Growth and Development Centre:

536 (GD-1) Maddison, Angus and Harry van Ooststroom, The International Comparison of Value Added, Productivity and Purchasing Power Parities in Agriculture (1993)

537 (GD-2) Mulder, Nanno and Angus Maddison, The International Comparison of Performance in Distribution: Value Added, Labour Productivity and PPPs in Mexican and US Wholesale and Retail Trade 1975/7 (1993)

538 (GD-3) Szirmai, Adam, Comparative Performance in Indonesian Manufacturing, 1975-90 (1993)

549 (GD-4) de Jong, Herman J., Prices, Real Value Added and Productivity in Dutch Manufacturing, 1921-1960 (1993)

550 (GD-5) Beintema, Nienke and Bart van Ark, Comparative Productivity in East and West German Manufacturing before Reunification (1993)

567 (GD-6) Maddison, Angus and Bart van Ark, The International Comparison of Real Product and Productivity (1994)

568 (GD-7) de Jong, Gjalt, An International Comparison of Real Output and Labour Productivity in Manufacturing in Ecuador and the United States, 1980 (1994)

569 (GD-8) van Ark, Bart and Angus Maddison, An International Comparison of Real Output, Purchasing Power and Labour Productivity in Manufacturing Industries: Brazil, Mexico and the USA in 1975 (1994) (second edition)

570 (GD-9) Maddison, Angus, Standardised Estimates of Fixed Capital Stock: A Six Country Comparison (1994)

571 (GD-10) van Ark, Bart and Remco D.J. Kouwenhoven, Productivity in French Manufacturing: An International Comparative Perspective (1994)

572 (GD-11) Gersbach, Hans and Bart van Ark, Micro Foundations for International Productivity Comparisons (1994)

573 (GD-12) Albers, Ronald, Adrian Clemens and Peter Groote, Can Growth Theory Contribute to Our Understanding of Nineteenth Century Economic Dynamics (1994)

574 (GD-13) de Jong, Herman J. and Ronald Albers, Industrial Output and Labour Productivity in the Netherlands, 1913-1929: Some Neglected Issues (1994)

Groningen Growth and Development Centre Research Monographs:

No. 1 van Ark, Bart, International Comparisons of Output and Productivity: Manufacturing Productivity Performance of Ten Countries from 1950 to 1990 (1993)

No. 2 Pilat, Dirk, The Economics of Catch-Up: The Experience of Japan and Korea (1993)