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Abstract

On the basis of a newly constructed dataset of the national accounts of the province of Holland in the period between 1347 and 1800, we analyze the pattern of growth in this region, which was one of the most prosperous and dynamic parts of the pre modern European economy. We demonstrate that this economy was characterized by almost continuous but highly unstable economic growth caused mainly by exogenous shocks related to international trade and shipping, and harvest fluctuations. The causes of this growth vary over time. Yet, the start of the Golden Age was characterized by the increase of total factor productivity. TFP-growth was an important factor behind growth in the period until the 1620s, was negative during the middle decades of the 17th century, and became positive again after the 1660s. This suggests a surge of technological change during the 1540-1620 period, followed by much more incremental changes in the next two centuries.

Keywords: GDP, national accounts, Holland, economic growth, historical development

JEL Codes: E01, E24, N13, N53, N63, N73

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INTRODUCTION

The debate about the character of economic growth before the Industrial Revolution of the late eighteenth century has gone through a number of stages. In the 1960s and 1970s the early modern economy of Europe was considered to be basically stagnant, a view that was most clearly expressed by Wilhelm Abel[1] and by the representatives of the French Annales school.[2] In the 1980s and 1990s this picture came under attack from several sides. Economic historians of the early modern period began to point out that the industrialization of the late eighteenth and early nineteenth centuries was made possible by structural changes that took place during preceding centuries. The development of urbanization and international trade networks,[3] agricultural productivity,[4] proto-industry,[5] national patterns of specialization[6] and labor markets,[7] the 'consumer revolution' and the 'industrious revolution',[8] all demonstrated that this was a dynamic period, when the basis was laid for the industrialization of Western Europe after c. 1780. This `revolt of the early modernists', as Jan de Vries has called it[9], has resulted in a much more optimistic interpretation of economic growth during the centuries before the Industrial Revolution.[10] In their book on 'The First Modern Economy. Success, Failure, and Perseverance of the Dutch Economy, 1500-1815', Jan de Vries and Ad van der Woude have carried this 'revolt of the early modernists' to its logical conclusion. Their thesis is not only that The

[1] Abel, *Agrarkrisen und Agrarkonjunktur*.
[2] Le Roy Ladurie, "L'histoire immobile", pp. 673-92.
[3] De Vries, *European urbanization*.
[4] De Vries, *The Rural Economy*; Hoffman, *Growth*.
[5] Mendels, "Proto-industrialization", pp. 241-61.
[6] Kussmaul, *A general view*.
[7] Lucassen, *Migrant Labour*.
[8] De Vries, "The industrious revolution".
[9] Idem, p. 253.
[10] An early example for Holland is Riley, "The Dutch economy after 1650," who claims that even in the 18th century, which generally was considered a period of stagnation, there was growth.

Netherlands in this period can be characterized as 'the first modern economy', but also that it went through a process (or rather a cycle) of 'modern economic growth' between 1500 and 1815.[11]

This re-assessment of the early modern period has not gone unchallenged, however. The old orthodoxy that the pre 1800 world was basically a Malthusian one in which the welfare of the population was stagnant in the long run, has returned to the scene with the appearance of Greg Clark's 'A Farewell to Alms', and the heated debate to which it gave rise.[12] Clark mainly focused on English data and estimates – most importantly (and controversially)[13] estimates of real wages – and did not pay a lot of attention to what was happening in the rest of Europe, however.

So far, the answering of the questions about the growth trajectory of the European economy before industrialization has thus been severely constrained by data problems. The optimism of De Vries and Van der Woude is based on a few scattered data points concerning possible levels of income in the Dutch Republic (or Holland),[14] whereas the pessimism by Clark is largely based on his real wage series for England.[15] What is missing, in our opinion, is a consistent set of estimates of the national accounts of the European countries in the pre-1800 period, making it possible to study the process of

[11] De Vries and Van der Woude, *First Modern Economy*, p. 721.
[12] Taken from a long list of reviews for example: Pomeranz, "Gregory Clark, Farewell to Alms"; Harley, "Gregory Clark, Farewell to Alms."
[13] Broadberry, Campbell, and Van Leeuwen, "The sectoral distribution of the labour force."
[14] Jan de Vries already in his study of the system of inland transport in the 17th and 18th century developed an innovative way to estimate income changes in this period, but also these results were tentative: De Vries, *Barges and capitalism,* pp. 241-270.
[15] His GDP estimates are also largely based on the real wage series and the assumption of a constant per capita days worked between 1200 and 1850. Furthermore, his main claim is, contrary to Shaw-Taylor and Jones, "An industrializing region" and Shaw Taylor and Wrigely, "The occupational structure of England", that the release of labor from agriculture only started after the mid-18th century, which again suggest a stagnationist view until around 1800. Estimates of faster economic growth between 1270 and 1800 in which agricultural labor was released already since the 17th century is brought forward is discussed by Broadberry, Campbell and Van Leeuwen, "The sectoral distribution of the labour force."

economic growth in detail. A research project with the aim to put together these sets of estimates of long-term economic growth in Western Europe before the Industrial Revolution already started in the 1990s (initiated by Herman van der Wee and Angus Maddison) [16], and is now reaching a stage in which detailed and annual estimates of GDP per capita for key regions in Western Europe are being put together such as for England, Italy, and Spain.[17] This paper presents the results of such a project for Holland, the most populous and wealthy province of the Netherlands, for which relatively rich historical sources are available making it possible to construct annual estimates of GDP and its components.

The case of Holland is of obvious importance for the debate sketched in the introduction. It was undoubtedly one of the most dynamic parts of Europe in the centuries before 1800 and had, as demonstrated by De Vries and Van der Woude, already a relatively modern institutional framework.[18] Their hypothesis of 'a first round of modern economic growth' is largely based on the case of this province. A reconstruction of the national accounts of the province should make it possible to answer the question if (and when) this region generated such a process. Or was its development a typical example of 'Smithian' growth, driven by the expansion of international trade and resulting from increased specialization and improved allocation of resources?[19] Was it another example of the wave-like character of an 'efflorescence', typical of the pre industrial economy,

[16] E.g. Blomme and Van der Wee, 'the Belgian economy'; Malanima, 'Italian economic performance'; Yun, 'Proposals to Quantify Long Term Performance in the Kingdom of Castile'; Van Zanden, 'Early modern economic growth.' This work has been completely ignored by Clark, however

[17] See for exampleBroadberry et al, "British Economic Growth," Prados de la Escosura and Alvarez Nogal, "The rise and decline of Spain," and Malanima, "Italian GDP."

[18] De Vries and Van der Woude, *The First Modern Economy*, pp. 693-699.

[19] See Mokyr, *The Enlightened Economy*, p.5.

which in the long run did not lead to a (much) higher level of GDP per capita?[20] How important were 'modern' drivers of economic growth such as technological change and the accumulation of human and physical capital? And, assuming that De Vries and Van der Woude are correct that institutions in this part of the world were indeed remarkably modern already in the 16th and 17th century, why did this 'first modern economy' cease to generate growth and structural change after 1650 or 1670? Or did it continue to grow after 1670?

The focus on the province of Holland has big advantages: it was the most urbanized, dynamic and richest province of the Dutch Republic, and is therefore typical for the pattern of change that can be found in the most developed parts of Western Europe in this period.[21] Studying this case inform us about the growth processes that were possible in this part of the European economy, which were not limited by the decreasing returns of the agricultural sector (because this sector was so small in this region). Moreover, we were also able to reconstruct the basic outlines of the growth trajectory of the Holland economy in the late Medieval period (between 1347 and 1500), which makes it possible to study a period in which structural transformation was dramatic and an important source of economic growth. By adding these 150 years to the growth record, we can also put the experience of this economy during its 'Golden Age' in perspective.

[20] Goldstone, 'Efflorescences'.

[21] Growth in Holland was probably faster between 1500 and 1650, but after 1650 the 'periphery' of the country started to catch up, and it was probably more dynamic in the late 17th and 18th century, as a result of which the overall performance between 1500 and 1800 may have been very similar; it requires another research project to reconstruct and analyze these patterns in detail; see also the discussion about these issues in; De Vries and Van der Woude, *First Modern Economy,* 172-179.

Finally, our intention is to chart the most important features of long term growth in Holland in this paper, focusing on its 'proximate causes'; we do not intend to test ideas about its 'ultimate causes' from new institutional economics or unified growth theory.

THE DATASET

We think we are now closer to answering above questions, because we have built a detailed dataset of the national accounts of Holland between 1510 and 1807, and also developed a likely 'scenario' for the pace and character of economic growth during the late Medieval period. As a result, we can present estimates of the development of GDP per capita for the whole 1347-1807 period; this also includes estimates of the structure of the economy (the share of agriculture in GDP, for example). In the appendices we give the details about this project; it describes the way in which the estimates of the national income for Holland before 1807 have been put together. The aim of the project was, for the period between 1510 and 1807, to produce annual estimates of gross value added of the main industries of the Holland economy in both current and constant prices, which could then be used to produce estimates of total GDP (and GDP per capita). The starting point consisted of two benchmark estimates, for 1510/14 and for 1807, the result of previous research into the structure of the Holland economy at the beginning of the 16th century,[22] and into the national accounts of the Netherlands in the 19th century.[23] Moreover, we used previous research into the development of Holland in the late medieval period, to produce tentative estimates of the growth performance of that period

[22] Van Zanden, "Taking the measure of the early modern economy."
[23] Smits, Horlings, and Van Zanden. *Dutch GNP and its components, 1800-1913*. The two studies by Horlings, *The Economic Development of the Dutch Service Sector* on the services sector and by Jansen, *De industriële ontwikkeling in Nederland* on the industrial sector in the first half of the 19th century were important as models for estimating output and value added in different parts of the economy.

as well, but these pre 1510 estimates are due to data constraints based on a much smaller body of evidence. We applied the standard System of National Accounts (SNA) methodology, concentrating on - as in previous work - the output side of the economy.

We will first briefly explain the estimates concerning the 1510-1807 period. The challenge of this part of the project was to find sources that reflect the annual variation in output or value added in different industries between 1510 and 1807 in order to 'interpolate' between the two benchmark estimates for 1510/14 and 1807. In the process of working with the data, we sometimes were able to improve on the estimates made for 1510/14 and for the 1807-1913 period, as a result of which the resulting estimates of GDP growth between these two benchmarks is slightly higher than we previously estimated (these, relatively small, discrepancies between earlier studies and the estimates presented here are discussed in appendix 1). Moreover, the 1807 estimates related to the Netherlands as a whole, and in order to link the Holland estimates to those of the Netherlands, we had to estimate its share in Dutch GDP, which also lead to a number of (generally small) modifications of the original estimates (appendix 1).

The economy has been broken down into three sectors (primary, secondary and tertiary). The primary sector includes agriculture and fishing (herring fishing and whaling); the main branch we miss here is fresh water fisheries which were quite important in the 16th century, but declined afterwards.[24] The secondary sector consists of textiles (wool and linen), clothing, construction, peat digging, food (bakeries, brewing, gin – *jenever* – distilling, and other foodstuffs), paper, shipbuilding, printing, soap production and sugar refining. The tertiary sector was covered by international shipping, international trade, domestic trade, inland transport (via inland waterways), banking,

[24] See De Vries and Van der Woude, *The First Modern Economy*, pp. 237-239.

education, government services (military sector and the rest), housing, domestic services, and professional services, which were approximated by notaries and book traders. In sum, we have annual estimates of the value added (in current and constant prices) of 27 branches of national income, many of which are constructed on the basis of several underlying time series; for example, the output of shipping sector is based on data on shipping to the Baltic, Asia, the Americas (including the slave trade), and 'the rest', the other trades which had to be estimated on the basis of the number of ships entering the Netherlands in these years. A lot of the underlying data relate to yields of various taxes, such as the famous Soundtoll registers and the many indirect excises levied by the government.[25] In addition, the detailed accounts of the Dutch East Indies Company, the central government of Holland, the Amsterdam Exchange Bank (Wisselbank) and the University of Leiden have also been used for the project.[26] Moreover, thanks to the work by Posthumus, Noordegraaf, De Vries and others, there is a wealth of information on the development of prices and wages, which is also of fundamental importance for reconstructing the national accounts.[27] The weakest part of the project are the estimates of technical coefficients and cost structures, for which we often have only very tentative estimates, related to one or two years (for the soap industry, for example, we know for only one year, 1699, what the share of value added is in gross output). We were mainly interested in the long term changes in the economy of Holland; for lack of sources, gaps in series sometimes had to be interpolated, but this probably does not affect the long term

[25] Bang and Korst, *Tabeller over Skibsvart og Varetransport,* and Fritschy and Liesker, *Gewestelijke Financiën.*
[26] De Korte, *De Jaarlijkse financiele verantwoording in de* VOC; Fritschy and Liesker, *Gewestelijke Financiën;* Van Dillen, *Mensen en achtergronden*; Sluijter, '*Tot ciræt, vermeerderinge ende heerlyckmækinge der universiteyt'*.
[27] Posthumus, *Nederlandsche prijsgeschiedenis*; Noordegraaf, *Daglonen in Alkmaar;* De Vries and Van der Woude*, The First Modern Economy*, pp. 609-614; for a recent overview see Van Zanden, "What happened to the standard of living before the Industrial Revolution?"

picture that we get. The *Informacie*, the very extensive and detailed census of 1514, which is probably the richest source for the study of the national accounts in the pre 1800 period, to some extent compensates for the data problems of the 16th century. From the 1580s onwards, when the newly independent Dutch Republic expands and starts to raise many new taxes, the data flow increases steadily, and the quality of our estimates increases as well.

These estimates show, as has been pointed out before, that already at the beginning of the 16th century the structure of the economy of Holland was very modern, with, for example, almost half the population living in cities and less than a quarter of the labour force active in the agricultural sector.[28] This of course raises the question whether the roots of 'modern economic growth' should not be sought in the period before 1500.[29] To address this question, we have also tried to chart the development of GDP per capita for the late medieval period, going back to the 1347, or just before the population decline caused by the Black Death. Unfortunately, we only have relatively good information on the performance of the agricultural sector (mainly arable agriculture), via the availability of a number of more or less representative series of the yields of tithes, and on the development of the urban population (and in particular the population of Leiden) in this period. This was used to develop a tentative scenario of what happened to GDP between 1347 and 1510 (the details are explained in appendix 2).

The estimates of the national accounts of Holland are, in our view, the best summary of the information that is available about the long term development of the economy of this region in that period. The beauty of the system of national accounts is

[28] See Van Zanden, "Taking the measure of the early modern economy", p. 134, 148.
[29] See the discussion in Van Zanden, "The revolt of the early modernists: an assessment."

that it allows for a consolidation of all available information, from many different sources and studies, which individually all have their limitations and are subject to certain margins of error, into one consistent framework, the SNA, which 'takes care' of the selection and the weighting of all the data. The result is a set of estimates of GDP and its components that is, in our view, the state of the art summary of our knowledge about this topic.

The estimated series obviously have their weaknesses. One weakness mentioned already is that in particular for the 16th century we often do not have annual observations of the variables measured. This can be quantified: for the first period (1510-1580) we have annual observations for only 35% of the economy (the rest is therefore based on intrapolations); after 1580 (when the Dutch republic emerges as an independent state and starts to produce large amount of data), this rises to almost 60% (59.1% in 1580-1650 and 59.5% in 1650-1750), to decline a bit (to 54.6%) in the 1750-1807 period.

It is also possible to address the issue of the degree of reliability of our estimates. In order to assess this it is necessary to estimate error margins. We applied a method to do this, developed by Feinstein and Thomas, who take as their starting point subjective estimates of the margins of error of the underlying series, made by the authors of the series. Their argument for doing this is that '[h]owever problematical such subjective assessments of unknown errors may be, they are much more informative than general statements formed from some favoured permutation of stock phrases (these estimates are very: 'approximate', 'imperfect', 'unreliable', 'tentative', 'uncertain', 'fragile'; they are: 'a best guess', 'a rough guide', 'an order of magnitude', 'a crude indication'; or, very occasionally, they are: 'reasonably reliable', 'broadly acceptable'; and so on).' In

calculating the error margins of the estimated series, they follow Chapman and attach margins of error to each component series, where four categories of error margins are distinguished: 3% for "firm estimates", 10% for "good estimates", 20% for "rough estimates", and 35% for conjectures.[30] Since these error margins were based on 95% probability, they are equivalent with two standard errors.

We attached these error margins to all series and time periods in our estimates; give the quality of the underlying data, we think that the estimates for the agricultural sector are weakest, and that those of the services sector have on average the lowest margins of error. The next step is to aggregate into an error margin for the total national income. Since some errors will be above, and other below the true value of the component series, it follows that, as long as the series are derived independently, the errors may offset each other. Therefore, Feinstein and Thomas (2001, 17) proposed the following equation:

$$\sigma_v = \sqrt{\sigma_x^2 + \sigma_y^2 + 2r_{xy}\sigma_x\sigma_y}$$

, where the standard error of the over-all series (σ_v) is equal to the square root of the sum of the variances of series X and Y, as well as the interdependence component of the two series r_{xy}, i.e the correlation coefficient of the two series. Following a multiplicative procedure of doing this for all 27 series in our dataset and all time periods, we arrived at estimates for the error margins as given in below Table 1. The estimated error margins are considerable (10-12% for the period before 1650), but decline over time (until the

[30] Chapman, *Wages and Salaries in the United Kingdom 1920–1938*; ; her categories have been adopted by Feinstein and Thomas 2001 (and by Smits, Horlings and Van Zanden 2000)

middle of the 18th century). We did not apply the same method to the pre 1510 estimates, because the number of underlying series is very limited, estimates are based on indirect evidence and therefore the margins of error are even much higher for that period – our subjective estimate is that those margins for the total GDP series for 1347-1510 are at least two to four times the level of the post 1510 period (and therefore vary between 20 and 40%). However, as shown in Figure 1, these error margins do not change the trend in the data.

Table 1

Margin of error in GDP and its components (95% probability)

	Agriculture		Industry		Services		GDP	
	Mean GDP	% margin of error (95%)	Mean GDP	% margin of error (95%)	Mean GDP	% margin of error (95%)	Mean GDP	% margin of error (95%)
1510-1580	16,226.4	30.2%	17,907.3	15.1%	44,631.0	9.7%	78,764.7	11.6%
1580-1650	23,105.0	27.8%	39,362.4	17.2%	102,173.8	7.3%	164,641.2	10.8%
1650-1750	29,954.4	21.2%	58,754.7	6.3%	120,201.3	5.0%	208,910.3	4.1%
1750-1807	35,286.8	31.4%	60,809.4	8.4%	128,160.1	3.7%	224,256.3	7.0%

Figure 1.
PER CAPITA GDP (1800 CONSTANT GUILDERS, INCLUDING ERROR MARGINS)

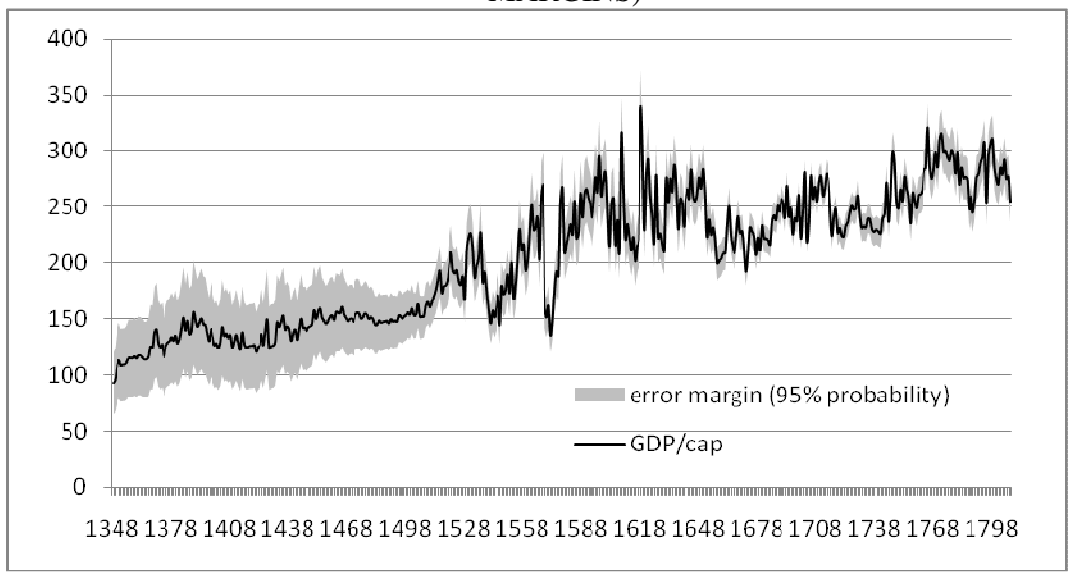
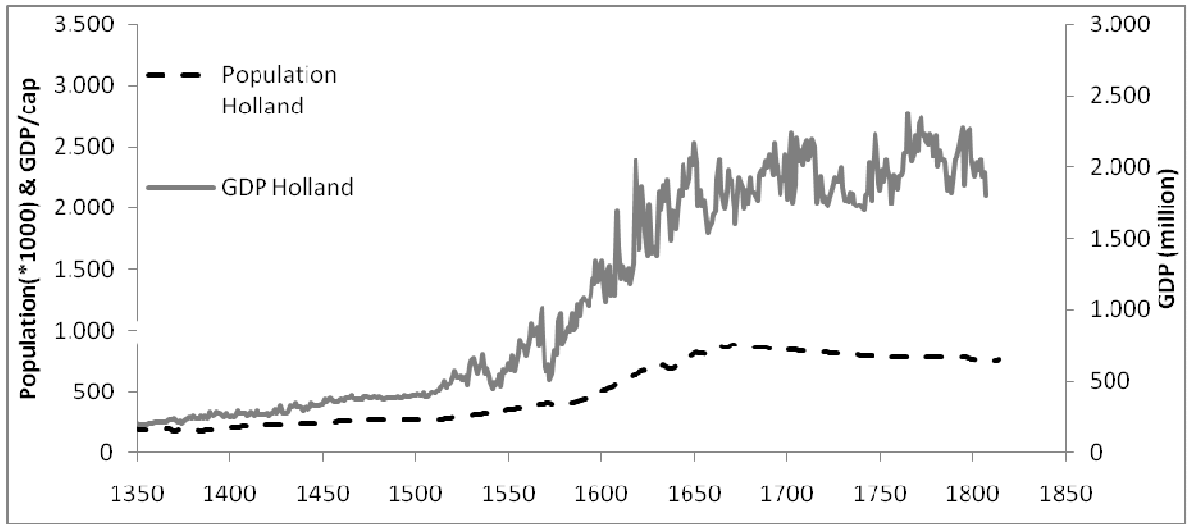


Figure 2

GDP (million 1990 GK dollars), POPULATION (*1000) IN HOLLAND, 1347-1807



Source: Appendix 1 and 2.

The 'big picture' that emerges from putting together the estimates for population and GDP for the late medieval and early modern period is presented in Figures 1 and 2. Three periods can be distinguished. During the late Medieval period GDP growth and population growth was rather slow; there was a strong increase in GDP per capita in the decades after the Black Death of 1348, stability or even some decline between the 1370s and the 1420s, a resumption of growth in the middle decades of the 15th century, and stability or even some decline towards the end of that century).[31] More importantly, the underlying trend was clearly upward, in spite of the fact (for example) that already during the middle decades of the 15th century population levels surpassed the pre-1348 peak, implying that per capita growth was not simply a due to population decline. Margins of

[31] De Boer, *Graaf,* 211-333; Van Bavel and Van Zanden, 'Jump-start'.

error are large for this period, however, so we cannot be too confident about the exact rate of economic growth.

The second period – of rapid GDP combined with rapid population growth – starts during the first decades of the 16th century and ends during the middle decades of the 17th century (Figure 2). This is the classical 'first round of economic growth' as analysed by De Vries and Van der Woude. It is after about 1670 followed by a third period of stable population levels (or even a slight decline), combined with a slow increase in total GDP. The picture of per capita growth is more nuanced, however. Again the trend is clearly upward between 1500 and 1620, but per capita growth is only marginally more rapid than before 1500, and appears to end already in the 1620s, when the per capita series shows a number of strong peaks. The 1620-1670 period is one of rapid GDP growth, but stability – perhaps even some decline – in the per capita series (because population growth is so rapid in these years, partially due to massive immigration from the neighbouring countries). The eighteenth century performance of the Holland economy is better than expected on the basis of current literature: GDP per capita recovers to the level of the peak years before 1650, and income levels in the 1760s and 1770s are even higher than ever before (and even the 1790s are in terms of GDP per capita not bad at all).

Perhaps the most striking result is the almost continuous growth of GDP per capita at on average 0.19 percent per year during the 1347-1807 period. Growth is already quite strong in the late medieval period, when during the second half of the 15th century per capita GDP increased at a slightly higher rate of 0.25 percent per year. Surprisingly, between 1500 and 1800 the familiar pattern of growth before ca 1670 and stagnation or even decline afterwards, is not that obvious in the per capita estimates.

What is perhaps most striking of the estimates presented in Figures 1 and 2 is the continued increase in GDP per capita in the 18th century, in particular in its second half. Seen in the very long run, per capita growth in the 18th century is not very dissimilar, and not (much) lower, than in the preceding three centuries. This is in sharp contrast with the usual view that growth came to a complete standstill, or was even negative, in the century and a half after 1670.[32]

It appears that trend growth of per capita GDP was remarkably stable in the very long run; in all periods - during the late Middle Ages, the period of expansion between 1500 and 1670 and the period of relative stagnation after 1670 - we witness an ongoing growth of per capita income. Between 1510/14 and 1807/08 GDP per capita increased by about 60%, somewhat more than was expected on the basis of the comparison of the two benchmark (1510/14 and 1806/7), which pointed to an increase of about 50%.[33] During the period of more than 450 years (1347-1807) per capita GDP more or less doubled.

Another, equally striking feature of the reconstructed series is the high instability of the economy. The second striking feature of the estimated national accounts is the instability of the pre-1800 economy. From the middle decades of the 16th century onwards (when the number of series with annual observations increases), trend growth is almost overshadowed by enormous swings in all sectors of the economy. There is rapid

[32] There are reasons to be even more optimistic about the growth performance during the 18th century. The Netherlands exported a lot of capital during this period, which led to strongly increasing flows of income to Dutch citizens. This means that the growth of real income was faster than the development of real product, measured here. On the basis what is known about these investments and income flows, it can be estimated that at the end of the 18th century Dutch GNP was perhaps five percent higher than GDP, a difference which was close to zero at the start of the century (Van Zanden and Van Riel, *The Strictures of Inheritance,* p. 21). Holland was contributing disproportionally to this, and may have received about 70 to 80 percent of the income from abroad, increasing its income by 6-8%. Real incomes therefore grew more than the GDP estimates suggest, and much of this increase was concentrated in the second half of the 18th century.

[33] Van Zanden, "Early modern economic growth"; Van Zanden, "Taking the measure of the early modern economy", pp. 153-154; the explanation is that our estimates differ sometimes from the benchmarks established for 1510/1514 and 1807 ; see the detailed discussion in appendix 1, Table 1.

growth during the middle decades of the 16th century (when Holland is closely linked to the Antwerp economy), followed by almost complete collapse during the first years of Revolt against Philip II (between 1566 and 1573), when, from peak to through, income per capita almost halved. It was probably the worst depression in early modern Dutch history. The period between the mid 1570s and 1620 was one of very rapid growth, initially in spite of the war with Spain, but the Truce with Spain between 1609-1621 lead to a further acceleration of economic expansion. The next phase, the renewed war between 1621 and 1648, is again a period of continued growth (although the peak of the early 1620s is not surpassed). The peace with Spain in 1648 was followed by a sharp contraction of the economy, however, partially the result of the ´peace dividend´, because expenditure on the army and the navy contracted sharply in these years (Figure 4). The rest of the economy also did not fare very well in these years. The sharp decline after 1713 has the same explanation: a massive reduction of public spending on defense. If we ignore the expenditure on navy and army the growth of GDP per capita becomes smoother, but the growth retardation of the second half of the 17th century still seems to be there.[34]

What are the causes of these huge swings in the level of GDP? We can start the decomposition of the variance by, for simplicity sake, assuming that we have the variance of two series:

$$X \sim (\mu_X, \sigma_X^2)$$

$$Y \sim (\mu_Y, \sigma_Y^2)$$

[34] In the submitted version of the paper this section is summarized as follows: In the working paper version of this paper we have analyzed the causes of high instability in detail and compare it with the much more stable growth path of the Netherlands after 1815. It could be demonstrated that the sector of international services was the main cause of high instability – industrial and agricultural output was fluctuating much less violently.

, where μ and σ^2 denote the mean and the variance of the series *X* and *Y* respectively and *s* and *z* are their variances. Now, if add the total of the two variables together, we get:

$$Z = X + Y$$

Where the new series *Z* has a mean $\mu_X + \mu_Y$ and, if they are uncorrelated, the variance is simply the sum of their individual variances. In case the series are correlated *Z* still has the same mean as before but the variance becomes:

$$\sigma_Z^2 = \sigma_X^2 + \sigma_Y^2 + 2 \cdot \sigma_{XY}$$

, where σ_{XY} is the covariance of X and Y. In other words, if the series are positively correlated, the variance of the sum of the series will go up. We can generalize this equation for *N* variables as follows:

$$Var(Z) = \sum_{i=1}^{N} Var(X_i) + 2 \sum_{i<j} Cov(X_i, X_j)$$

The results of the decomposition of the variance are presented in Table 2. It appears that the services sector is the main cause of volatility; especially (international) trade fluctuates enormously, largely due to exogenous shocks such as wars (Jonathan Israel gives a detailed overview of these developments).[35] The openness of the Dutch Republic therefore contributed significantly to the instability of its economic development, a factor that declined after 1670.

The same method can be used to analyse why the variance of GDP and its components was so much smaller during the 19th century (Table 3). We concentrate on the three main sectors here. The services sector is still the most important source of instability although declining after 1807. However, one has to keep in mind that after

[35] Israel, *Dutch Primacy in World Trade, 1585-1740.*

1807 the data refer to the Netherlands instead of Holland. More interesting is a relative decline in volatility in industry. Even though we are again confronted with a change to the Netherlands in 1807, the decline in industrial volatility is still part of a trend that already started after 1670 and picks up again only after ca 1850 (see Table 3). This suggests that the decline in growth in the Holland/Netherlands economy was largely caused by a decline in dynamism of the industrial sector and, to a smaller extent of the trade sector. It is noteworthy that not only the effect of industry on volatility declined between 1670 and 1850, but also that also the general coefficient of variance declined between 1670 and 1850, possibly caused by the slower GDP growth during this period, which reduced the variance and decreased the CV.[36]

Table 2

. DECOMPOSITION OF THE VARIANCE OF GDP PER SUBSECTOR IN HOLLAND, 1510-1807

		1510-1670	1670-1807	1510-1807
Agriculture		**9.40%**	**6.48%**	**11.04%**
	Agriculture	6.14%	7.15%	8.55%
	Fisheries	3.26%	-0.66%	2.49%
Industry		**26.17%**	**-0.43%**	**27.03%**
	building	6.82%	2.01%	6.01%
	textiles	7.36%	2.14%	8.92%
	food	11.20%	-4.33%	10.96%
	Other industry	0.79%	-0.25%	1.14%
Services		**64.43%**	**93.95%**	**61.94%**
	trade	30.75%	82.14%	27.80%
	transport	15.90%	1.07%	12.15%
	government	0.07%	2.68%	2.15%
	army	8.30%	6.91%	9.11%
	Other services	9.41%	1.14%	10.73%
GDP		**100.00%**	**100.00%**	**100.00%**

[36] For a description of the effect of the presence of a trend on the coefficient of variance see Földvári and Van Leeuwen, "What can price volatility tell us about market related institutions?"

Table 3
DECOMPOSITION OF THE VARIANCE IN GDP, 1510-1913

	Holland		Netherlands	
	1510-1670	1670-1807	1815-1850	1850-1913
Agriculture	9.40%	6.48%	24.72%	7.71%
Industry	26.17%	-0.43%	30.16%	38.87%
Services	64.43%	93.95%	45.12%	53.42%
GDP	100.00%	100.00%	100.00%	100.00%
Coefficient of Variation	0.42	0.11	0.18	0.37

We can test whether growth is continues over the entire period between 1347 and 1800. Since we do not want to impose breakpoints in the model, we use the Quandt Andrews unknown breakpoint test.[37] The model takes the first and last 15% of observations in the sample and then tests for all in-between years whether including a breakpoint improves the fit of the model. The 0-hypothesis is that no breakpoints exist. The results are reported in Table 4. This shows the possible F-statistics which indicate if the 0-hypothesis is rejected. As one can see, in all cases the p-value is 1, indicating that the hypothesis of no breakpoints cannot be rejected.

[37] Quandt, "Tests of the hypothesis that a linear regression system obeys two separate regimes." and Andrews, "Tests for Parameter Instability."

Table 4

QUANDT-ANDREWS UNKNOWN BREAKPOINT TEST FOR PER CAPITA GDP GROWTH

Quandt-Andrews unknown breakpoint test
Null Hypothesis: No breakpoints within trimmed data
Equation Sample: 1357 1850
Test Sample: 1429 1763
Number of breaks compared: 335

Statistic	Coefficient (without smoother)	Coefficient (with Baxter-King smoother)
Maximum LR F-statistic		
(without smoother: 1579)	5.124096	6.014991
(with smoother: 1635)	(0.9226)	(0.1597)
Exp LR F-statistic	0.757583 (0.9964)	1.070419 (0.1775)
Ave LR F-statistic	1.145506 (1.0000)	1.549063 (0.1806)

Note: probabilities (in parentheses) calculated using Hansen's (1997) method
Warning: estimation sample is non-continuous (probabilities calculated assuming a continuous sample)

One might argue that above results have low power because either more breakpoints are present, or because of strong volatility in the series caused by wars and plagues making the breakpoints turn out insignificant. However, we tried this test also on sub periods which did not alter the results. Furthermore, the volatility present in the data consists largely of changes in the level of GDP per capita, while during the inbetween periods growth seems to have continued. This is a finding that has also been found for present day developing economies: countries with good institutions know long periods of stable growth while countries with sub-optimal institutions experience relatively fast

growth inbetween periods of stagnation.[38] Since this seems to apply to Holland as well, we presented in the second regression in Table 4 the same coefficient after using a Baxter-King filter to remove volatility. In the smoothed and non-smoothed series the coefficients are insignificant, suggesting that no breakpoint can be determined. Table 4, however, does show that, if a breakpoint is present, it should be around either 1579 (acceleration) or 1635 (slowing down).[39]

STRUCTURAL CHANGE AND GROWTH BETWEEN 1347 AND 1510

Although per capita growth seemed to have taken place almost during the whole period, this does not imply that the character and sources of per capita growth remained the same over the entire period. Before we analyze the 'proximate causes' of growth in the period after 1500 in some detail, first a few words about the late Medieval period. This was without doubt a period of very rapid structural change. In the 1340s, between 50 and 55% of GDP originated in agriculture, and probably an even larger share of the labor force was employed in the primary sector. This changed in the following 150 years. At about 1490 the share of agriculture had already declined to less than 20%, after which the process of structural change proceeded much more slowly (Figure 3). At the same time the share of the population living in urban areas increased from 23% just before the Black Death to 45% in 1514, making Holland the most urbanized region in Europe.[40] This dramatic restructuring of Holland's economy was induced by exogenous shocks that undermined

[38] Pritchett, "Understanding patterns," Jerzmanowksi, "Empirics of hills, Mountains, plateaus and plains."
[39] We checked these results also via the CUSUM test, a graph showing the one-step recursive forecast errors. If the model at the start of the period remains the same for the entire period, e.g. a constant per capita growth rate, the recursive forecast error must not be significantly different from 0; such a graph also shows no breakpoints during the 1347-1807 period, confirming the results of table 2.
[40] Van Bavel and Van Zanden, "The jump start of the Holland economy", p. 505.

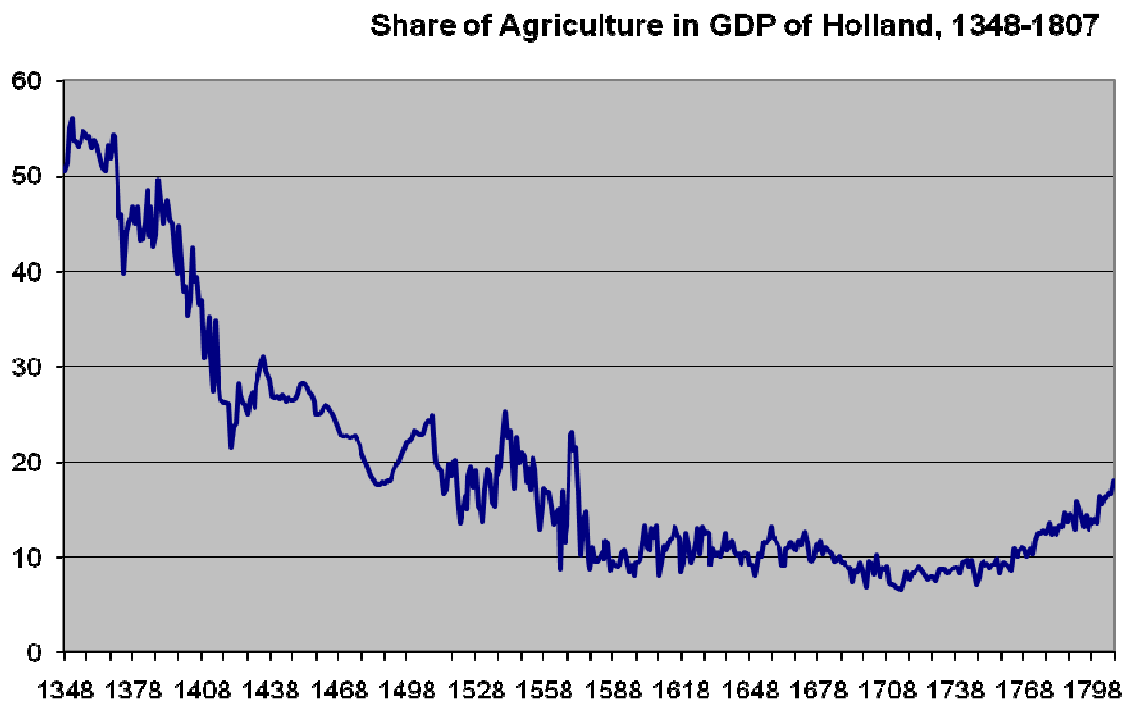
the agricultural basis of the region; a rising water level, storm surges (such as the St. Elisabeth flood of 1421) and the gradual subsidence of the peat lands on which most of the arable farming was taking place sharply reduced arable output from the 1370s onwards.[41]

In the long run, the economy of Holland was able to respond well to this crisis, however. Within the agricultural sector there was a switch towards livestock farming; exports of cheese, butter and livestock increased, which was accompanied by a rapid commercialization of this sector. On the countryside new 'proto-industrial' activities also spread quickly: spinning for the urban wool industry, for example. During part of the year the rural population became active as wage workers on the herring fleet and on the merchant fleet, in dike building and maintenance and in peat digging.[42] Finally, the urban sector also expanded in this same period, stimulated perhaps by immigration from the countryside.[43] Two major export industries, woolen textiles and brewing, developed rapidly, and Holland also acquired a strong international position in international shipping (long distance trade was still concentrated in the southern Netherlands).

In short, the crisis in agriculture led to a rise of market-oriented activities in which the Holland economy specialized. This was, however, made possible by the relatively efficient market institutions that had emerged in preceding centuries. As a result of these changes, in 1514 only about half the rural population was active in agriculture – other rural activities had became equally important.

[41] De Boer, *Graaf en Grafiek*, pp. 218-224.
[42] Van Bavel, "Early proto-industrialization in the low countries?"
[43] De Boer, *Graaf en Grafiek*, pp. 142-164.

Figure 3
THE SHARE OF AGRICULTURE IN TOTAL GDP IN HOLLAND, 1348-1807



Sources: see Appendix 2.

Structural change obviously was a very important source of growth in the late medieval period. The benchmark estimates for 1510 (Table 5) demonstrate that the level of labor productivity in industry and in services was much higher than in the primary sector. Switching 30-40% percent of the labor force from low productive agriculture to high productivity activities in the secondary and tertiary sector could therefore easily account for an increase of 15-20% of GDP per capita. Total growth was much more, however, almost 60% in per capita terms. A first per capita growth spurt is related to the effect of the sudden decline of the population after 1347. The return to pre-Plague population levels does not result, however, in a decline in income levels; growth in fact continues in the 15th century, when population growth also picks up again. During a

period of high nominal and real wages, the Holland economy was able to acquire a strong international position in the production of textiles (woolens and linen), beer, herring, peat, and shipping.[44] This suggests that growth was to a large extent also driven by technological change making possible increases in total factor productivity, which were probably also linked to the economies of scale that resulted from urbanization and specialization.

Table 5
STRUCTURE OF THE ECONOMY AND RELATIVE LABOR PRODUCTIVITY, 1510 AND 1807

		Primary*	Industry	Services
1510	GDP	27.2%	35.1%	39.7%
	Occupational structure	39.4%	38.4%	22.2%
	Labor productivity	0.64	0.91	1.79
1807	GDP	18.2%	31,3%	50.5%
	Occupational structure	23.0%	42.0%	35.0%
	Labor productivity	0.79	0.74	1.45

* includes agriculture, fisheries, and peat digging
Source: see Appendix 1.

THE PROXIMATE CAUSES OF GROWTH BETWEEN 1510 AND 1807

As a result of the dramatic decline of agriculture in the late medieval period, structural change in the next three centuries was rather limited. What happened between 1510 and 1807 – to make a long story short – was that the share of services in the labor force and in GDP increased strongly, which is what may be expected during economic development. Moreover, its relative productivity remained higher than in industry and agriculture,

[44] Van Bavel and Van Zanden,"The Jump-Start", pp. 511-526.

implying that this shift contributed to income growth. At the same time, the share of the primary sector in GDP (and employment) declined (from 27% to 18%); the share of industry in employment increased somewhat, but in GDP it fell, indicating a relative fall in its productivity (but the 1800-1812 period was exceptional, with very high agricultural prices, inflating the relative productivity of agriculture).

Consistent with these changes in relative share of sectors, the services sector was indeed growing relatively rapidly, as Table 6 demonstrates, but this was almost matched by industrial growth (0.53 percent annually of industrial value added, compared with 0.56 percent of services); agriculture was in fact the least dynamic from this point of view (0.28% annually). Within industry, textiles is the most dynamic industry, while within services, banking, government (including army), and transport are the three fastest growing sectors.

Table 6
ANNUAL GROWTH RATES BY ECONOMIC SECTOR(%)

	Growth rates by economic sector (%)											
	Agriculture	Industry	Of which				Services	Of which				
			Food & Drink	*Textiles*	*Building*	*Other Industry*		*Transport*	*Trade*	*Government*	*Banking*	*Other Services*
1512-1565	0.37	0.88	0.80	0.05	1.60	0.88	2.07	2.19	2.46	0.66		0.84
1665-1620	0.86	1.48	1.42	2.46	1.33	0.55	1.11	1.77	0.79	3.17		1.15
1620-1665	-0.02	0.50	0.65	0.79	0.16	-0.18	-0.45	0.21	-1.18	-0.10	2.22	0.85
1665-1720	-0.11	0.02	0.18	-0.09	-0.33	0.27	0.06	-0.47	0.38	-0.25	1.77	-0.07
1720-1800	0.28	0.00	-0.40	0.64	-0.03	-0.44	0.14	0.11	-0.13	1.15	1.40	-0.07
1512-1800	0.28	0.53	0.44	0.76	0.50	0.16	0.56	0.71	0.44	0.98		0.47
Average share of sector in GDP (%)	0.17	0.27	0.12	0.07	0.04	0.04	0.56	0.09	0.31	0.07	0.003	0.1

Source: see Appendix 1.
NB 1512 is the average of 1510/14, 1565 is 1563/67, etcetera

For the period after 1540 it is possible to do an exercise in growth accounting and analyze the sources of economic growth: increased inputs of labor, capital and human capital, and total productivity growth. Because the output of the capital goods sector consisting of shipbuilding and the construction industry is known, it is possible to make tentative estimates of the capital stock from 1540 onwards using the Perpetual Inventory Model (to turn estimates of the flow of capital goods into stock estimates we assumed a asset life of ships of 10 years, and of other capital goods – mainly buildings - of 20 years). In addition, we have estimates of the population, of the annual years of schooling of the population (via the 'output' of the education system), and of the cultivated land used in agriculture. Their weights, derived from very tentative estimates of the income side of the economy, are assumed to be 40% for labor (where the share of the labor force in total population is assumed constant over time), 30% (capital stock), 20% (human capital stock) and 10% (land) (for a further description, see appendix 1). For example, in the base period 1540, agriculture has a share of about 20% in GDP (Figure 3), about half of which is the rent of the land used, which brings the share of land in GDP to 10%. The share of human capital (measured as the average years of education of the labor force)[45] to GDP can only be estimated in a very tentative way (on the basis of data on the skill premium and the salaries earned by skilled employees); therefore also estimates excluding human capital (and raising the share of the labor force to 60%) have been presented.

[45] See Figure 4 of Appendix 1; average years of education increases from about one in the 1550s to about 2 in the 1790s.

Table 7

THE ESTIMATED SOURCES OF ECONOMIC GROWTH, 1540-1800

	Population	Human Capital	Capital Stock	Land	Weighted Inputs	GDP	TFP (1)	TFP (2)
1540-1620	1.05	1.17	1.56	0.17	1.14	1.92	0.65	0.81
1620-1665	0.68	1.28	0.75	0.17	0.77	-0.18	-1.00	-0.83
1665-1720	-0.04	0.56	-0.26	0.03	0.02	0.08	0.08	0.18
1720-1800	-0.30	-0.10	0.22	0.07	-0.07	0.04	0.09	0.15

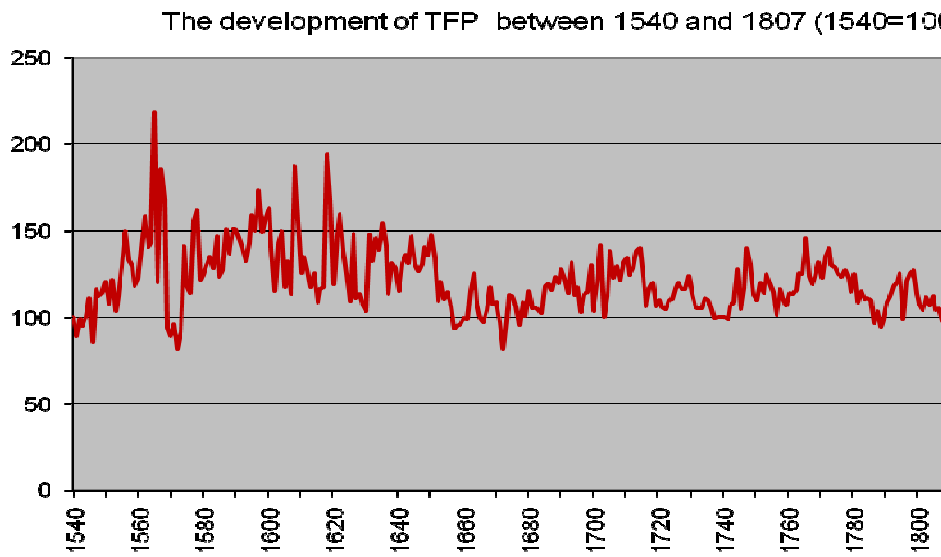
Note:
TFP (1) shares of inputs: population 40%, capital stock 30%, land 10%, human capital 20%;
TFP (2) shares of inputs: population 60%, capital stock 30%, land 10%
1540 is 1538/1542, etc.
Human capital is population corrected for changes in the average years of education.

The results, presented in Table 7, show that TFP growth was contributing significantly to growth between 1540 and 1620 and again – but at a lower rate of change – between 1665 and 1800. TFP-growth was strongest in the final decades of the 16th century, when in a way the economic basis for the ensuing 'Golden Age' was laid. It then slowed down during the first half of the 17th century, and even declined from the 1620s onwards. For the 1660s onwards, however, it stabilized and even began to play a now much more modest role in economic growth. The wave-like character of technological development during the 'long' Golden Age is confirmed by studies of the number of patents granted by Dutch authorities, which peak in the 1620s and 1630s, and slowly decline afterwards[46], and by the qualitative information on the rise and decline of Dutch technological leadership collected and analyzed by Davids.[47] There clearly was an 'explosion' of innovation in the 1540-1620 period, followed by a long period in which technological change continued, albeit at a much slower pace. Moreover, the

[46] Van Zanden and Van Riel, *The Strictures of Inheritance,* p. 27.
[47] Davids, *The rise and decline of Dutch technological leadership.*

development of TFP of the economy as a whole is also almost identical to the estimates of the growth of TFP in the shipping sector, presented by Van Zanden and Van Tielhof,[48], which show a strong increase in TFP until the 1620s, and decline afterwards.

Figure 5
THE DEVELOPMENT OF TFP BETWEEN 1540 AND 1807 (1540=100)



The Medieval phase of growth was dominated by structural transformation and a perhaps rather slow process of technological change, which together resulted in substantial TFP-growth. After 1540 technological change probably accelerated, and TFP-growth contributed a lot to per capita increase in GDP. A third phase of continuing per capita growth, after the 1660s, was largely based on factor substitution and a modest increase in TFP. After 1720 the physical capital stock increased in per capita terms (Table 7). As Adam Smith already noticed, interest rates in the Netherlands were very low in these years, which contributed to international competitiveness, and must also, in

[48] Van Zanden and Tielhof, "Roots of Growth and Productivity Change."

combination with high wages, have furthered capital deepening. In shipping, for example, the labor input was reduced relative to the capital input, as a result of which the tonnage per sailor increased strongly, a process analyzed by Lucassen and Unger.[49]

Structural change was a rather limited source of growth in this period, because this economy was already strikingly modern from the start of the period. The most significant change in this respect was probably the increase of the banking industry – based on the low interest rates, the excellent financial infrastructure, and the availability of large domestic savings surpluses which were exported abroad.[50] But even the banking industry contributed only a few percent to GDP during its best years in the 1770s, 1780s and 1790s.

A source of per capita growth that was becoming increasingly important was human capital formation. Already in the 16th century levels of human capital in Holland were relatively high, as was remarked by contemporary visitors, who found that not only men but also women could usually read and write, and that these skills were not only concentrated in the cities, but also spread over the countryside. We estimated the development of the average years of education of the Holland population at (not more than, but also not less than) about 1 year in the middle of the 16th century, increasing to about 2 years in the second half of the 18th century when 84 percent of the males and 64 percent of the females did sign a marriage certificate. Levels of literacy were very high by international standards – much higher, for example, than in England or Belgium.[51]

[49] Lucassen and Unger, "Labour productivity in ocean shipping."
[50] Riley, *International Government Finance.*
[51] Buringh and Van Zanden, "Charting the Rise of the West." Human capital is measured in the usual way in studies based on national accounts, as the average years of education of the population; we acknowledge that for the pre 1800 period in particular other forms of human capital – such as on the job training by apprentices as part of the guild system – were perhaps more important, we cannot measure this part of

Summing up, we can distinguish three phases in the process of economic growth: the first one, between 1347 and 1500, is characterized by rapid structural transformation and (modest) technological change; the second one, from the middle of the 16th century to the middle of the 17th century, was based on relatively rapid technological development, and is combined with relatively fast growth of population; during the third phase, which begins in the 1660s, population growth comes to an end, technological change slows down, but changes in relative factor proportions and human capital formation allow for a further increase in per capita incomes during the 18th century.

CONCLUSION

The central question of this article was about the character of economic growth before the Industrial Revolution: was there some kind of 'first round of modern economic growth', a sustained increase in income per capita accompanied by structural change? Or should we interpret the Dutch Golden Age as an example of the cyclical nature of growth in this period, of a brief efflorescence of the economy, inevitably followed by stagnation or even decline?

The answer to these questions was based on a detailed reconstruction of the national accounts of Holland in the period between 1510 and 1807, linking these series to the available estimates of GDP and its components for the Netherlands (for the 1807-1913 period). Moreover, we also were able to produce highly tentative estimates for long-run growth in the late Medieval period (1347-1510), to analyse in more detail the growth

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human capital (which is, however, often ignored in studies on the effects of human capital on growth – see the discussion in Van Leeuwen, *Human capital and economic growth.*)

process during the Dutch Golden Age. On this basis we could establish the following features of economic growth before the Industrial Revolution.

1. Growth was relatively slow (by post 1800 standards) but it is difficult to find an economy which was growing as rapidly as Holland in the 450 years between the Black Death and the Napoleonic Wars. For example growth in England only matched the 0.19 per cent per annum growth of Holland from 1650 onwards.[52] The trend rate of growth of per capita GDP of 0.19 per cent per annum led to a total increase of real incomes by more than 100% in the 450 years under study, and made Holland into one of the wealthiest parts of the world economy by the end of the 16th century.
2. Growth was persistent: the Holland economy shows remarkable resilience in this respect; it goes through a number of crises, due to harvest failures and dramatic decline of arable yields between 1370 and 1440, the Revolt and the following civil war between 1572 and 1609, and the increased competition by its neighbours (from 1650s onwards), but it manages to adapt its economic structure and to resume its growth path after each successive crisis.
3. GDP was highly unstable – much more unstable than after 1820; this was mainly due to the importance of international services in the economy, which showed enormous fluctuations in output and income, in rare cases doubling or halving over the course of a year. This is linked to fact that this economy was first of all dominated by its large services sector, by international shipping and -trade in particular (contributing around 31% to GDP), which made Holland an open economy affected by the booms and busts of world trade;

[52] Broadberry, Campbell, Klein, Overton, and Van Leeuwen, "British Economic Growth," Table 19.

4. The Holland economy went through a phase of intense technological change, between the middle of the 16th and the middle of the 17th century, which was an important factor behind the rapid growth of GDP in this period; before and after this 'big wave', technological change was much slower, but it continued to contribute to growth after the 1660s;
5. The relationship between structural change and GDP was growth was different before 1800 than afterwards; there are broad similarities with what Crafts[53] found for the English economy, that structural change of the labour force and of GDP tended to be much more radical in the pre 1800 period than per capita growth. Or, in terms of the relationship between structural change and GDP growth, one percent of 'decline of agriculture' was accompanied by a much smaller increase in real income than in the 19th century. According to Crafts this was a peculiar feature of the British economy, but we find a similar pattern in Holland, suggesting that this was a more general characteristic of the process of pre modern economic growth. Interestingly, comparing the 19th century patterns for Europe as discussed by Crafts with the post 1950 patterns found in Chenery and Syrquin points to a further change in this relationship.[54]
6. International trade and shipping were the most dynamic sectors of the economy, and its expansion went together with rapid structural change that must have contributed a lot to GDP growth. In that sense, growth was typically 'Smithian', but at the same time modern drivers of growth –

[53] Crafts, *British economic growth*, 61-62.
[54] Whereas a halving of the labor force in agriculture (from 66 to 33%) before 1820 correlates with an increase of GDP per capita of about 90%, during the 19th century such a change would be consistent with an increase of 165%; in 1950-1970 the growth of GDP would be even larger: 369%; Crafts, *British economic growth,61-62;* Chenery and Syrquin, *Patterns of development.*

> technological change, the increase of human and physical capital – also contributed a lot to the increase of real incomes. The growth accounting exercise presented here does not allow us to carefully make a distinction between these two sources of growth, however, because they both result in an increase in total factor productivity.
>
> .

Growth was, in sum, episodic, unstable, dependent on world markets, driven by a mixture of 'Smithian' and 'Schumpeterian' forces, but resilient, and in the very long term more or less constant – after each crisis the economy found new ways to increase output and productivity. This, in our view, neatly solves the problem, implicit in the interpretation by De Vries and Van der Woude, that Holland had a (more or less) modern set of institutions and was a (more or less) modern market economy, but, after being successful during the Golden Age, failed to generate continuous growth after 1670.[55] De Vries and Van der Woude underestimated performance after 1670 – because trend growth did continue after a break – which points to even greater resilience of this economy than they had expected.

It is, however, also quite clear that growth before 1800 was different from growth after that date. It was much slower than after the Industrial Revolution: it took more than 350 years to double real income in Holland, but 'only' one century to double real income of the Netherlands after 1807. Whereas after 1807 every generation could count on the fact that it was by and large better off than the previous one, this was not the case in the pre 1800 period; it not only took more time to increase real income, but annual fluctuations in output and income were also much larger than in the 19th century. Part of the explanation of the acceleration of growth is, perhaps, that growth after about 1820

[55] De Vries and Van der Woude, *The First Modern Economy*.

was a pan-European process, which profited from positive feedbacks between countries and regions. In contrast, before 1800 growth was concentrated in only a few regions, which also heavily competed with each other. The slowing down of the Holland economy in the second half of the 17th century was linked to increased competition from other European countries, which resulted in strong protectionism on their part. Both Cromwell's Navigation Acts of the 1650s, and Colbert's protectionistic policies of the 1660s and 1670s aimed at undermining Dutch supremacy on the high seas and international markets, and both had very serious consequences for Dutch trade and shipping (for good reasons, it lead to major wars between the countries involved).[56] The greater stability of growth after 1820 may also be related to the fact that the 19th century knew a long period of relative peace, whereas the almost continuous warfare of the early modern period was a very important cause of instability, especially of the international sector of the economy, on which Holland depended so much. Obviously, the underlying rate of technological change also accelerated during the Industrial Revolution.

Economic growth therefore, did indeed exist in the pre-1800 period, but its rate was much slower and its instability much higher than in the period after the Industrial Revolution. We have demonstrated that this process of 'pre modern economic growth' – of slow, and very unstable increases in per capita income - already began in the late Medieval period, which is consistent with much of the new literature on the topic, which is however to a large extent based on the evidence of the development of real wages in this period.[57] Apparently, this economy was able to adapt successfully to the situation of labor scarcity that emerged after 1348, and developed the right institutions and incentives

[56] Israel, *Dutch Primacy*, pp. 207-236, 282-291.
[57] E.g. Allen, "The great divergence in European wages and prices"; Van Bavel and Van Zanden, "The Jump Start of the Holland economy"; Pamuk, "The Black Death and the origins of the 'Great Divergence."

to transform itself in a highly successful 'high wage economy', capable of generating positive trend growth.

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Appendices to Bas van Leeuwen and Jan Luiten van Zanden, '**The origins of 'modern economic growth'? Holland between 1347 and 1807'.**

Appendix 1. The estimation of the national accounts of Holland 1510-1807[58]

1. Introduction

This appendix describes the way in which the estimates of the national accounts for Holland in the period 1510-1807 have been put together. The aim of the project was to produce annual estimates of gross value added of the main industries of the Holland economy in this period, in both current and constant prices, which could then be used to produce estimates of total GDP (and GDP per capita) for these three centuries. The starting point consisted of two benchmark estimates, for 1510/14 and for 1807, which resulted from previous research into the structure of the Holland economy at the beginning of the 16th century (Van Zanden 2002), and into the national accounts of the Netherlands in the 19th century (the results of which have been published by Smits, Horlings and Van Zanden 2000). The two studies by Horlings (1995) on the services sector and by Jansen (1999) on the industrial sector in the first half of the 19th century were important as models for estimating output and value added in different parts of the economy.

The challenge of this project was to find sources that reflect the annual variation in output or value added in different industries between 1510 and 1807 in order to 'interpolate' between these two benchmark estimates. It was not possible to create another benchmark at, for example, some point during the 17th century. Although this was originally the intention, it proved not possible to find the right sources for this (but it may be subject of future research). In the process of working with the data, we sometimes were able to improve on the estimates made for the 1510/14 and 1807+ period, as a result of which there are some discrepancies between earlier studies and the estimates presented here (which we discuss in section 6). Moreover, the 1807 estimates related to the Netherlands as a whole, and in order to link the Holland estimates to those of the Netherlands, we had to estimate its share in Dutch GDP, which lead to a number of (generally small) modifications of the original estimates.

The aim of this appendix is to explain which sources were used, and which procedures applied to them, in order to measure the development of value added in current prices and in constant prices in the different industries. In general, we have rather good data on the development of output of those industries, although their quality differs from branch to branch and from period to period (in general, the quality of data improves over time). Also, price information is of a relatively high quality, making it possible to convert output series into series of gross value added. Data on the structure of inputs and on the share of value added in gross output generally are only available for one or two years, and estimates are often based on very small samples. However this applies to almost all studies of historical national accounts, because input and output tables have not been constructed in the past.

[58] We thank Christiaan van Bochove, Oscar Gelderblom, Peter Koudijs, Matthias van Rossum, Christiaan van der Spek, Milja van Tielhof and dr. F Snapper for their help in collecting the data.

The economy has been broken down into three sectors (primary, secondary and tertiary). The primary sector includes agriculture and fishing (herring fishing and whaling); the main branch we miss here is fresh water fisheries which were quite important in the 16th century, but declined afterwards (see De Vries and Van der Woude 1997: 237-239). The secondary sector consists of textiles (wool and linen), clothing, construction, peat digging, food (bakeries, brewing, gin – *jenever* – distilling, and other foodstuffs), paper, shipbuilding, printing, soap production and sugar refining; the largest branch for which we have no good information is metal working, but we assume that this (in Holland) relatively small sector was dominated by the demand from the military sector (for guns, canons) and from shipbuilding, and we have estimated the value added of these sectors in such a way that this part is of the metal trades is included there. Finally, the tertiary sector was covered by international shipping, international trade, domestic trade, inland transport (via inland waterways), banking, education, government services (military sector and the rest), housing, domestic services, and 'the rest', which was approximated by the development of notaries and book traders. The services sector was continuously the largest of the three sectors; moreover, it was also the sector which was most difficult to measure; therefore, we start with the way in which we approached this sector, and will then move on to industry; the primary sector (the smallest of the three) will be dealt with last.

2. Services

2.1 Services: international shipping

The biggest challenge was the estimation of the development of international services, which was probably the most dynamic part of the Holland economy, but at the same time a sector with a very high degree of volatility, which makes it less easy to make reliable estimates. In a related paper, by Van Tielhof and Van Zanden (2008), the details of the construction of the series of value added of this branch have been explained. The study by Horlings (1995) on the Dutch services sector in the period 1800-1850 has been used as a model, making it possible to link the estimates from this study to the 19th century estimates. The following estimates have been made:

1. The volume of international shipping (in million tonkm) between Dutch ports and other ports;

2. The load factor (per route and on average): which share of the shipping capacity (on different routes) was actually used to transport goods;

3. The volume of transported goods (in million tonkm), the product of 1. and 2.;

4. The freight rate (per route): how much was being paid for transporting these goods;

5. The total freight sum, the product of 3. and 4;

6. The value added of the shipping industry, the result of subtracting estimates of the value of inputs from the total freight sum;

7. The real value added is acquired by deflating 6. with an index of freight rates (resulting from 4.).

It is clear that much information is needed. Fortunately, the Dutch shipping industry has been the subject of a lot of in depth research. We are particularly well informed about two large segments: the route to the Baltic via the Sound (thanks to the invaluable registers of the Sound toll and the many studies based on this source), and the trade with Asia, carried out by the Dutch East Indies Company (VOC), of which the accounts have been preserved and have been studied quite intensely. Also the development of shipping with (West) Africa and the Americas could be analyzed separately, thanks to a number of sources pertaining to this route. The other routes however – the trade with Russia/Archangel, Norway, England, France, Portugal/Spain and the rest of the Mediterranean (which will be grouped under the heading 'the rest') – could not be reconstructed independently. For the period after 1642 their importance could be derived from the total number of ships entering Amsterdam/Holland, which forms the basis for the annual estimates for 'the rest'. Moreover, for a number of benchmark years there are detailed estimates of the size and composition of the merchant fleet and the routes on which they are active, which can be used to anchor all estimates; in particular the estimates for 1636 and 1780 are extremely valuable, but additional benchmarks are available for about 1500, 1532, 1567, 1607 and 1695.[59] Because we have these relatively reliable benchmark estimates, most of the work is to construct annual series for the intrapolation of these benchmarks. This also implies that the estimates of the long term trends are relatively robust; the margins of error are particularly large in the estimates of the yearly changes in between those benchmarks. First shipping through the Sound was estimated for 1503, 1528, and 1537-1780, using the information from the Sound toll registers (Bang and Korst 1906/53). Starting point was the number of voyages to the west, and estimates of the average size of the ships acquired from 1/ the data on ships sizes for the period 1537-1644 and 2/ estimates of the size of the transported goods divided by the number of ships for the period 1600-1780; the comparison of these estimates shows that the estimates number of lasts of ships between 1600 and 1644 is almost the same as the estimates tonnage of actually transported goods, suggesting a loading factor of 50% (as one last is two tons).[60]

Shipping volume by the VOC could easily be estimated on the basis of the data on the number and size of ships leaving for Asia and coming from Asia;[61] shipping within Asia was not included in the estimates, and it was assumed that all ships went to/came from Batavia (distance 21107 km).

Shipping volume of the WIC/to the Americas is estimated in the following way: for 1780 we used the benchmark estimates by Van der Oudermeulen, who gives detailed estimates of shipping volumes on all major trade routes at about 1780; this series was linked to the yield of the paalgeld paid explicitly by WIC/American ships from Heeres

[59] A recent survey of these estimates for the 17th and 18th century in Van Lottum 2007, and Van Lottum and Lucassen 2007; for the 16th century benchmarks Van Zanden 1987; the two most important benchmarks are those of 1636, which were part of a detailed inquiry by the Estates of Holland, and of 1780, the result of the work by the merchants and political economist Van der Oudermeulen; both estimates are considered to be highly reliable.

[60] Moreover, it was assumed that ships came from/went to Gdansk, to which the distance is 1552 km.

[61] Bruijn, Gaastra and Schöffer (1979/87) and Bruijn 1990.

(1983), a series that goes back to 1712 (Heeres 1982; 1983). Between 1636 and 1712 the series was based on an index of the activities of the WIC in these years, derived from Den Heyer (1997). It is based on data on the trade in slaves and the export of gold from West Africa. For 1636 this could be linked again to the benchmark estimate of total shipping activity by the States of Holland; between 1592 (when this trade began) and 1636 this estimate is based on the development of sugar imports from Brazil from Gelderblom (2004).

The remaining shipping activity is reconstructed as follows: from a number of sources (a.o. paalgeld and lastgeld) Welling (1998) has estimated the number of ships entering the Amsterdam port between 1742 and 1810, a series that can be extended back in time (until 1643) using the same data for 1662-1747 published by Oldewelt (1953), and in addition the yield of the lastgeld for the period 1643-1662 from the same source (Welling 1998, Oldewelt 1953). We estimated the share of other port cities via their share in the 'convooien en licenten' of these years to get a series of ship entries into the Netherlands (Amsterdam's share fluctuated around 75%). From this series of total number of entries into the Netherlands between 1643 and 1810 we substracted the entries from the Sound, from Asia and from Africa and America estimated previously, to get a series of entries from 'the rest'. The average 'production' in terms of tonkm of these entries can be estimated from the benchmark data for 1636 and 1780, which appears to be almost exactly the same (457.000 tonkm in 1636 and 462.000 tonkm in 1780). We therefore have assumed that this 'production' per entry remained constant. For the period before 1643 we have assumed that the growth of the 'rest' was related to the expansion of the shipping through the Sound, and to the degree of *voorbijlandvaert* that can be found in the data on that source. The idea is that the share of *voorbijlandvaert*, which increased from 1-2% of total shipping in 1557/58, when the first data are available, to sometimes as high as 35% of total shipping in the 1620s and 1630s, reflects the multipolarity of the trading system, in particular the growth of other routes besides the 'mother trade' through the Sound. The expansion of the *voorbijlandvaert* from the mid 1550s onwards is related to the growth of shipping to Spain and Portugal, where the demand for grains from the Sound increases strongly, leading to a rapid expansion of Dutch shipping. The formula for estimating the shipping volume of the 'rest' is chosen in such a way that when *voorbijlandvaert* is zero (as it was in 1557/58), the volume of shipping of 'the rest' is identical to that via the Sound.[62] For 1636 we know from the benchmark estimates mentioned already that the ratio between Sound and 'the rest' is 1.7 (which is also exactly the ratio we get in 1643 when going back in time via the total number of entries, as explained above); before 1557 it was assumed that the shipping volume of 'the rest' was equal to that via the Sound.

Three intermediary factors have to be estimated to arrive at estimates of the value added of the shipping industry:

1. The load factor: the share of the shipping capacity used to transport goods; Horlings estimated these for the 1800-1850 period, and arrived at averages of about 30 to 40%, the result of the unbalanced character of most trade, and

[62] The assumption, therefore, is that in the 1550s total shipping to 'the rest' was in terms of volume the same as the total shipping through the Sound, which is consistent with Lesger's analysis of the structure of Holland's trade in 1545, see Lesger 2001: 33-39.

practical limitations of using the shipping capacity; similar (low) shares were estimated for the Sound route, where we know the share of ships that left for the Baltic in ballast (on average about one third), and we actually from 1600 onwards have estimates of the goods transported by the ships going westward; also for the VOC trade a low load factor could be estimated, as it is again known that most ships left for Asia almost empty, which was to some extent also true for the trade with Africa and Latin America; for the shipping on the other routes, it was estimated that the share of ballast was half that of the Baltic (as this trade was generally more balanced); overall, our estimates result in a small decline in the overall load factor from 40-45% in the 16th century to 35-40% in the 18th century, which is mainly the result of the growing importance of long-distance trade with a below-average load factor;[63]

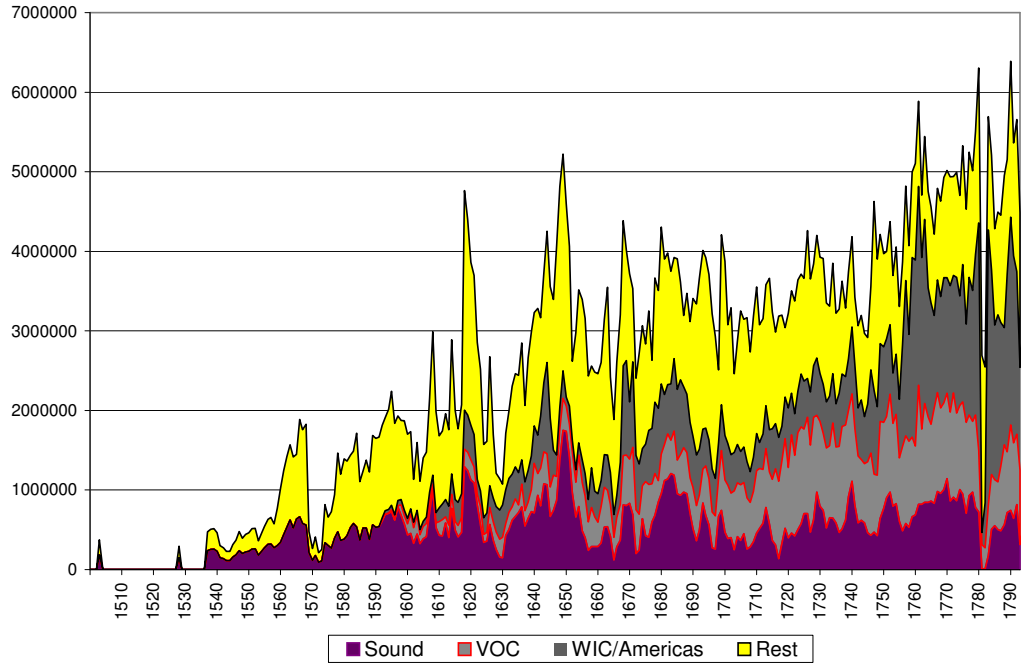
2. The estimates of the long term development of freight rates are presented in a separate paper, which documents the large dataset on which these are based (Van Tielhof and Van Zanden 2008); on the basis of these data the development of average freight rates on shipping via the Sound, on 'the rest' (we estimated the average freight rate per tonkm on routes to Archangel, Bordeaux and Livorno), on Africa/Latin America.[64]

3. Finally, the share of value added in total freight sum had to be estimated; we used the estimates of the structure of the shipping costs discussed previously to estimate this share at 70% for shipping via the Sound and 'the rest', and 60% for long distance routes (Asia and Africa/Latin America), as the later used more inputs from outside, mainly as a result of the higher capital intensity of shipping on these routes, a.o. the use of more cannons and other means of defense as a result of the greater risks at sea, and the much larger size of the ships (Horlings estimated this share at 66%).

[63] Horlings 1995: 393; his estimate for 1807, a year of crisis, is 34%, rising to 45% in 1830.

[64] On the basis of actual freight costs of the Middelburgsche Commercie Compagnie from Reinders Folmer-van Prooijen 2000: 182-211, and estimated the actual costs of shipping by the VOC, from Bruijn 1990 and De Jong 2005.

Figure 1 Volume of shipping 1500-1793 (in 1000 tonkm)



The estimates of the volume of shipping (in tonkm) are presented in Figure 1, which clearly demonstrates the enormous growth of the shipping industry in the Netherlands. The total volume increased by a factor of 17 between the first estimate of 1503 and the absolute peak in 1790. The average annual growth rate between those dates was slightly less than 1% (0.9958%), which is quite high for such a long period. As can be seen from Figure 1, growth was initially rather slow at less than 0.5% per annum between 1503 and 1550; only during the 1550s and 1560s did the rapid expansion began, which is consistent with other studies (De Vries and Van der Woude 1997: 373). The conflicts of the late 1560s and early 1570s were disastrous for shipping, but after 1576 a rapid recovery followed. From the 1590s onwards long distance shipping began to contribute to growth, and a period of extreme fluctuations of shipping followed, with a remarkable boom during the Truce with Spain (1609-1621), during which shipping more than doubled. This was followed by a serious downturn in the late 1620s and early 1630s, after which a very strong increase in activity occurred, peaking in the years before and directly after the Peace of Westphalia (the highest level is reached in 1649). In the next century wars still have quite an impact on the industry – with serious declines during the Anglo-Dutch wars – but the level remained more or less constant at 3 to 4 billion tonkm. Whereas during the previous century growth rates of total output had been in the order of 2.6% (1550-1600) and 2% (1600-1650), between 1650 and 1750 growth rates were barely positive in the long run. Shipping through the Sound declined in these years, as did the trade with the Mediterranean, but this decline was to some extent compensated by the further growth of long-distance routes – on Asia and the Americas. In the second half of the eighteenth century growth resumed (to a rate of 1.2% per annum between 1750 and 1790), although it was much less spectacular than during the 1550-1650 period. The Atlantic economy

became the most important source of renewed growth. This renewed growth after 1750 is perhaps the most surprising result of these estimates, as the eighteenth century – and in particular its second half – is usually seen as a period of decline (De Vries and Van der Woude 1997: 674-683). Again the impact of the Fourth Anglo-Dutch war is very clear from the estimates (shipping in 1781 and 1782 is less than half the level before the War), but the recovery after 1783 is surprisingly strong.

A check on these estimates is possible by converting them into the size of the fleet that is needed to producing this shipping volume, which can then be compared with a number or estimates of the size of the Dutch/Holland fleet from contemporary sources (Van Zanden 1987 and Van Lottum 2007). This series at the same time can be used as estimate of the capital input. This can be done in the following way:

- The size of the VOC fleet can be estimated on the basis of the same sources mentioned before (the VOC accounts);

- The size of the fleet via the Sound: the Sound toll tables give, from 1565 (once every ten year) the average number of passages of the same ships via the Sound, a figure that is about 3 in 1565, increases to 4.4 in 1615, and then declines with ups and downs to about 2 in 1710/20, after which it recovers to about 3 between 1730 and 1780; this can be used to estimate the fleet needed to carry out the traffic through the Sound (as we already estimated the average size of the ships);

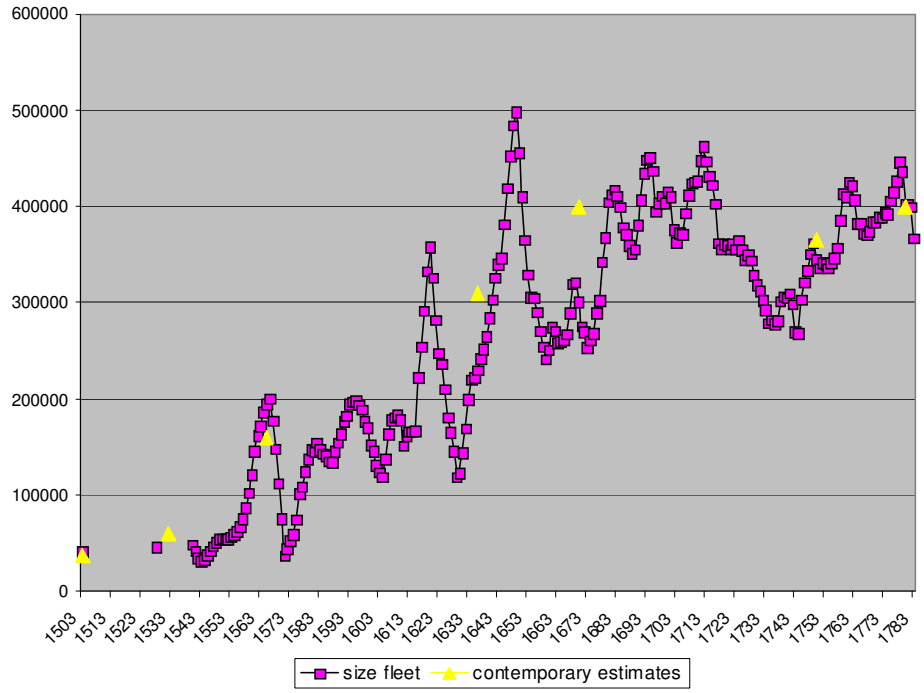
- The size of the WIC/Americas fleet is estimated on the basis of the benchmark estimates for 1636 and 1780, when the ratio between shipping volume and fleet is known; it appears that the ratio between production and size of the fleet is roughly constant between those years (which also applies to the VOC ships, where we see a similar constancy in this ratio); we estimated the size of this part of the fleet by assuming a constant ratio between fleet and production volume, based on the 1636 and 1780 benchmark years;

- The size of the rest of the fleet: as already mentioned the benchmark years of 1636 and 1780 show that the production per ship did not increase, and was about 83% of the level of the Sound traffic; this ratio was used to estimate the size of the rest of the fleet;

Adding up the four series leads to the following estimates of the development of the fleet size, which can be compared with data from contemporary sources (see Figure 2). Both series correspond well, which may perhaps increase confidence in these results. The size of the fleet increased from 43.000 tons in 1503 (contemporary estimate: 38.000 tons) to about 400.000 tons in the late 18th century, an increase of 0.9% annually during these three centuries, only slightly lower than the growth of the volume of shipping in the same period. The very large fluctuations in shipping fleet are also evident from Graph 6; in practice, changes in capacity utilization will probably further have dampened these fluctuations.

Figure 2

Estimates of the size of the merchant fleet, 1503-1783 (five year moving averages, in tons)



2.2 Services: international trade

The estimates for the shipping sector are rather robust, and confirmed/checked by more or less independent estimates from contemporary sources. The very large sector of international trade is even more difficult to estimate, although there are again relatively reliable starting points, in particular the estimates by Van der Meulen (for 1780) and the Estates of Holland (for 1634) of the size and value of international trade in these years. Moreover, as with the shipping industry, we have detailed sources of trade with the Baltic and of the activities of the VOC, which make it possible to estimate the development of trade on these routes in detail. It can also be assumed that the income earned from shipping services is a large part of the total value added of this sector; for the trade with Danzig, for example, it can be demonstrated that the freight costs of a last of rye is about one third of the total margin of international trade between Danzig and Amsterdam (measured by the difference in price between the two cities), although this ratio does change a bit over time (it is somewhat lower during the first decades of the 17th century, but returns to the one-third level in the 18th century) (Van Tielhof and Van Zanden 2008). The estimates of the value added of the shipping sector can therefore also be used to check the plausibility of the estimates of the trade sector.

We used the same classification of routes as applied in estimating the shipping industry.

1. VOC: the accounts (published by De Korte 1984) give full details of the sales in the Netherlands, and the commodities bought in the Netherlands to buy those goods in the Indies (and elsewhere); the gross trade margin is the difference between the two; for the period before 1640 this has to be estimated on the basis

of the number of ships sailing to the Indies and arriving from the Indies; the results of the first trips (also of the Voorcompagnieën) are known from a variety of sources (an overview in De Jong 2005).

2. The Baltic: the volume of goods transported through the Sound (in both directions) can be estimated/derived from the published Sound-tables (Bang *et al* 1906-1953); we also know which share consisted of grains – dominated by rye; we also known the prices of rye in Danzig and in Amsterdam/Holland (from Furtak 1935; Pelc 1937; and the Van Zanden dataset of Holland prices in the 1450-1800 period)[65]; we have assumed that margins on other trades were 30 to 50% smaller than on rye, which was without doubt the main product traded; margins on exports to Danzig were relatively low because of the oversupply of cheap transport capacity (a large part of the ships went out in ballast to the Baltic, because they could not find a suitable export product, which must have depressed margins on export trade to the east) (Van Tielhof and Van Zanden, 2008).The Atlantic trade consisted of a number of trades, of which the slave trade is very well documented (Postma 1990 in combination with the website of David Eltis (http://www.slavevoyages.org) gives the numbers of slaves traded; added to this is the recent information on the illegal trade in slaves from Paesie (2008, p. 361-369); slave prices are from the same sources (and Eltis, Lewis and Richardson, 2005, and Den Heijer, 1997, p. 159); linked to this was the trade in sugar, the main export commodity of the Brazil colony conquered by the WIC in the 1630s (and lost in 1654), and of Surinam, the main Dutch colony in the Americas during the 18th century; Surinam also produced large quantities of coffee and some cotton; different sources make it possible to estimate the size and value of these trade volumes (Den Heijer 1997 for the WIC, and Van Stipriaan 1994 for the exports of Surinam); about the third leg of this trade – to Africa – we are less well informed, but a few sources (Den Heijer 1997) make it possible to estimate the ratio between African trade to the trade in slaves; taken together the annual estimates are consistent with the 1634 and 1780 benchmark estimates, and probably are an accurate reflection of the growth of this part of the trading network between 1640 and 1780 (and after 1780); the weakest part is the period before 1640, for which the data are rather scanty (but we also do know that this trade did only emerge in the 1590s, which creates a handy benchmark of zero trade for the early 1590s).
3. the most difficult to estimate trade is 'the rest', the trade with other European cities and countries, of which we have no detailed information; we basically applied the same method as used for estimating 'the rest' (the same category) of the shipping sector, but it is clear that this is a very rough approximation of the goods being traded and their value added for this important part of the international trade sector.

For these four groups of routes we could therefore estimate the total value of trade (measured in terms of the export and import prices on the Dutch/Amsterdam market) and, more importantly, the trade margin. In addition, we estimated the international trade with the hinterland (mainly Germany) using the following sources: the master thesis by Verheul (1994) presents data on the size of this trade flow in the 1780s, and a series of

[65] The Holland price data from http://www.iisg.nl/hpw/brenv.php

yields of toll of Schenkenschans, a strategic toll covering the trade going up and down the Rhine river (just before it split into different branches). The tolls were levied on the amounts of goods transported and therefore reflect the trade flow rather accurately. The series goes back to the 1540s; additional information on the size of trade flows during the middle decades of the 16th century is acquired from Weststrate (2008); for the 1510-1540 period we assumed that Rhine trade increased as fast as overseas trade. The trade margin on this branch was estimated at 15%.

The final problem to solve here was to determine which share of trade and shipping of the Netherlands has to be allocated to Holland? For the VOC this is determined by the shares of the Holland Chambers in its organization, which was 80%; for the WIC this was 78%. We estimated that 95% of Sound trade was carried out by Holland merchants, which may be too optimistic for the 18th century; finally we assumed that 75% of the trade with the rest of Europe, and 80% of trade with the German hinterland, was on account of Holland merchants. The resulting series were linked to our benchmark in 1510.

2.3 Services: domestic trade

We follow Horlings (1995, 381) taking the value of agricultural and industrial production as indicative of domestic trade since total net exports had only a small effect. The value of industry and agriculture is taken from sections 3 and 4 below. For 1510 Van Zanden (2002) estimates the share of domestic trade and transport at 519,000 guilders. However, as transport alone is already valued at 380,000 guilders, this leaves 139,000 guilders for trade. Horlings (1995, 381), on the other hand, estimates the value added of domestic trade for the Netherlands in 1804 at 39.4 mln guilders, which, corrected for the population size, results in 14 mln guilders in Holland. This figure is plausible since it is roughly at the same order of magnitude as domestic transport.

Next, we use the series of current price value added in industry and agriculture to interpolate our benchmarks for 1510 and 1804. The weighted price series of industry and agriculture are used to deflate these series.

2.4 Services: banking

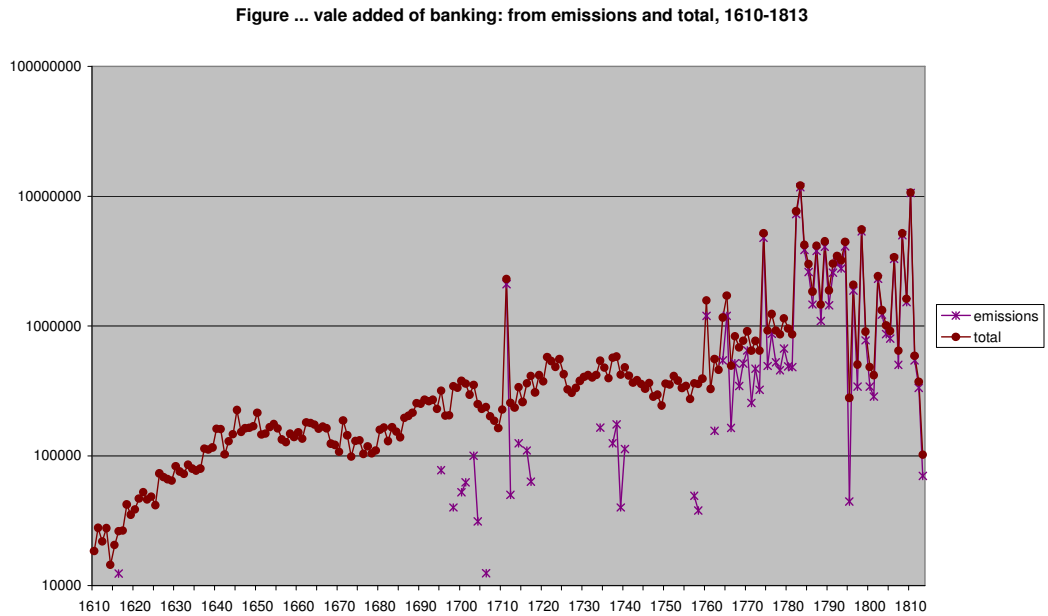
During the second half of the 17th century, and even more so during the 18th century, (international) banking activities became increasingly important as a source of income. To a large extent, the service of taking care of the transfer of money from one place to another (via for example bills of exchange), is included in the sector of international trade, because the remuneration for this part of the commercial deal was also included in the margin earned by the merchant. This however began to change during the second half of the 17th century, when – related to the success of the Amsterdam Exchange Bank – Holland merchants increasingly became involved with specialized banking transactions, which were not necessarily related anymore to the trade in commodities they undertook. Amsterdam became the clearinghouse of commercial exchange in Western Europe, the Amsterdam Exchange Bank being its central hub. Amsterdam merchants increasingly concentrated on these banking functions, which became an important source of income. A related activity that became quite important during the 18th century was the emission of bonds for foreign governments. The Dutch economy has a large savings surplus, which was channelled abroad, first mainly to Great Britain, later on to almost all European

monarchies. The banking firms organizing this trade, earned a share of between 5 and 8% of the capital sum involved (Riley 1980).

To estimate the income earned in this way, we firstly used data from the Amsterdam Exchange Bank as an indicator of the activities in international banking (taken from Van Dillen 1964); it concerns the size of inlays at the end of the year, which is the best measure of the activities carried out via the bank. The second source of information is a dataset of all the IPO's undertaken by Amsterdam bankers in this period, which show an enormous increase during the second half of the 18th century (this dataset was kindly made available to us by Joost Jonker and Peter Koudijs, who have put the dataset together; their main source in Riley (1980), but they added a lot of 'new' IPO's based on detailed archival research). It is estimated that 5% of the sum of the IPO was earned by the bank and its network of distributors (this may be an underestimate, as the available data on this collected by Peter Koudijs suggest that the range may be between 5 and 8%).

Before the middle of the 18th century, the banking sector is rather small, with earnings not exceeding half a million guilders; this changes after 1760, when earnings often increase to 2 to 4 million guilders; the peak value is 1783 with more than 12 million guilders, almost as high as the international trade sector in these years.

Figure 3 Value added of the banking sector: from emissions and in total, 1610-1813



2.5 Services: Education

Primary education:

The number of pupils was calculated using the data on literacy: the percentage of people who could set their signature on marriage certificates in Amsterdam, provided by Kuijpers (1997) and Hart (1976). We assumed that those people followed primary education 15 years earlier (average age of marriage varies from 22 to 28 years). From Van Leeuwen and Oeppen (1993: 87-88), we took the number of people living in

Amsterdam and the number of people living in Amsterdam who are between age 5-9 (primary school going age). Using the total population of Holland we calculated the total number of people aged 5-9 in Holland under the assumption that the population structure of Holland and Amsterdam are the same. We multiplied the percentage that could sign the certificates (in year t+15) with the age class 5-9 for Holland (in year t) and divide that by 5 (as we only want 1 year, not 5). Now we assume that people who can sign followed at least 2 years of primary education (this matches with the average years of education in 1800 estimated by Albers (1997, 6)). The % people who finished the first, second, or third year of the 3-year primary school is taken from De Booy (1977, appendix 24). This allows us to calculate the total number of pupil-years of education followed each year.

The salary of schoolmasters is that which the Leiden guesthouse paid to the schoolmaster.[66] Gaps in the data were interpolated using the journeyman wage from De Vries and Van der. Woude (1997). From De Booy (1977, appendix 23), we took the ratio of pupils to teachers. Hence, we arrived at the total wage expenditure of teachers per pupil.
Multiplying this with the wage per pupil, gives the total VA in primary education

Secondary education:
The development of wages of teachers are taken from primary education, but, following the *quotisatie of 1742* (an income tax for this year), their level was estimated at three times the level of teachers in primary schools.[67] The total number of pupils was taken for Latin schools from Frijhof (1985). We assume 7 year education per pupil. Therefore we take 2 years from the age group 5-9 and 5 from the age group 10-14. From benchmark year from Frijhof (1985) we can calculate benchmark percentage of relevant age group following Latin education and extend these percentages using interpolation.

To this, we have to add children in French schools which started in the mid-17th century and overtook Latin schools in the 18th century. The ratio with Latin schools is available from Frijhof for the early nineteenth century and is assumed to go linearly to 0 in 1620.

The sum of pupils in Latin and French schools is argued to be equal to the total number of secondary school pupils in Holland. Multiplying the wage per pupil with the total number of pupils results in total VA in secondary education.

Higher education
The number of professors and their wages at Leiden University (the only university in Holland) is given in Sluijter (2004, appendix 2). Herewith we have to add the Atheneum of Amsterdam. Amsterdam increased from 2 to around 6 professors between 1575 and 1810. In addition we know that in 1810 the number of students in Amsterdam was 80% of that of Leiden. The number of pupils from Leiden is taken from Frijhoff (1981) and from Amsterdam from Van der Byll *et al.* (1932, 3). Using this information we can interpolate the share of students in Amsterdam versus Leiden between 1810 and 1575. Multiplying this ratio with the total wage sum in Leiden results in the total VA in Higher education in Holland.

[66] NEHA: Posthumus archief no. 407, box I.
[67] Sources of Quotisatie of 1742: Oldewelt 1945, 1950 and 1951.

The educational sector increased rapidly between 1500 and 1800, but from very small beginnings (about 6 thousand guilders in 1510/14); in 1807 it contributes 490 thousand guilders to GDP. This corresponds with an increase in average years of education (see

Figure 4
Average years of education in Holland

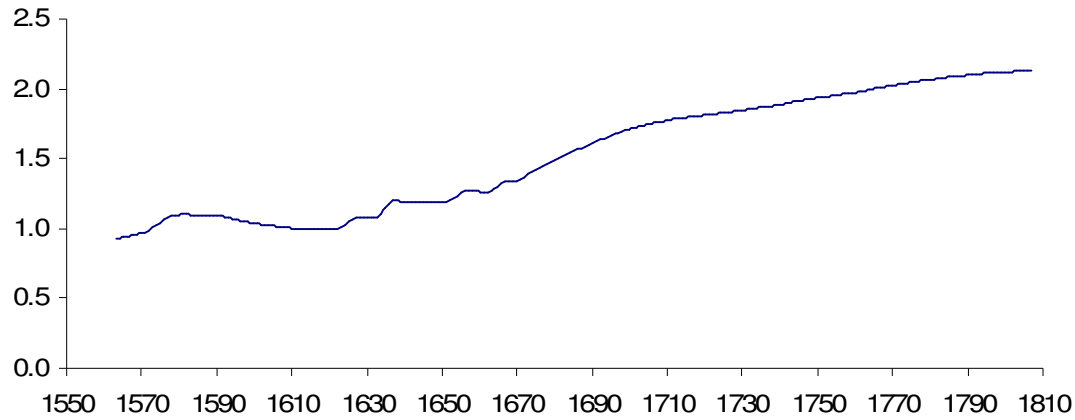


Figure 4) from about 1 in the middle decades of the 16th century to about 2 in 1800.

2.6 Services: Army and Navy (including production of inputs for this branch)

This is a very rapidly growing sector, because it was close to zero during the 16th century (only during the middle decades of that century there was a certain expenditure on the establishment of a standing navy), but grew enormously during the Revolt of 1572-1648, and remained quite high during the rest of the period, with sharp ups and downs. The data are available thanks to the important work done by Fritschy and Liesker (2004, 390, 392, 394, 406) on public expenditure of Holland in this period. Next, the number of soldiers was calculated using Zwitzer (1991, 190-191) and wages were taken from Van Zanden (2002b, 624). On this basis, we assume that 90% of the expenditure calculated by Fritschy and Liesker and is value added: wages and salaries of soldiers and sailors, and the domestic value added of industries supplying military equipment, including ships.

Another source of finance of government expenditure, specifically for the navy, were the convooyen and licenten, from which the expenditure of the Admiralties on the navy was financed. We do not know the actual expenditure of these institutions, but do know their income (from these convooyen and licenten), which is given by Becht (1908) and, from 1707 onwards, by Johan de Vries (1968, pp.186-192). For the expenditure on the navy prior to 1589 we used the data from Sicking (1998, p. 184). For 1799-1807 the data could be obtained from Van Zanden and Van Riel (2004, p. 45 and 49). We assume that 60% was contributed by Holland. The period 1795-1799 was interpolated.

The deflator is based for 50% on the military wage data from Van Zanden (2002b) and the unskilled wage index from De Vries and Van der Woude (1997). The other 50% consist of 35 percentage points iron and copper and 25% CPI.

2.7 Services: Housing

The starting point is the house rents index from Eichholtz and Theebe (1998). The missing years were extrapolated using the CPI from Van Zanden (2005: see www.iisg.nl/hpw). This house rent index was for Amsterdam only, and therefore not necessarily representative for Holland as a whole. Fortunately, we have the rent per house for 1632, 1732 and 1832 from the tax registers of these years (see Van Zanden 1987). We interpolated and extrapolated these points using the Amsterdam rent index to get a modified rent index.

This rent index was multiplied with the number of households in Holland (based on its population of Holland and an average household size). Multiplying the number of houses with the average rent index results in an index of the VA in current prices of housing. This is linked to the 1510 estimate of housing. The resulting series is deflated using the house rent index.

2.8 Services: Government

Fritschy and Liesker (2004, p. 446) gives the wage sum of provincial civil servants in Holland for several benchmark years. These are interpolated using the categories of expenditure that cover these wages or are otherwise linked to it (*huislasten, collectlonen* and *inningskosten*, taken from Fritschy and Liesker (2004, p. 160 and 430)). This results in a series of provincial government VA between 1575-1795.

These data, however, only cover the provincial wages. Therefore, we still have to add the wage sum of local government. Before 1575 local government must have been small while it increased strongly during the Revolt. For the period after 1620, when local government must have been relatively extensive, Fritschy and Liesker (2004, p. 383-384) estimates the total *ambtgeld* (a tax on civil servant wages), which was equal to half all the total value of all government salaries. These estimates are, however, only comparable for the years 1717 and 1725. Using these years as benchmarks and assuming that the ratio between total salaries and salaries paid out by the central government remained constant during this period, we can estimate total government expenditure on wages between 1620 and 1795.

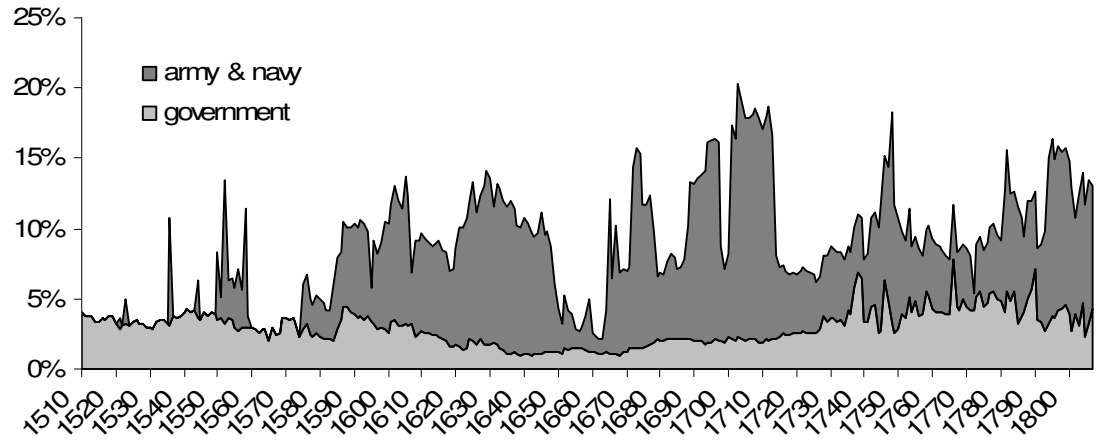
Unlike the period 1620-1795 where we directly estimate the total wage sum, we have to build up the wage sum prior to 1620 from individual wage data. To proxy civil servant wages, we used a wage index that consists of 50% schoolmaster wages and 50% skilled labour. Of course, population (and therefore the number of civil servants) also increased during this period. Hence, we multiplied this wage index with population size in order to create an index of civil servant wage sum. This index was linked to a base estimate of total civil servant wages in 1510/14. As the 1510/14 figures also included religious and educational professions, we subtracted from the 1510/14 estimate the value added of education and clergy, the latter assumed to be 0.5% of the population and having a yearly wage equal to that of 50% schoolmaster and 50% skilled labourer. Linking the index with the modified 1510 benchmark results in a series of total government value added for 1510-1575.

Between 1575 and 1620, when local government increased relative to provincial government, we have the earlier estimate of provincial government expenditure. Also, we have the ratio between local and provincial government VA in 1575 and 1620. So, assuming a gradual increase in local civil servants, we linearly interpolated the ratio

between local and provincial VA between 1575 and 1620. This resulted in an estimated of total value added for government for this period.

Finally, for 1799, the government expenditure is taken from Van Zanden and Van Riel (2004, p. 45 and 49) where we assumed 90% of government expenditure (exclusive military) is value added while the share of Holland is this value added is 60%. The years 1800-1807 is taken from Horlings (1995) under the assumption that 60% of the expenditure is for Holland. Finally, the years 1796-1798 are interpolated.

Figure 5
Share of government (including army and navy) in GDP, 1510-1807



Note: The share of the army and navy is taken from section 2.6

2.9 Services: Domestic servants

We took the percentage urban population in Holland from De Vries and Van der Woude (1997, p. 58; 61). These data were interpolated. Next, we multiplied it with the total population of Holland in order to get the share of the population living in towns. Under the assumption that most of the domestic servants were living in cities, multiplying with the unskilled wage index by De Vries and Van der Woude (1997) results in an index of the nominal wage sum of domestic servants.

This index is linked to an 1807 VA benchmark obtained from Gogel (1844, p. 482-485). Gogel reported the domestic servants in the departments of Maasland and Amstelland (roughly Northern Holland, Southern Holland and Utrecht). In order to remove the share of Utrecht in domestic servants, we multiplied this figure with the share of the population of Holland in the total population of Holland and Utrecht (ca. 90%). The resulting number of domestic servants was multiplied with the unskilled daily wage where we assumed the wage to be 20% higher than in the rest of the Netherlands. This, in turn, was multiplied with 150 days worked as there was a lot of part-time work among domestic servants. In addition, this made the results fit good to the 1807 benchmark calculated by Horlings (1995).

2.10 Services: Domestic transport

Domestic transport consists of the “trekschuit” (inland barges) and “other transport”.

Trekschuit:
De Vries (1981, 68) estimates the total passenger km capacity by trekschuiten in Holland-Utrecht in 1660. In addition, De Vries (1981, 69) estimates that only 50% of this capacity was actually used. Combining this information gives the total used passenger km for trekschuiten in 1660. Assuming that intercity trekschuiten developed in line with over-all trekschuiten, this benchmark figure was extended back and forward using an index of passenger km of the trekschuit for intercity purposes only (De Vries 1981, 246).

Next, we calculate the tariff per passenger per km on the basis of De Vries (1981, 76-78). This number of passenger km, multiplied with the tariff, results in the total value added for Utrecht and Holland. Just as we did for domestic servants, in order to remove the share of Utrecht, we multiplied this figure with the share of the population of Holland in the total population of Holland and Utrecht (ca. 90%).

Other domestic transport
We have data for two important transport routes. The most important route was through Holland, connecting Amsterdam/IJsselmeer, with the south; all ships had to go through Gouda, where as tax was levied on using the sluce. The yield of this *sluisgeld* reflects a large part of the domestic transport of Holland (see Van Zanden 1993 for this source).[68] The second series is linked to the trade of peat from Northern Netherlands to Amsterdam – according to Horlings (1995) this was the most important transport route in the early 19th century. We know the development of the production of peat in the Northern Netherlands (from Gerding 1995) and have assumed that exports were a constant percentage of output; consequently, we could use the output of 'northern' peat index also as an index of transport activity via the IJsselmeer. It was assumed that in 1807 both trades were equally important (see Horlings 1995). The resulting index of "other transport" was reflated using a price index of 75% skilled wage and 25% peat prices.

The resulting nominal index has to be linked to total domestic transport in 1807. Horlings (1995, 85-87) estimates domestic transport at 30.8+12.9=43.7 mln (inland navigation and "other transport"). We assume that Holland's share in inland transport was equal to its share in Dutch population. Next, we subtract the value added of the *trekschuiten*; the remainder (15.6 mln) is used as a benchmark estimate of the value added of other domestic transport (without trekschuiten).

Next we add trekschuiten and "other domestic" transport together to obtain all inland transport. The price index is a weighted average of the price indices of both series.

2.11 Services: Other services (notaries and book traders)
Because the notaries are, from the 1520s onwards, a strictly regulated profession, we know the number of new entries into this business; in combination with the estimate of an average career of 20 years (this could be based on the 18th century data related to Amsterdam, when it is known that the number of notaries was frozen at 60). Before the 1520 we assume that the number of notaries increased with the population.[69]

[68] Data for the sluisgeld for the period 1570-1800 were collected by Christiaan van der Spek.
[69] Data on the number of entries into the profession of the notaries in Holland between 1520 and 1800 were kindly made available by dr. F. Snapper.

The number of book traders is known from Gruys and De Wolf (1989). Their numbers shows a strong correlation with book production in the Netherlands (see under industry). The relative wage of book traders and notaries is derived from the Quotisatie of 1742 (Oldewelt 1945, 1950 and 1951), and the index of salaries estimated in section 2.5 is applied to this level to get a series of incomes of book traders and notaries.

3. Industry

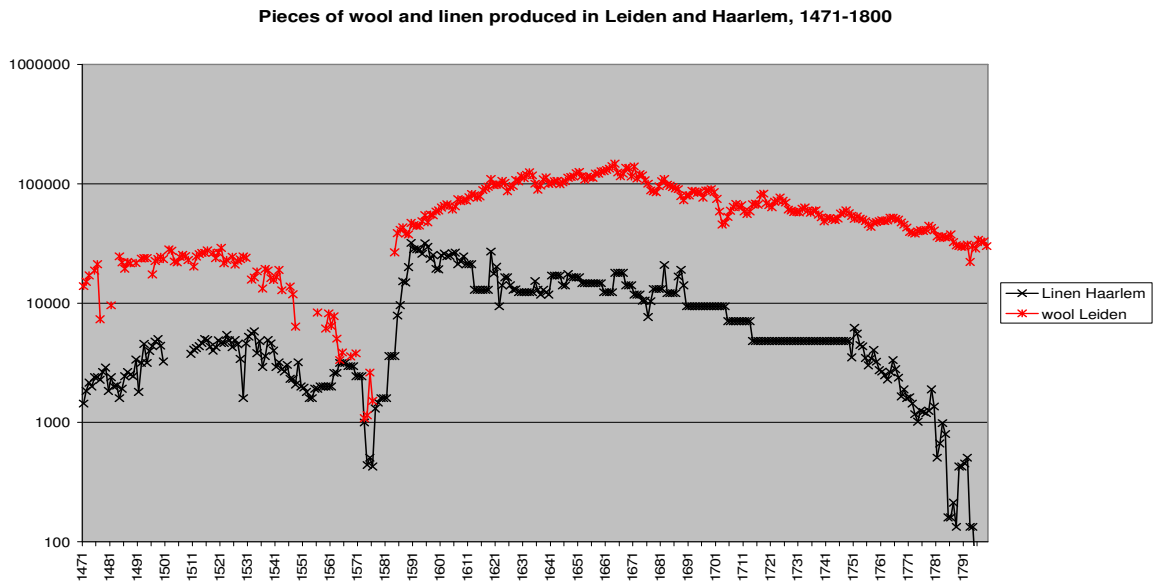
3.1 Industry: Wool

The total wool production in Leiden is given by Posthumus (1908-39) and Jansen (1999, 328). Weighted average prices of all sorts of woolens for benchmark years were obtained from Posthumus (1908-39, Vol. 3, 941). These prices were interpolated using the price index for textiles from Van Zanden (2005). These series were extended after 1800 by the series of Van Riel (see http://www.iisg.nl/hpw/prijzen19earthur.xls). Multiplying prices with volumes results in the total value of output of woollens in Leyden. Following Van Zanden (2002, p. 145), who took the data from Posthumus (1908, 276), we put the value added-output ratio at 0.7. This gives the total value added for woolens in Leyden. The share of Leiden in Total output of Holland was calculated in Posthumus (1908, vol. 1, p. 368) as 51% for 1514. Jansen (1999, 280-81) estimates the share of Leiden in 1807 at 61%. The intermediate years were interpolated and the VA of Leiden modified accordingly.

3.2 Linen

Holland also had an important linen industry, which was concentrated around Haarlem. Kaptein (1998) shows that the yield of the tax on the 'reep and ellemaat' reflects the development of this industry in Haarlem. Fortunately, this series is available for the whole period (Kaptein 1998, 256-7); the latter source also gives information about the changes in the tax rate happening after the 1570s). This could be used to estimate gross output and value added (estimated at an unchanging 70% of gross output). It was assumed that Haarlem's linen industry accounted for 50% of total production of linen in Holland (see Jansen, 1999).

Figure 6
Pieces of wool and linen produced at Leiden and Haarlem, 1471-1800



3.3 Clothing

Van Zanden (2002, 163) estimates value added at 138,000 guilders in 1510 for clothing. For 1807, we have an estimate of 15.45 million based on Janssen (1999) under the assumption that 50% took place in Holland. The in between years were interpolated using the urban population growth (see domestic servants), reflated with an index of 50% wages of journeymen and 50% school masters.

3.4 Paper

The number of paper mills since the 16th century is given in Voorn (1960; 1973). For calculating total productivity, the number of "kuipen" per mill must be calculated. Fortunately, for almost all mills in Northern Holland, the personal archive of Voorn (Coda Apeldoorn, Collectie Voorn) contains estimates per mill of the number of "kuipen wit en grauwpapier". Following Jansen (1999, 192) we assume a production of 25000 kg per kuip in Northern Holland, meaning 2000 riem witpapier or 1200 riem grauwpapier.

For Southern Holland the no. of "kuipen wit en grauwpapier" is not recorded. We assume that the no. of kuipen per mill is equal to the average of Northern Holland for the respective year. In addition, we assume, following Jansen (1999, 399) that the no. of produced riemen paper per mill in Southern Holland in 1800 is equal to 31000. That figure thus declines together with the average no. of kuipen per mill.

Thus having derived at the total no. of paper produced in Northern and Southern Holland, we use the price index of paper from Van Zanden (2005) and benchmark that with the price of "grauwpapier and "witpapier" for Northern Holland (Jansen 1999, 394-395) and to an average price of paper of fl 3.48 for Southern Holland. For the period after

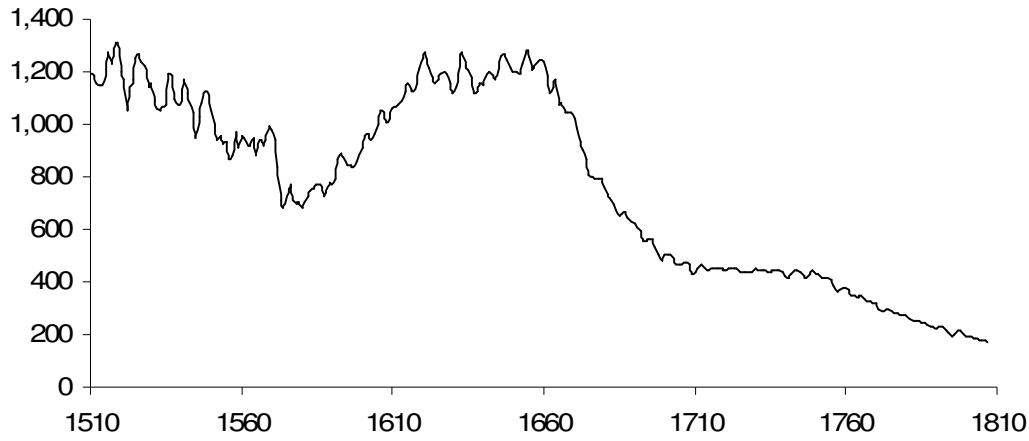
1800 the prices were extended using the price data from Jansen (1999, 399). Thus having arrived at the total value of output, we arrive at the value added by assuming, following Jansen (1999), that the Value Added is 65% of gross output.

3.5 Beer

Benchmark estimates of beer consumption and production (and of exports) are taken from Yntema (1992); additional time series for the large producer cities are derived from the work by Unger (2001). In addition, the post 1650 decline of beer production can also be read from the decline in the excise on beer available from Fritschy and Liesker (2004). Beer production was multiplied with the price of beer. The index of the beer price is taken from Van Zanden (2005) and is benchmarked with the price of beer taken from Yntema (1992). After 1800, the resulting series was extended using beer prices from Van Riel (http://www.iisg.nl/hpw/prijzen19earthur.xls).

Multiplying the price and volume results in the total value of output. To obtain the value added, we follow Jansen (1999, 357) in assuming that 20% of output is equal to the Value Added. Because of different sorts of beer in the sixteenth century, Van Zanden (2002) takes a ratio of 28% in 1510. The intermediate years are interpolated to obtain the complete series of value added.

Figure 7
Beer production (1000 ton)



3.6 Jenever

Dobbelaar (1930) gives information of the number of gin distilleries and the average output per distillery, as well as estimates of the input of grains. The price data for gin and brandy were taken from Posthumus (1964) from the Holy Ghost Children's Hospital. The remaining years are extrapolated using barley prices. From 1800 the price data were taken from Van Riel (http://www.iisg.nl/hpw/prijzen19earthur.xls). Multiplying the price and volume of gin results in the total value of output.

From the total value of output we have to subtract the total costs. A big part of these costs is the grain used for brewing. Following Jansen (1999, 175) we assume that gin consists of 30% barley and 70% rye. The price of barley is taken from Posthumus

(1946) (Frisian Winter barley and Groningen Winter barley) and (1964) (St. Catherijnen-gasthuis). Rye prices are taken from Van Zanden (2005). Both series after 1800 are extended by Van Riel (http://www.iisg.nl/hpw/prijzen19earthur.xls). Subtracting the costs of grain results in the gross value added. Following Jansen (1999) we multiply this with 0.125 in order to get the net value added.

3.7 Bread

The amount of grain for the production of bread has been estimated in the following way. Van Zanden (2002) estimates grain consumption (excluding beer) in the early 16th century at 200 liter per capita (see also VandenBroeke 1975); this is kept constant until the second half of the 18th century, when potatoes become increasingly important, leading to a decline of consumption of bread by 15% in the 1750-1807 period (Van Zanden 2005). This is converted in kg of bread using the conversion factor from Van Zanden and Van Riel (2004, 146). However, this amount of bread needs to be divided in wheaten and rye bread since the latter has a much lower value added than the former while there was a strong shift over time towards wheaten bread. From the study of Fritschy and Liesker (2004) we know the different excise tariffs for wheat and rye and we know the total amount of excise as well as the total amount of grain used for bread. Equalizing these values results in the share of rye and wheaten bread for benchmarks years. This is confirmed by a separate benchmark observation for 1760 and by an estimate for 1808 by Vries (1994, 202). These observations show a long-term decline in the share of rye bread in total consumption from 90% to 30% (wheat increases from 10% to 70%).

The total output can now be calculated, as well as the costs of grain. The price of rye bread is taken from Van Zanden (2005) and modified for Van Riel (http://www.iisg.nl/hpw/prijzen19earthur.xls) after 1800. The ratio of rye-to wheat bread after 1800 is known. Before 1800 the price of wheaten bread must be 250% higher than that of rye bread. The price of wheat is taken from Posthumus (1946) (Zeeland wheat and Koningsberg wheat) and (1964) (St Catharijnengasthuis, p. 449-550). The price of rye is obtained from Van Zanden (2005) and updated after 1800 with Van Riel's estimates for the 19th century.

Unfortunately, simply subtracting the costs of grain from the total value of bread does not result in the value added since we also have to subtract the costs for oil, salt, and excise. The excise data are obtained from Fritschy and Liesker (2004). Oil and salt as a percentage of the wage sum is known for benchmark years from De Vries (2009). Any remaining years were interpolated with the CPI (Van Zanden 2005).

3.8 Sugar

Most of the sugar estimates are taken from Gelderblom (2004). He estimated the costs of sugar refineries, had the amount of Atlantic trade, prices, and the loss of sugar in the refining process. The data from Gelderblom needed to be updated with the imports from Surinam which was an average of Van Stipriaan (1994) and Postma and Enthoven (2003). Further, we added the Dutch East Indies Company (VOC) sales in Holland; the VOC archives contain detailed statistics of sales in Amsterdam, which have been processed for this research (source; National Archives, VOC), which is exactly half the

total sales in Holland. Hence, the Amsterdam sales were multiplied with 2. Prices were updated with Posthumus (1946).

3.9 Other food

Not much information is available for the category "other food". Van Zanden (2002, 163) estimates this category at 271,000 in 1510/14 while The National Accounts project estimated the total food production in the Netherlands in 1807 at 41 million guilders. Subtracting the food produced and accounted for in Holland (sugar, beer, gin, and bread) and assuming that this was 60% of the Netherlands (since all products where either overwhelmingly produced in Holland or had a higher value added in Holland) we are left with a category of other food (i.e, meat) in the Netherlands of 13.4 million. Under the assumption that the per capita production was equal in all the Netherlands, the value added for "other food" in Holland becomes in 1807 4.9 million.

Assuming that the consumption grew in line with population, we interpolate these two years using the population growth, reflated with an index of 50% wages of journeymen and 50% school masters.

3.10 Building

Building industry consists of "polderlasten" (the costs of maintaining polders), drainage (the costs of reclaiming new land), creating and maintaining waterways for "trekschuiten", and house building.

The "polderlasten" were calculated based on the expenditure per *morgen* of land as given in Van Tielhof (2006, 328, appendix 5). This series was multiplied with estimates of the cultivated area (see agricultural sector). As these series do not cover all costs, we used the 1832 benchmark of all "polderlasten" (based on the cadastral survey of that year) and used the index to bring this series back in time. Following Van Tielhof (2006, 327, appendix 4) we assume that 80% of this amount was value added. This series can be deflated using an index with 1/3 sand, 1/3 skilled and 1/3 unskilled wage obtained from Posthumus (1964) and De Vries and Van der Woude (1997).

Reclaiming of new lands was based on Van der Woude (1983, 50) who estimated the cost of reclaiming land at 690 guilders per hectare around 1600. Just as for "polderlasten", we brought this series back and forward using a price index of 1/3 sand, 1/3 skilled and 1/3 unskilled wages. The resulting index is multiplied with the annual increase in the cultivated area (almost all increase was due to reclamations).

The building of waterways for "trekschuiten" was also an important source of value added. De Vries (1981, 105) estimates the average costs of maintenance of these waterways per km. De Vries (1981, 99) also gives an overview of the increase in he total length of these waterways over time. Multiplying these two series results in the total costs of maintenance. This is multiplied with 0.95 to correct for a small management. Finally, just as above, the series is deflated using an index of 1/3 sand, 1/3 skilled and 1/3 unskilled labor.

Another major component was house building. For the period 1651-1806 this could be based on the excise for "grove waren", i.e. all sorts of building materials obtained from Fritschy and Liesker (2004). These series were back and forward extended using multiple imputation and a simple regression with household size. These resulting

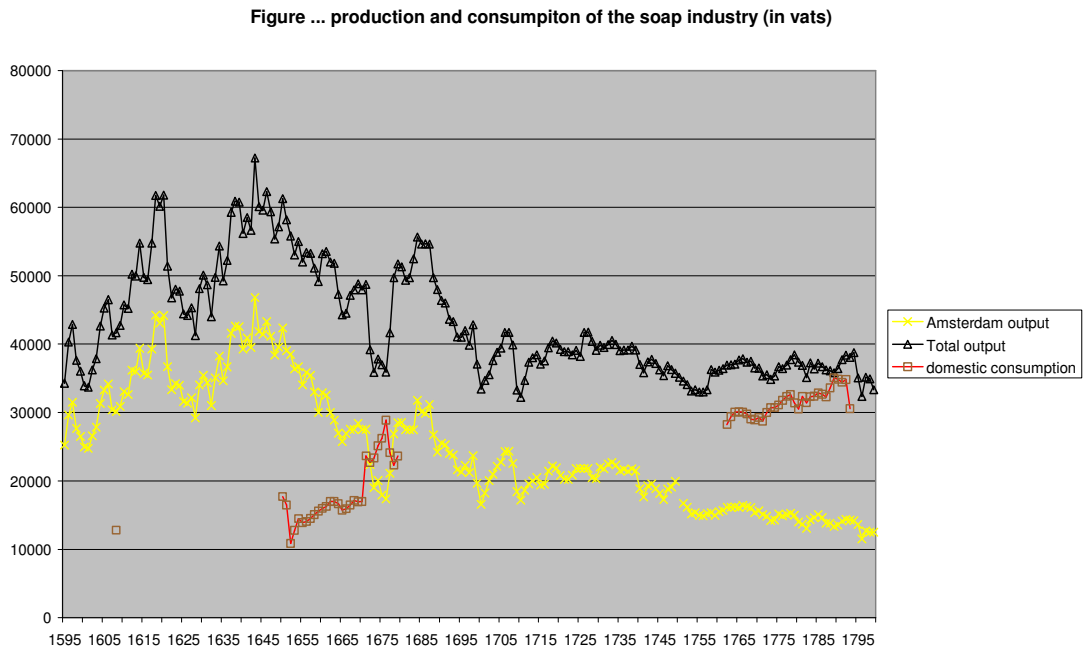
series were reflated (as it was in constant prices) using a price index consisting of 25% skilled wage, 25% unskilled wage, 23% bricks, 13% wood, 4.5% lime, 4.5% sand, and 5% lead. These weights are based O'Brien (1985) and were taken from Posthumus (1946-64) and Van Riel (http://www.iisg.nl/hpw/prijzen19earthur.xls) Van Zanden (2005). Since house building is an index, we still need to benchmark it in 1807. Therefore, we take the no. of builders in the Netherlands and assume this is in Holland equal to the ratio of the population of Holland versus the rest of the Netherlands. We add 10% to this figure (assuming more building in Holland) and 20% higher wages. This figure is multiplied with 300 days worked and 50% skilled and 50% unskilled wages. To this we add 10% capital. This results in a total value added for construction of 9.77 mln. From this figure we subtract polderlasten, droogleggingen (land reclamation) and trekschuiten. The resulting figure is brought back in time using the reflated and extended series of "grove waren".

3.11 Soap

There is a wealth of information about the soap industry, in particular that of Amsterdam. The guild of soap makers (zeepziedersgilde) of Amsterdam has left a large archive available at the Amsterdam Gemeentearchief, containing amongst others data on the production of soap in Amsterdam from 1595 onwards (with only a few small gaps in the data). In addition, Holland collected a tax on soap production, the proceeds of which are known for 1590, 1608, and from 1650 onwards (Fritschy and Liesker 2004). Amsterdam's share in total production was 75% in 1590, 72% in 1608 and 73% in 1650, making it possible to estimate output of the Holland industry using the 'inflated' Amsterdam figures for the intermediate years. For the period between 1650 and 1750 we have corrected for the fact that there is a growing gap between the estimated production based on the amount of tax paid by the Amsterdam soap makers, and the actual production known from the sources collected by the guild; the guild became the sole buyer of the tax (which was rented out), but used its power to pay much less than they were expected to do. On a much smaller scale the same happened with soap makers outside Amsterdam, as can be inferred from the differences between the yield of the tax before 1750 and after 1750; from 1750 onwards, the tax was actually collected by the government, and not leased out anymore, which lead to an important upward correction.

Because there was a separate tax on the consumption of soap (again derived from Fritschy and Liesker 2004), we can also estimate the internal market and the share of exports in production (see Figure 8). The estimates of soap production before 1590 are based on a constant consumption per capita (between 1608 and the 1660s per capita consumption also did not change much, but it doubled in the 18th century), and the assumption that the share of exports in total output increased from 50% in 1510/14 (when already large exports to the Baltic occurred) to 80% in 1590. The prices of soap are derived from Van Zanden (2005). The share of value added in total production is derived from Emeis (1954) and refers to the year 1699.

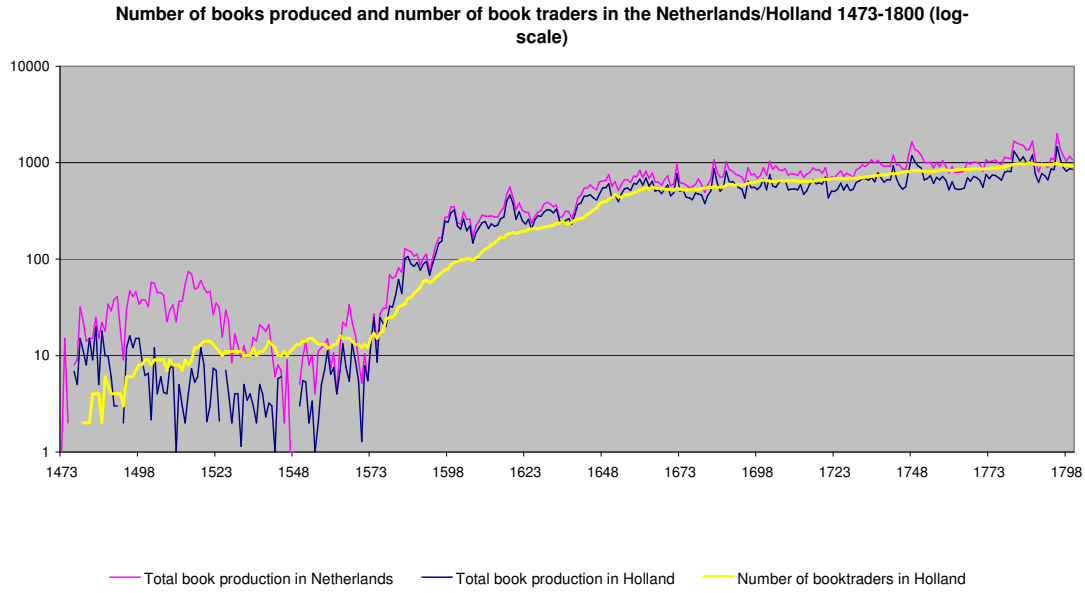
Figure 8
Production and consumption of the soap industry (in vats)



3.12 Books/printing industry

A dataset of the number of new books published in the Netherlands (and in Holland), including estimates of the development of the average price of books, has been put together in previous research (Van Zanden 2004b). For the post 1780 series use is also made of the tax on 'printed wares' (*geprinte waren*) collected by the Estates of Holland (Fritschy and Liesker 2004), which is based on a broader definition of output of the printing industry, and therefore preferred. Estimates of the share of value added in output are from Cuijpers (1998).

Figure 9
Number of books produced and number of book traders in the Netherlands/Holland 1473-1800 (log-scale)



3.13 Shipbuilding

Elsewhere we discussed how we estimated the development of the merchant fleet (as part of the estimates of the shipping industry). The output of shipbuilding consisted of two parts:

- The maintenance of the fleet, which required expenditure to the tune of 10% of the fleet itself per year;
- The net increase of the fleet from year *T* to year *T +1*.

In principle, the output of the shipping industry was the sum of the two (maintenance and net growth of the fleet); in years in which the fleet declined, however, this could lead to negative output levels. In those cases it was assumed that the output of the industry was the maintenance of the fleet only (and the effect of a decrease of the fleet size was ignored).

We did some work on estimating a price series for ships, consisting of the weighted average of the prices of inputs (see Van Tielhof and Van Zanden 2009 for details). The different series used are:

- Wages of skilled labourers taken from De Vries and Van der Woude (1997);
- Prices of copper and iron, taken from Posthumus, which are from fifteenth and sixteenth century Utrecht and Leiden institutions and from the Amsterdam exchange for the seventeenth and eighteenth centuries[70]; additional data from De

[70] N.W. Posthumus, (1943-1964), *Nederlandsche prijsgeschiedenis*, 2 Vols., Leiden, Vol 1.

Moor (2000)[71] for the fifteenth and sixteenth centuries, and from De Jong (2005) for the period 1585-1620;[72]

- Timber prices were derived from ongoing research by Christiaan van Bochove into the timber market in the seventeenth and eighteenth centuries, the data being linked to similar numbers from the abbey of Leeuwenhorst published by De Moor (2000).[73]

The long term development of these prices was rather similar, as it was dominated by the price revolution of the sixteenth century. Only the price of iron changed much in relation to the other price series. Prices of timber and copper more or less moved with the general price level. In order to convert these individual series into one set of estimates of the development of total factor costs, they have to be weighted with their share in total costs of the shipping industry. It is not easy to find data on the structure of costs in shipbuilding. Based on nineteenth century data the costs of shipbuilding have been distributed as follows: timber 40 per cent, wages 30 per cent, iron 15 per cent and copper also 15 per cent (see for all details Van Tielhof and Van Zanden 2008).[74]

3.14 Peat

A lot has been written about the importance of the peat industry to Holland's economic development (Unger 1984; De Zeeuw 1978; Van Zanden 1997). The best recent survey is Cornelisse (2008), confirms previous estimates by Van Zanden (1997) about the level of peat consumption per capita, derived from tax yields from the early 16th century, 1608 and 1650-1800. The 1608 yield showed a somewhat higher level of peat consumption than the post 1650 estimates; Van Tielhof found in the Zeeland archives more details about the 1608 yield of the tax on peat, which made clear that 73% of the yield is related to the actual consumption of peat, the remaining 27 being levies on exports and actual production.[75] This makes it possible to estimate production (and exports) directly for this year, and makes it necessary to lower the previously published consumption estimates. This also implies that the decline of consumption per capita that did occur was more concentrated in the 16th century; it was probably related to the relative decline of the brewing industry, and to the switching of this industry to coal (which happened during the first half of the 17th century). The estimates are based on a constant estimate of per capita consumption of 12 ton, plus the estimated consumption of the brewing industry (see the sources there).

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[71] T. de Moor, *Prijzen en lonen in het cistercienzerinnenklooster bij Noordwijkerhout tussen 1410/11 en 1570/71* (Amsterdam: Historisch seminarium 2000).

[72] De Jong, '*Staat van oorlog'*.

[73] De Moor, *Prijzen en lonen*.

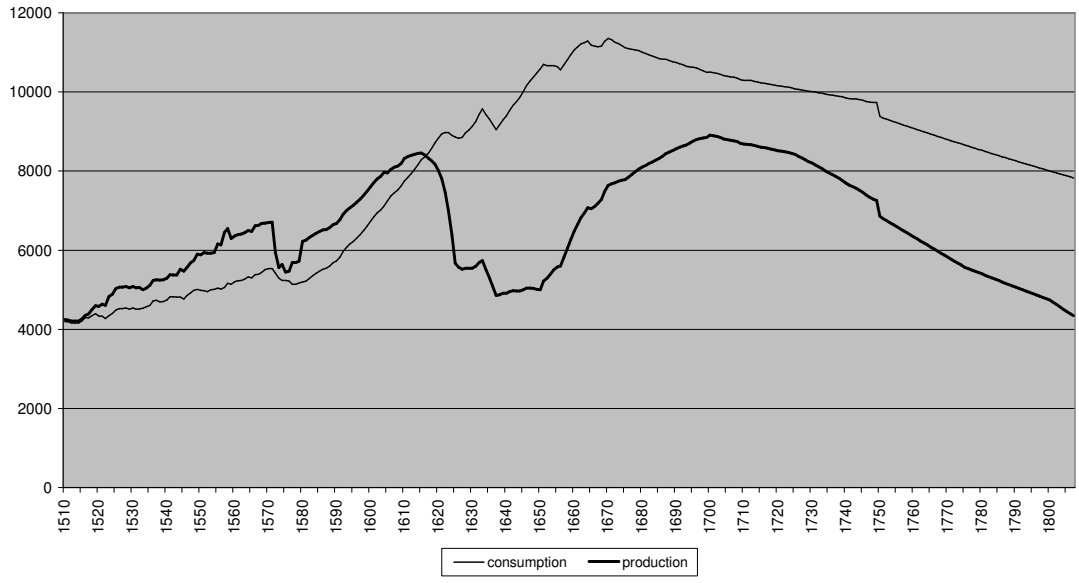
[74] Michael Jansen, *De industriële ontwikkeling in Nederland 1800-1850* (Amsterdam 1999) 288, 292-293; The most important price series that could not be included, is the price of hemp or canvas – our series of total factor costs therefore does not cover the costs of sails and ropes. We do know the long term development of the price of linnen, which was produced under more or elss the same circumstances as hemp and canvas; linnen prices declined compared to almost all other prices (with the exception of iron prices). Assuming that hemp knew a similar price curve, the addition of hemp and canvaes to the index of total factor costs would have lowered its long term increase, and by implication also lowered the increase in total factor productivity.

[75] Zeeuws archief, Staten van Zeeland, inv.nr. 1894.

To get from consumption to production, two additional series of estimates are necessary. Exports are known for the 1560s (Diepeveen 1950) and 1608; for the 16th century we assumed that the series of the traffic through Gouda (see the section on inland transport) can be used to link the various estimates. At the beginning of the 16th century, exports were limited, the real export boom occurred in the middle decades of the 16th century (Diepeveen 1950). From about 1600 onwards, imports from northern Netherlands (Overijssel, Drenthe, Friesland and Groningen) became increasingly important. Gerding (1995) has estimates the long term trends of the production in these regions; we assume that 60% of it was being exported to Holland.

Figure 10
The long term trends in the production and consumption of peat in Holland 1510-1807 (in 1000 peat-tons)

Figure The long term trends in the production and consumption of peat in Holland 1510-1807 (in 1000 peat-tons)



4. Agriculture and fisheries

4.1 Fisheries and whaling

The value added of fisheries and whaling is calculated by Van Bochove and Van Zanden (2006) for 1600-1795. These estimates need to be extended both prior 1600 and after 1795. Van Bochove (2004) also made calculations of the catch of herring for years prior to 1600. Since whaling only emerged in the first half of the 17th century, this does not cause a distortion. We calculated the average value added per last for 1600-1610. These were used to modify the linear interpolated catches between 1500-1600 to constant 1600 prices value added. Next, these constant price series was reflated using the herring prices. For the period 1795-1807 we took the same approach with the catch data for herring from Poulson (2008) and assumed whaling to move in line.

We used herring prices to reflate these value added series. These prices were taken from Van Zanden (2005) and from Posthumus (1946) (full herring and matie) and (1964) (Holy Ghost, Municipal Orphanage, and St. Catherine).

4.2 Agriculture

For 1812/13 and 1510/14 two benchmark estimates were put together on the basis of the sources used in previous studies (Van Zanden 1985 and 2002); for these years we could also estimate the share of rents and of labour in value added in agriculture.

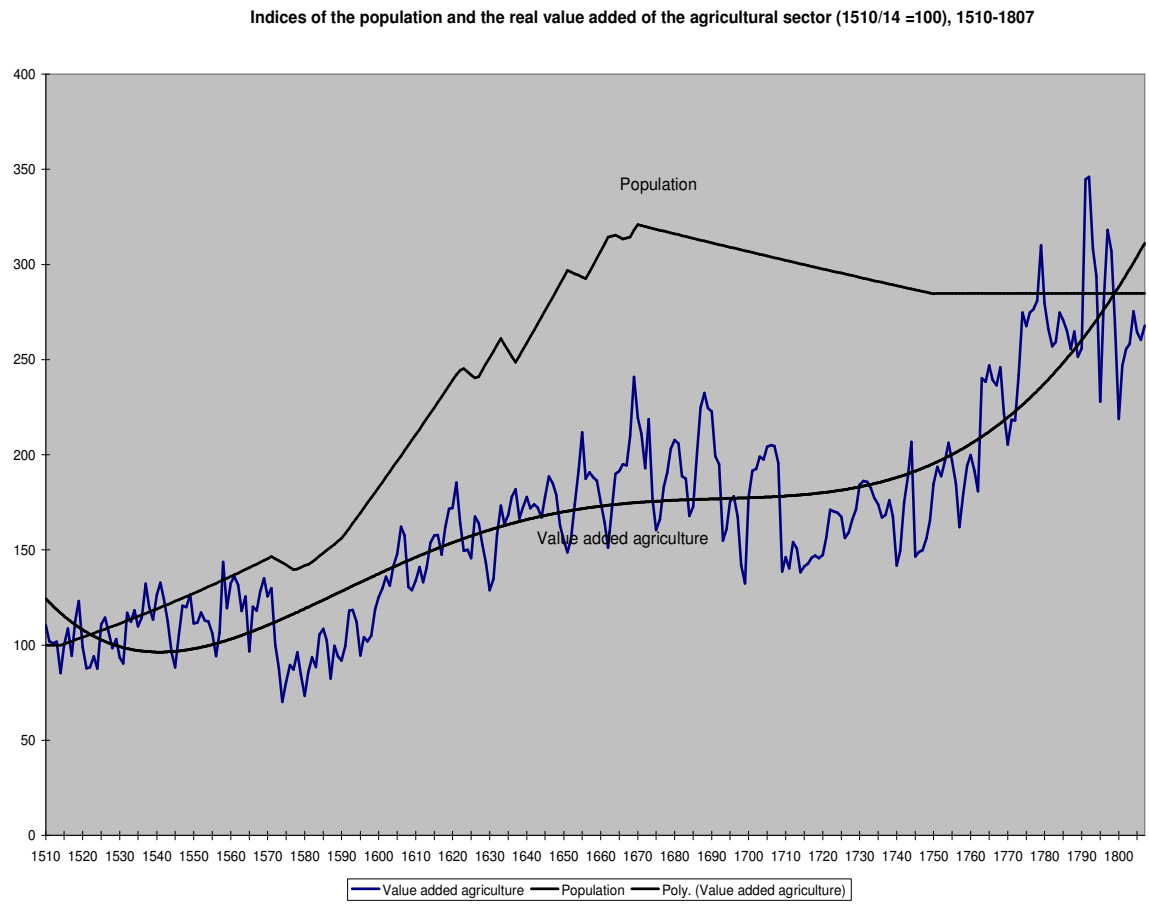
The cultivated land is known from the kadaster of 1832 (Van Zanden 1985), and the different reclamations (mainly newly created polders) are known from De Vries and Van der Woude, 1997, 32); the estimate of the cultivated land is based on the 1832 benchmark, and the different reclamations are subtracted from it; this gives an estimate for 1510 that is consistent with the data from the Informacie of 1514 estimated by Van Zanden (2002).

The development of the rent per morgen (.87 hectare) for the period 1500-1650 can be derived from Kuys and Schoenmakers (1981); for the 1650-1832 we have a benchmark estimate for the 1820s (based on the cadastral survey), and various estimates of the development of the level of rents by Van der Woude (1983), Prak (1985) and Baars (1973) for the intervening period.

Next, we assumed that the total rental value of the land was a certain percentage of total value added; in 1510/14 this was 65%, in 1807 61%, in between this percentage was intrapolated. Prices were derived from Van Zanden (2005).

As the figures below demonstrate, the growth of agriculture did not keep pace with population growth during the 1560-1700 period (and Holland was already a large importer of agricultural commodities in 1510); this changed during the second half of the 18th century, when agriculture grew relatively strongly, whereas the population stagnated. Land productivity more or less doubled during these three centuries; the growth of labour productivity was much more modest, and concentrated in the 17th century.

Figure 11
Indices of the population and the real value added of the agricultural sector (1510/14=100), 1510-1807

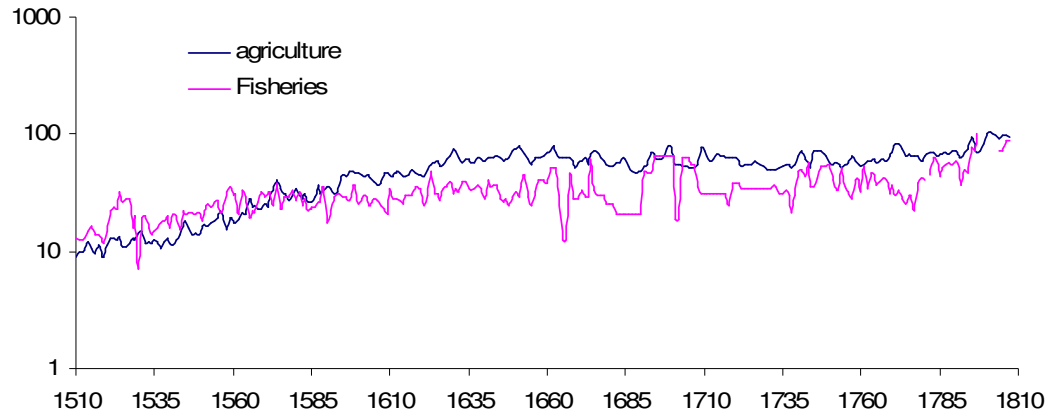


5. Prices and deflators

In the previous sections we discussed both current and constant prices with their deflators. Most series were reflated with the price of the most common product, e.g. herring prices for fisheries, sugar prices for sugar refining. Other series consist of weighted index of several prices and/or wages. For example, the building deflator consists of 25% skilled wage, 25% unskilled wage, 23% bricks, 13% wood, 4.5% lime, 4.5% sand, and 5% lead. Reflators in services were, however, by necessity largely based on wages, most commonly on a weighted average of the wages of skilled labourers and schoolmasters.

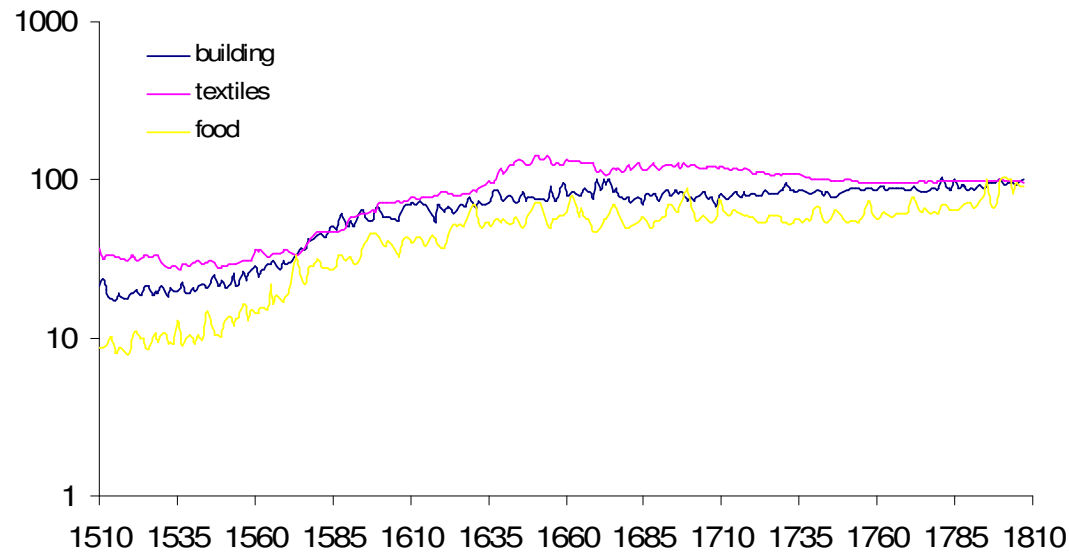
A comparison of price indices in agriculture is given in below figure. Both

Figure 12
Price indices in agriculture (1800=100), on a log-scale



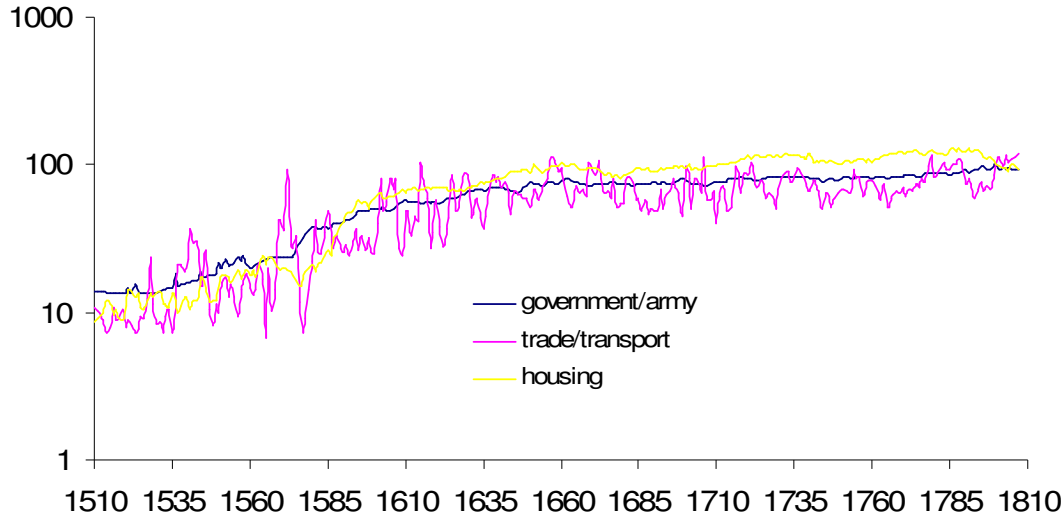
fisheries and agriculture show a strong increase in prices from 1510 onwards; the prices of agriculture in particular increase a lot during the 80 years war. This strong growth in agricultural prices can also be found in the food sector in industry (see Figure 13). Food prices increased fastest, largely driven by the price increase in agriculture,

Figure 13
Price indices in industry (1800=100), on a log-scale



followed by a much slower growth in building and textiles. The relative decline of prices of textiles suggests a marked improvement in (labor) productivity vis-a vis the other sectors. Since most of the service sector is based on wages, we do not expect much variation here.

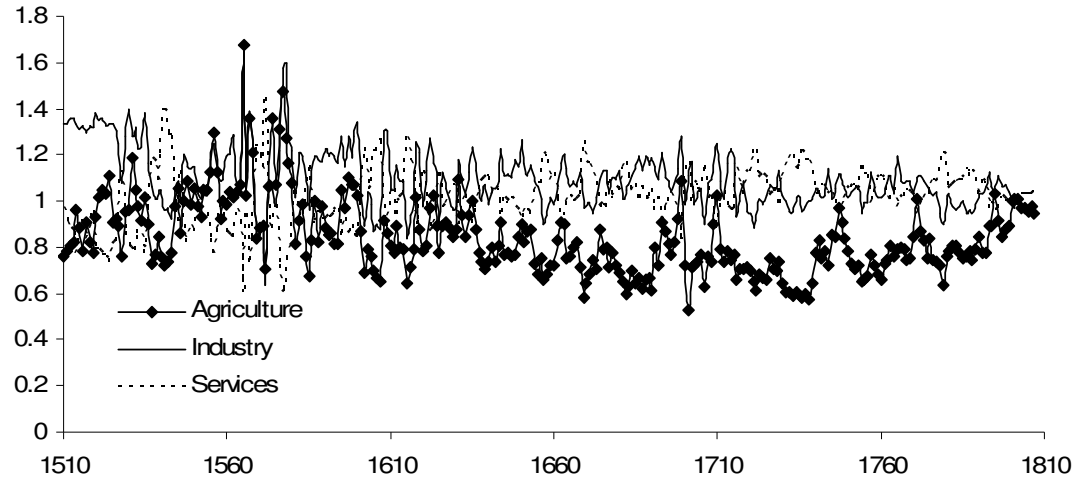
Figure 14
Price indices in services (1800=100), on a log-scale



Indeed, we can see that, although house rents clearly show the fastest growth, especially during the 1580s, all series move more or less in line.

If we now compare price developments in agriculture, industry, and services, we find the same pattern: agricultural prices on average grew faster than those in other

Figure 15
Price indices in the aggregate economy (1800=100) relative to the GDP deflator



sectors, suggesting a relative increase in labor productivity in services and industry (assuming no massive growth of the urban population and no decrease in per capita GDP). Another interesting development is the decline of agricultural prices vis-à-vis the other sectors between 1650 and 1750.

6. A comparison with other estimates

We can make a comparison between our new estimates and previous estimates made for 1510 and 1807. This is given in below table.

Table 1
A comparison of the new estimates for 1510 and 1807 with the previously published estimates for those years

		1510		1807		
		Van Zanden Holland	This text Holland	This text Holland	estimate based on Netherlands Holland	GDP project Netherlands
Agriculture		**1,882**	**1,543**	**33,093**	**30,016**	**120,700**
of which:	agriculture	1,282	1,281	32,908	28,790	119,300
	fisheries	600	262	185	1,226	1,400
Industry		**2,577**	**2,152**	**56,719**	**75,562**	**134,148**
of which:	Building, shipbuilding, metalworking	942	564	14,184	11,840	21,300
	textiles	603	576	463	2,487	6,984
	clothing	138	138	15,450	18,540	30,900
	food	618	542	21,944	25,892	41,948
	paper	0	0	674	800	1,000
	mining	195	322	2,979	2,840	3,100
	other	81	10	1,025	13,163	28,916
Services		**2,026**	**2,022**	**84,193**	**112,590**	**209,200**
of which:	Trade/transport	1,449	1,449	48.346	67,654	129,800
	housing	275	275	9,707	7,844	19,700
	other services	302	713	33,656	37,092	59,700
GDP		**6,485**	**5,717**	**174,005**	**218,168**	**464,048**

The results are, in our view, reassuring; some differences do exist between these sets of estimates, but they are relatively low in general, and do not seem to affect the overall patterns very much. The main problem is the fact that the selection of industries on which we have good data is somewhat smaller for the 1510-1807 period, as a result some industries which are included in the 1807-1913 estimates (utilities, word processing, leather working) are missing in the pre 1807 series. This explains the big difference between the post 1807 and the pre 1807 estimates for 'other industries'. Also, we have the impression that the value added of international trade and shipping in the 1807-1913 estimates is perhaps somewhat overestimated, which helps to explain the gap that we get between the two sets of estimates, in particular for the services sector. But such relatively small inconsistencies are almost inevitable when two sets of more or less independent estimates of size and structure of GDP are compared with each other – it points to the sizeable margins or error that are inherent in these reconstructions.

7. Factors of production

7.1 Land

See under Agriculture (estimates of cultivated area)

7.2 Population

There are three more or less reliable benchmark estimates of the population of Holland, in 1514, 1622, and 1795; on this basis, and additional data, De Vries and Van der Woude have in a number of publications also made estimates for 1670 (when Holland's population probably peaked) and 1750 (when its decline, which began after 1670, came to a stop) (see for example De Vries 1984, and De Vries and Van der Woude 2001). Moreover, we know from a number of papers that Holland was a couple of times struck by epidemics (of the plague), which led to strong declines of population levels (Noordegraaf and Valk 1996, Rommes 1990). Moreover, it is also known that during the 1580s and 1590s population growth must have accelerated as a result of massive immigration from Flanders (but this followed a probable set back of the population during the 1570s as a result of the civil war and emigration of Catholics to the south). To create a time series, we have tried to take these demographic developments into account; firstly we intrapolated the point estimates available for 1514, 1622, 1670, 1750 and 1795; next, we included a number of corrections to take into account 1) decline during the 1572-1576 period; 2) accelerated growth after 1580, and 3) declines during the epidemics of the 1630-1670 period. The resulting time series is very tentative.

Finally, we estimated Holland's population after 1795. First, we took the population of Holland from Oomens (1989, p. 16) for 1795 and 1814. From this, we subtracted the population of Amsterdam from Van Leeuwen and Oeppen (1993) because the population of Amsterdam moved differently from population in general). Next we took the population from *200 jaar statistiek in tijdreeksen* for the Netherlands 1804-1814. We calculated the ratio with the population in Holland (minus Amsterdam) in 1814 and brought the series back to 1804. Next, we interpolated the remaining years (1796-1803) for the population of Holland without Amsterdam. Finally, we added the interpolated population of Amsterdam (1795-1814) to the population of Holland minus Amsterdam to obtain the total population of Holland.

7.3 Human capital

See under education.

7.4 Physical Capital

The estimates of the capital stock have been made in the following way. We know the value added and the output of the two sectors that produce capital goods, shipbuilding and construction. The average asset life of a ship has already been estimated at 10 years, and the rate of depreciation at 10% (Van Zanden and Van Tielhof 2009); the average asset life of buildings was (much) longer, and can be estimated at 20 years, or a rate of depreciation of 5%. We can check the latter assumption by comparing the value of the total rents of all buildings in Holland, estimated for the annual tax on these properties, with the value of the buildings according to the estimates produced here. In 1632 a new set of registers for the *verponding* was put together; the total rental value was estimated at

6,4 million guilders, or 5,4% of the value of the buildings according to the estimates produced here. In 1732 a similar new set of registers produced a total rental value of 15,5 million guilders, or 8,1% of the value estimated here (rental values in 1632 and 1732 from Van Zanden 1987). Perhaps 5.4% is rather low as a net yield on the capital invested in buildings; the 8.1% is, on the other hand, perhaps too high. This implies that our estimates perhaps somewhat understate the increase in this part of the capital stock in these years. The underlying reason may be that the asset life of buildings increased, as wood to some extent were replaced by brick. When it is assumed that, for example, the rate of depreciation fell from 5% to 4% (for example between 1632 and 1732), the estimates of the capital stock increase even stronger than they already do (because the capital stock in the 18th century is larger than initially assumed). Obviously, this also has an impact on TFP-growth, which is even more 'depressed' after 1650 when such an assumption is made.

8 The income approach: a test.

An alternative way of measuring national income is via the income approach. We can estimate the wage income, the income accruing to land and buildings, indirect taxation (to get from factor prices to market prices), but it is more difficult to estimate the profit income, which usually is the weakest part of the income approach.

Wage income is the results of average wage multiplied by the labor input. The labour force is estimated at a constant 40% of population (it may have been less in the period of rapid population growth before 1650 and more than this in the period of stagnation of population after 1670, but we cannot correct for this). The number of working days is 250 before 1570, rises to 285 in 1620, and remains stable afterwards (following De Vries and Van der Woude, pp. 616-7). Wages are taken from the same source (pp. 610-11). We use the series of unskilled labourers, but in addition assume that 40% of the labor force was active in skilled activities, and add an average skill premium of 50% for this part (we therefore probably underestimate the growth of wage income, as average levels of human capital increased during the 1500-1800 period). This brings us to total wage income.

Income from land and buildings has already been estimated as part of the agricultural sector (see 4.2) and of services sector (2.7). Indirect taxes for the period after 1575 can be derived from the accounts of Holland (from Fritschy and Liesker (2004)), and from (Van Zanden 2002, p. 163) for 1510/14. Figure 16 below presents these two series: the sum of wage income, rental income and indirect taxes, and the GDP estimated from the output side. Both series show a very similar long term trend, but the wage plus rental income is almost always 10-20% lower than the GDP estimates (and as a result of the way in which these incomes are estimated, the annual fluctuations in the series is much less sharp). The difference obviously is the profit income. Most profits were made in trade, banking and shipping; when we add very rough estimates of the share of these sectors that consisted of capital and profit income (banking: 100%; international trade: 70%; international shipping: 25%) we get the third series presented in Figure 16, which generally overlaps with the GDP estimates from the output side. Only after 1770 do these series diverge – estimates via the output approach are substantially higher than via the income approach. This may be due to the fact that we underestimate working days and working hours in these years, or the size of the labor force. This check via the income

approach does therefore confirm the long term trends in GDP, but perhaps casts some doubt on the growth spurt that is present in the output series, but does not show in the income series.

Figure 16

Figure 16 Comparison of Income and Output Approach, 1510-1807 (log-scale)

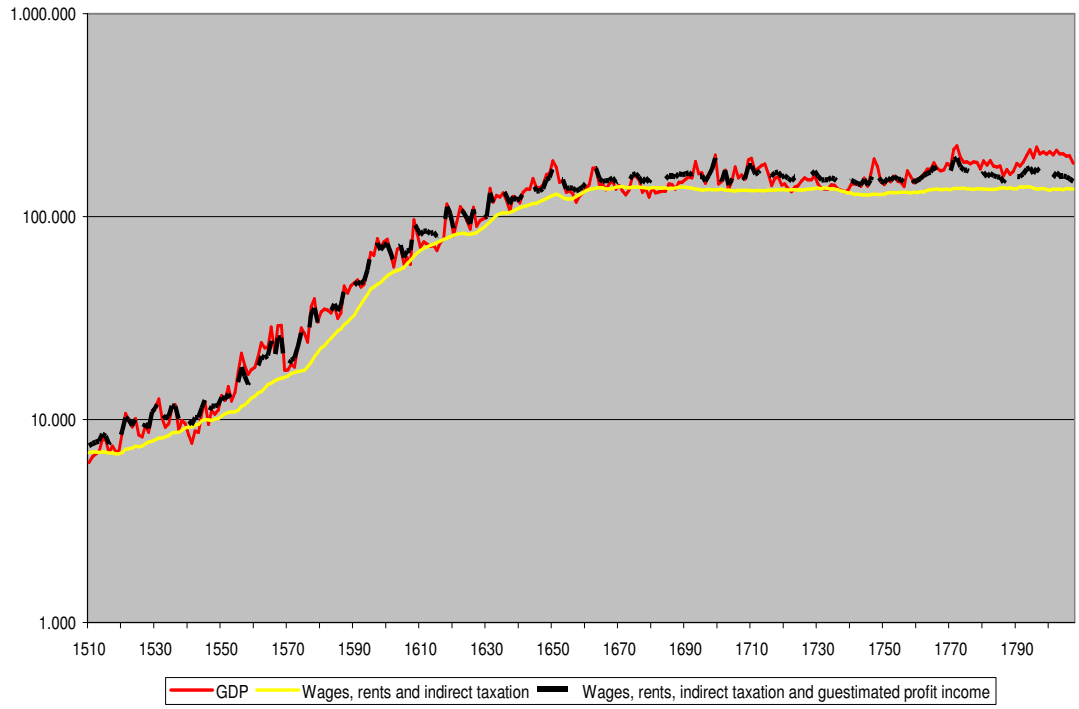


Table 2
Estimates of GDP from output and income side (averages per ten year period), 1511/20-1801/07 (in guilders)

	GDP current prices	Wages, rents and indirect taxes	Idem, plus guesstimated profit income	GDP constant prices of 1800
1511/20	7.303	6.864	7.979	50.210
1521/30	9.692	7.474	9.796	57.528
1531/40	10.133	8.571	10.831	62.086
1541/50	10.347	9.827	11.238	55.840
1551/60	16.202	11.583	14.869	71.839
1561/70	23.276	15.116	21.063	86.100
1571/80	27.783	18.768	27.087	75.936
1581/90	38.435	27.747	38.641	99.346
1591/1600	62.563	43.501	61.205	124.821
1601/10	69.013	58.843	72.716	133.014
1611/20	81.242	75.103	88.671	149.537
1621/30	98.743	84.099	99.680	163.486
1631/40	122.927	103.518	124.132	182.136
1641/50	149.004	118.456	142.655	203.463
1651/60	137.744	126.480	143.698	180.835
1661/70	148.725	137.878	154.887	195.760
1671/80	139.571	139.058	152.267	189.797
1681/90	140.118	138.530	156.632	202.578
1691/1700	164.924	136.198	164.837	206.897
1701/10	162.840	134.683	160.081	216.385
1711/20	160.386	134.800	165.134	206.030
1721/30	146.130	136.162	158.983	195.493
1731/40	137.841	134.983	148.849	185.348
1741/50	154.969	128.258	151.462	202.169
1751/60	151.794	131.333	153.248	202.217
1761/70	171.405	135.087	164.829	222.570
1771/80	191.572	137.113	171.054	233.773
1781/90	173.721	137.152	155.298	208.516
1791/1800	201.379	137.978	166.050	224.581
1801/07	200.062	136.614	156.526	206.351

Appendix 2. A scenario for growth between 1347 and 1514

It is not possible to estimate the national accounts of Holland for the period before 1514 in the same, relatively detailed way, via the estimation of the value added in constant and current prices for different (27) branches of industry. The necessary data and time series are simply not available to do this in the same way. What can be done, is to develop a 'scenario' of the most likely development of real GDP per capita, using the detailed benchmark of 1510/1514 as a starting point. What do we know for the period 1347-1514 is the following (this overview is largely based on Van Bavel and Van Zanden 2004):

- In contrast to large parts of Western Europe, the population of Holland recovered quickly from the Black Death of 1347/48 and its aftershocks; the total population in 1400 was 'only' about 10% smaller than in 1348, and increased continuously after 1400 to a level that in 1514 was 17% larger than before the Black Death (275 thousand versus 235); moreover, population growth was concentrated in the cities that saw their share in total population increase from 23% in 1348 to 45% in 1500; the rural population in 1500 was still somewhat smaller than in 1348;[76]
- Due to ecological problems (rising water levels, storm surges etc.) agricultural went through a crisis between about 1390 and the middle of the 1420s (when large parts of the countryside became inundated by the Saint Elisabethflood of 1421); there are a number of tithe series that probably closely reflect the development of cereal output in these years; they show a recovery after the mid 1420s, another crisis in the 1480s (which is also documented well by other sources: the Enqueste of 1494), and another recovery afterwards (for details see Van Bavel and Van Zanden 2004); because the cultivation of grains became much more difficult, the agricultural output mix shifted towards livestock products, made possible by the growing demand from the cities, and from abroad; from the 15th century onwards, Holland becomes a net exporter of butter, cheese, livestock etc.; whereas at about 1350 Holland was more or less self –sufficient in foodstuffs, in 1514 it was a large importer of grains from northern France and the Baltic, and a net exporter of livestock products; this change can be estimated in the following way: we assumed that Holland was indeed self sufficient in 1348, and that consumption per capita was the same as in 1510/14, which gives us a set of estimates of agricultural output in 1348; the gap between 1348 and 1514 has been filled by assuming that the available tithe series represent the evolution of grain production, and that the output of livestock products grew with the expansion of cities (which we estimate below); Figure 16 presents the two series of grain production and total production; between 1348 and 1390, agricultural output goes up somewhat, and there is almost no structural change; the rising trend in output in this period is remarkable, as population went down somewhat in these years; output per capita seems to have increased by about 40% in the four decades after the Black Death; the ecological crisis between 1390 and 1425 leads to a diversification of agricultural output, a process that continues during the rest of the 15th century;

[76] The years in which the population of Holland declined due to epidemics of the Plague are derived from De Boer (1978: 40-91).

- The rest of the economy is much more difficult to measure; we do know something about the growth of the urban population, and can follow the annual evolution of the population of the relatively new and fast growing city of Leiden from 1365 to 1514 (thanks to information on the immigration of new citizens in these years, which make it possible to estimate its growth – see Van Bavel and Van Zanden 2004); the example of Leiden is important, because it represented the new growth industries – textiles, brewing, herring fisheries and shipping– that hardly existed at all in 1350, and were the most dynamic parts of the Holland economy in the 1350-1500 period; we have therefore assumed that output in these new industries (with a share of 37,5% of GDP in 1510/14, half the non-agricultural part of the economy) increased at the same rate as the population curve of Leiden; this assumes that labor productivity was stagnant, which is a strong assumption leading to an underestimation of GDP growth in this period; the rest of the non-agricultural economy, the other 37,5%, consists of activities which also increased rapidly in the 1350-1514 period, but were of some importance already in 1348: commerce, other services, and industrial activities linked to the domestic market (foodstuffs – apart from brewing – etc…); here we assumed that output increased with the number of urban inhabitants – again assuming that labor productivity did not increase;
- The combination of these estimates result in the following structure of the economy at about 1350: 50-55% of GDP is earned in agriculture (in prices of 1510/14), which seems consistent with a rate of urbanization of 23%; in 1510/14 the share of agriculture had dropped to 24%, and the urbanization ratio was 44%; both estimates are more or less consistent with the assumption that each urban citizen gives rise to the employment of one non-agricultural worker outside the cities.

The rising urbanization ratio illustrates that there was substantial economic growth in the period 1348-1514. We estimate that GDP per capita almost doubled. The long term rate of economic growth was 0.18% per year (which is, by the way, very similar for per capita growth during the 1514-1806 period). There was rapid growth in the decades immediately following the Black Death – part of the increase in GDP per capita was the Black Death bonus of a decreased population. The period 1390-1425 was quite difficult, and income per capita probably fell quite a bit. Then followed, from 1430 to 1477, a period of expansion – the golden years of the Burgundian economy. The 1480s were difficult again (this time mainly due to political conflicts), but followed by recovery and further growth after about 1490.

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