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The ecological constraints of an early modern economy The case of Holland 1350-1800

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1. Introduction

Ecological constraints have been one of the key issues in the analysis of the early modern economy since the days of Malthus and Ricardo. More recently, the focus on the limited potential of the economy before the Industrial Revolution was one of the main themes of the Annales-school. In particular the results of research into the long term development of the yield of tithes, which tended to show that in large parts of Europe agricultural productivity (i.e. output per ha) did not grow in the long run between the 14th and the 18th century, was interpreted as a clear proof of these constraints.¹ Demographic developments, the long swings in population between 1000 and 1800, were also viewed in this way: as it was stated in the classic paper by Le Roy Ladurie on 'L'histoire immobile', the early modern economy was characterized by a more or less constant production ceiling.² When the population surpassed this ceiling, a series of famines and associated diseases would ensue, as happened in the 1320s and 1340s, and again after 1590, leading to a sharp reduction of population numbers.

This 'Malthusian' interpretation of the early modern economy had its parallels in the historiography of other countries – Postan in the UK, Slicher van Bath in the Netherlands, and Abel in Germany are the obvious examples (although there were of course differences in their approach; Abel was, for example, perhaps more 'Ricardian' than 'Malthusian'). What these authors had in common is that they focused on agriculture and on food supply as the keys to understanding these processes. The ecological constraint that was identified was the limited possibility to raise the output of foodstuffs to feed a rapidly growing population. A secondary

1 J. Goy, E. Le Roy Ladurie, eds., *Les fluctuations du produit de la dîme* (Paris 1972).

2 E. Le Roy Ladurie, 'L'histoire immobile', in : *Annales E.S.C.*, 29 (1974) 673-692.

but related theme was that rapid population growth would also cause - through Ricardian forces i.e. the increase of real rents, and through the growth of a rural land-less proletariat - a deterioration in the distribution of income, which would magnify the problems at the end of the long boom.

A somewhat different interpretation of the ecological constraints to long term economic expansion has more recently been put forward by scholars working on environmental history. Their main focus is energy supply, or the limited possibilities of the early modern economy to generate energy from different sources such as agriculture, forests, animals, wind and water. One of the most innovative books in this tradition is the interpretation by Wilkinson of the causes behind the Industrial Revolution: he shows that wood scarcity – the result of the disappearance of the British forests due to population growth and economic expansion (the iron industry was for example an important consumer of wood) – was a driving force behind the rise of coal consumption in England, and that pressures to produce more coal were behind the invention and initial spread of the steam engine.³ This ‘ecological crisis’ – and the flexible response of the British to its emergency – was in his view the real cause of the Industrial Revolution. The problem of the rising wood scarcity during the early modern period has also been the subject of research and debate on the Continent, in particular in Germany. This debate is related to the wider discussion about the energy supply of the early modern economy. Perhaps the most consistent expose of the problem is by Siefertle, who in his book on the subterranean forest develops a consistent approach to analyse energy systems and their development over time. In his view one energy system, the agrarian solar system, is typical of the period between the Neolithic and the Industrial Revolutions – between 10.000 BC to 1800 AC. During this period almost all energy is biomass, the result of photosynthesis by plants that convert the energy of the sun.⁴ The Industrial Revolution is identified as a radical break in the energy system, because large quantities of fossil energy (i.e. coal) become available, and this ‘free’ energy makes it possible to restructure the economy. But before the Industrial Revolution the constraints set by the limited supplies of energy determine to a large extent the pattern and direction of economic change; land is, for example, becoming increasingly scarce as it is an indispensable input into food production and into wood production. This approach, which is related to comparable work by Malanima⁵ on the energy supply during the early modern period, is more comprehensive than the Malthusian approach that dominated much of the writings of the Annales-

3 R.G. Wilkinson, *Poverty and Progress: an Ecological Model of Economic Development* (London 1973).

4 R.P. Siefertle, *The Subterranean Forest. Energy Systems and the Industrial Revolution* (Cambridge 2001).

5 P. Malanima, ‘The Energy Basis for Early Modern Growth, 1650-1820’, in: M. Prak, ed., *Early modern capitalism* (London 2001) 51-69.

school.⁶ The latter only focused on the supply of foodstuffs, on the limited capabilities of the agricultural sector to raise the output of foodstuffs before the ‘agricultural revolution’ of the 18th century. The new literature focusing on the energy-supply shows that this was only one part of the problem, and that there existed trade offs between augmenting the supply of foodstuffs and that of – for example – firewood.

The basic point of these approaches is that the early modern economy had limited technological capabilities for raising output and productivity; certain key factors of production – agricultural land, wood, or other inputs – were in short supply, although they could, to a certain degree, be substituted for by other inputs. Some substitution did occur – peat and coal replaced wood, for example, and larger inputs of labour made it possible to increase the output of foodstuffs per ha – but the possibilities were restricted, which limited the degree of structural transformation of the economy and therefore economic growth.

This ‘classical’ interpretation of the early modern economy does not seem to apply to the Low Countries, however. Already in the 15th century a relatively modern and highly productive economy came into existence there – in particular in the western part of the country, in Holland – which appears to have broken through the early modern production ceilings. Within the international economy the Netherlands specialized in services (shipping, trade, finance) and in industrial products (textiles, beer, and, after 1580, all kinds of luxury products ranging from sugar to paintings), and became and remained a net importer of agricultural commodities from the Baltic and the colonies.

The question can therefore be asked: why was Holland so successful in breaking through the early modern production ceiling? Was this related to the availability of a cheap source of energy, i.e. peat? Which role was played by the agricultural sector? How did this strongly urbanized economy organize its supply of foodstuffs?

One of the points I will try to make is that the success of the economy of Holland was related to the special position it attained within the international economy; its early specialization on services and industrial products made it possible to simply buy those inputs – grains, wood or peat – that it needed to maintain its energy-economy. At this point I disagree with the interpretation of its success that attributes too big a role to the favourable energy-supply. The latter interpretation of the Dutch miracle has been relatively popular in the national and international historiography. In a classic paper J.W. de Zeeuw formulated the hypothesis that the Dutch Golden Age was based on peat; without the supply of this cheap source

6 I should also mention the 1962 paper by Wrigley on the supply of raw materials: E.A. Wrigley, ‘The Supply of Raw Materials in the Industrial Revolution’, in: *Economic History Review*, 15 (1962) 1-16.

of energy, the economic boom of the 17th century would not have been possible.⁷ In their introduction to a volume on *Urbanization in History* Van der Woude, De Vries and Hayami made a similar point: the very high level of urbanization of the Netherlands was made possible by peat (if those urban citizens had to use firewood, it would have been much too costly to grow and transport it from far away).⁸ The abundant and cheap supply of peat is therefore often seen as an important reason for the particular development of the Dutch economy in the Golden Age.

It is perhaps illuminating that economic historians writing about the problem of the food supply of Holland have identified exactly the opposite reason for its success. Here the classic interpretation is that the *absence* of a sufficient supply of foodstuffs from domestic sources (the result of changes I will discuss below) resulted in the rise of the ‘mother trade’ – the grain imports from the Baltic – which was a key to the early emergence and later development of the economy of Holland (see the discussion in Van Tielhof).⁹ Whereas in the case of one resource – peat – its abundance is being praised as a key factor of economic development, in the case of another – grains – its absence is seen as an important reason why Holland was so successful. One wonders what would have happened if Holland had had the rich clay soils of Zeeland or Groningen, producing ample supplies of wheat and rye, but lacking the vast peat resources that were in fact characteristic of its ecology: would economic historians have explained its success in that scenario from the absence of wood and coal, which made it necessary to develop an efficient import trade of those commodities from Norway, the Baltic or (northern) England? The point is, that the fact that a resource is available in itself cannot explain much. Drenthe, for example, the most ‘backward’ province of the Netherlands, had vast resources of peat, but these remained undeveloped until Amsterdam merchants began to exploit them during the 17th century (and the province was hardly affected by those almost marginal ventures which did not change its predominantly agricultural structure). Nor can, in my view, the fact that a particular resource is lacking in itself explain much. Yet, nobody will deny that these stories are important for understanding the long term development of the economy of Holland. In this paper I, however, try to develop a new interpretation of the issue of the ecological constraints of early modern Holland by linking the two stories of food supply and energy supply (following the approach developed by Siefertle who shows that food is another form of energy).¹⁰ First I will focus on the

7 J.W. de Zeeuw, ‘Peat and the Dutch Golden Age. The Historical Meaning of Energy-Attainability’, in: *AAG Bijdragen*, 2 (1978) 3-32.

8 A.M. van der Woude, J. de Vries and Y. Hayami, ‘Introduction’, in: A.M. van der Woude et.al., eds., *Urbanization in History* (Oxford 1990) 1-20, 11-13.

9 M. van Tielhof, *The Mother of All Trades. The Baltic Grain Trade in Amsterdam from the Late 16th to the Early 19th Century* (Leiden 2002).

10 R.P. Siefertle, ‘Energie’, in: F.J. Brüggemeier, Th. Rommerlspacher, eds., *Beseigte Natur*.

emergence of Holland's economy during an 'ecological crisis' in the late Middle Ages; this is an attempt to re-interpret the relationship between a rather sudden and exogenous decline of the food supply in the period 1350-1450, and the emergence of a modern economy in this period. In the third section this story is continued, and the development of food supply – in particular grains – in the 1500-1800 period is sketched. Finally I will turn to the role of peat, and I will argue that it was perhaps more limited (during the 17th and 18th century) than much of the current literature suggests. Throughout the paper the focus will be on Holland, because this was by far the most dynamic and atypical province of the Netherlands. Many of the results that will be presented here, are based on a project to reconstruct the historical national accounts for this region between 1510 and 1807; the paper also makes it possible to evaluate some of the results of this project against the background of current debates on the early modern economy.

2. The emergence of the economy of Holland 1350-1500

In the late Middle Ages the Dutch economy underwent a very radical transformation of its structure. Perhaps the best proof of this is a view at the economic structure of Holland at the beginning of the 16th century (see table 1). Only about a quarter of the labour force was active in agriculture, and this sector supplied less than 20% of GDP, an astonishing low share for a 'pre-industrial' economy. Other parts of the primary sector – in particular fisheries and peat digging – were also quite important, but the most dynamic and productive activities were in industry (a.o. textiles and beer brewing produced large quantities of exports) and in services (shipping and trade, again also catering for foreign needs).

The paradox of Holland's economic development in the late Middle Ages is that this precocious structure was to a large extent the result of an ecological crisis, a relatively sudden contraction of agricultural output.

The starting point of this story is the year 1350, when the structure of the economy of Holland was still rather 'normal': its countryside was dominated by an agricultural sector which more or less catered for the needs of its population, the cities (with about a quarter of the population) exported beer and textiles but in much smaller quantities, and shipping and international trade were small to virtually non-existent.¹¹ The share of agriculture in the total labour force can be estimated at about 50 to 60%, which is not unusual for an early modern economy. Already during the second half of the 14th century this economy underwent a deep

Geschichte der Umwelt im 19. und 20. Jahrhundert (München 1989) 20-42; idem, *The Subterranean Forest*, op. cit.

¹¹ H.P.H. Jansen, *Hollands Voorsprong* (Leiden 1976).

Table 1. *The occupational structure of the labour force and the structure of GDP in Holland in 1510/14 (in percent)*

	Labour Force	GDP
Agriculture	24	19
Fisheries	12	9
Peat Digging	3	3
Primary Sector	39	31
Construction/dikes and dams	5	[16
Woodworking/metal industry	9	
Leather working	1	1
Textiles	11	9
Clothing	5	2
Brewing	3	4
Other food	4	6
Industry	38	39
Trade	8	[21
Transport	9	
Other services	5	9*
Services	22	30
Total	99	100

* includes housing services Source: J.L.van Zanden, 'Taking the Measure', 138.

agricultural crisis, which was caused by the erosion of its peat soils and the rise of (internal) water levels. This gradual erosion of the peat soils had already started after the large scale reclamations between 900 and 1300, which by draining them had made these soils suitable for arable agriculture, but at the same time set in motion a gradual decline of the level of elevation.¹² This fundamental ecological problem of late medieval agriculture on Holland's peat soils helps to explain the special path it followed. To begin with, special institutions were set up, the so-called *waterschappen* (drainage boards), to control water levels and improve drainage. After 1408, when the first windmill for drainage was erected, these institutions began to play a role in introducing this new innovation.¹³ But for some time to come the ecological forces were quite stronger than these institutional and technological responses, and the problem of worsening soil conditions aggravated.

12 P. van Dam, 'Sinking Peat Bogs. Environmental Change in Holland, 1350-1550', in: *Environmental History*, 6 (2001) 1, 32-45.

13 P. van Dam, *Vissen in veenmeren* (Hilversum 1998) 83.

Van Dam has recently suggested however that the 'weak' response to these 'ecological' challenges may be related to the high labour costs and the low grain prices in this period of 'agricultural depression'.¹⁴ The growing of bread grains (winter grains such as rye and wheat) became increasingly difficult because the problems with the high water level were especially acute during winter. Peasants switched to summer grains (which were an important input of the brewing industry), to cattle farming, to peat digging, to fisheries (first on the inland lakes, which expanded due to the growth of peat digging, then to the Zuiderzee and the North Sea) and other hunting and gathering activities ('vogelen', rabbit farming etc.).¹⁵ The basic story is therefore that the ecological problems in agriculture forced the peasants to develop new activities, many of which were linked to urban activities and international markets.

The ecological crisis has been documented well for the period 1350-1415 for the southern part of Holland by De Boer.¹⁶ New, unpublished research by Kronenberg on the yields of tithes in the border region of Holland and Utrecht, makes it possible to follow the crisis between the 1370s and the 1520s in some detail.¹⁷ Already in the second half of the 14th century yields in agriculture were characterized by huge swings, but an almost total collapse of yields occurred during the 1410s and 1420s, when the region was struck by a number of storms and floods, of which the most famous, the Elizabeth-flood of 1421, inundated large parts of the countryside of Holland, which were only partially reclaimed again afterwards. In the border region with Utrecht the net result of this was that arable output halved between the 1390s and the 1430s and 1440s, after which it stabilized again (Figure 1). A new crisis hit the countryside of Holland in the 1480s and 1490s, which is well documented from other sources (for example the *Enquete* of 1494, which was an inquiry into the difficult state of the province in this year).¹⁸

The decline of arable yields which occurred in large parts of Holland (with significant differences in speed and rate of decline), can be seen as an exogenous shock which set in motion a process of transformation of agriculture (towards livestock farming), the growth of non-agricultural activities on the countryside and the rapid growth of cities. The 'miracle' of what happened during the 15th century is that the deep crisis that occurred in the arable farming did not result in a strong decline of the population - by contrast, population numbers probably grew

14 P. van Dam, 'Het onderaardse bos in Engeland en Nederland', in: *Tijdschrift voor Sociale Geschiedenis*, 2002.

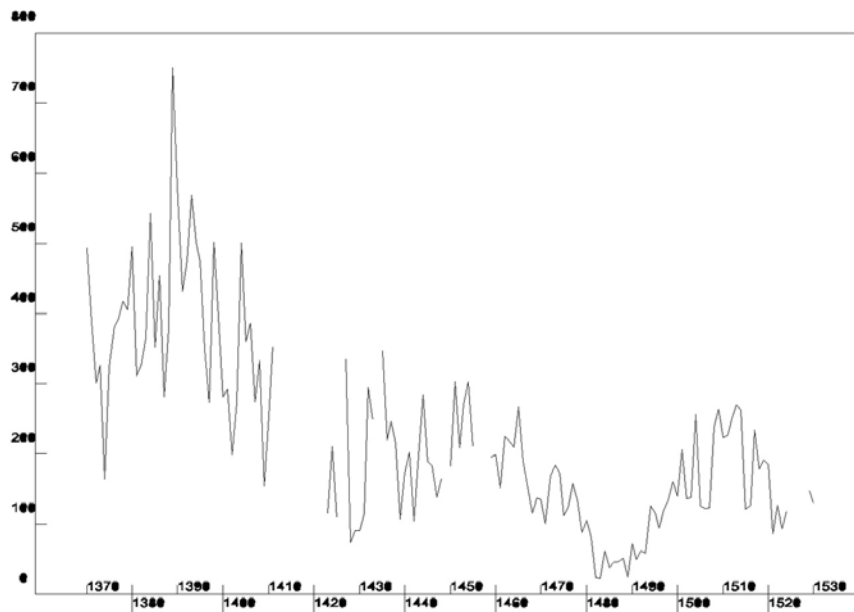
15 P. van Dam, *Vissen*, op. cit.; Idem, *Sinking Peat Bogs*, cit..

16 D.E.H. de Boer, *Graaf en grafiek* (Leiden 1978).

17 A.J.Kronenberg, *Tienden en landbouwproductie (14de-18de eeuw) in zuidwestelijk en noordoostelijke regio's van het Sticht van Utrecht*, unpublished manuscript University of Utrecht, 1997.

18 Also C. Lesger, *Hoorn als stedelijke knooppunt* (Hilversum 1990) 70-71.

Figure 1. *The yield of a number of tithes in the border region between Holland and Utrecht, 1370-1530 (deflated, in he. wheat)*



rapidly, in particular in the cities - but went together with an enormous expansion of the urban sector and of non-agrarian activities on the countryside.¹⁹ One way to look at this is that average and marginal productivity in the agricultural sector fell sharply after the 1370s, which would normally result in the contraction of output and perhaps a certain shift towards non-agricultural activities. But this 'forced' shift to other activities must have been accompanied with sharp increases in (marginal) productivity in the non-agrarian sector. What happened during the 15th century, the large increase in the output of beer, cloth, herring, and services for the international market, suggests that this 'forced' movement of labourers into these activities created learning effects, economies of scale and of specialization which made it possible to increase their productivity rapidly (i.e. the long run supply curve of non-agricultural activities seems to have been sloping downwards). Using imported technology from different sources (mainly the southern Netherlands and Germany), Holland's industry, fisheries and shipping sector became highly competitive and were able to gain access to foreign markets rapidly.²⁰ Holland

¹⁹ *Ibid.*, 60.

²⁰ Cf. N.W. Posthumus, *De Oosterse Handel te Amsterdam* (Leiden 1953) 172-211, for an overview.

ships and merchants came to dominate the Baltic trade; beer from Gouda, Delft and Haarlem conquered the markets of Flanders. Of course, the strong position in the Baltic was also based on the sharply rising demand for grains from the domestic market, but obviously the inhabitants of Holland found the means to pay for these rising imports. The flowering and continued expansion of the economy of the southern Netherlands played an important role in this process; it was fundamental for the success of the beer industry, and craftsmen and ideas from the south were important in the development of the fisheries and the textile industry. A more complete 'integration' of Holland with this more developed region only occurred during the first half of the 16th century, however, when also peat digging, cattle farming, the shipping industry and the trade of Amsterdam became closely intertwined with the Antwerp staple market.²¹

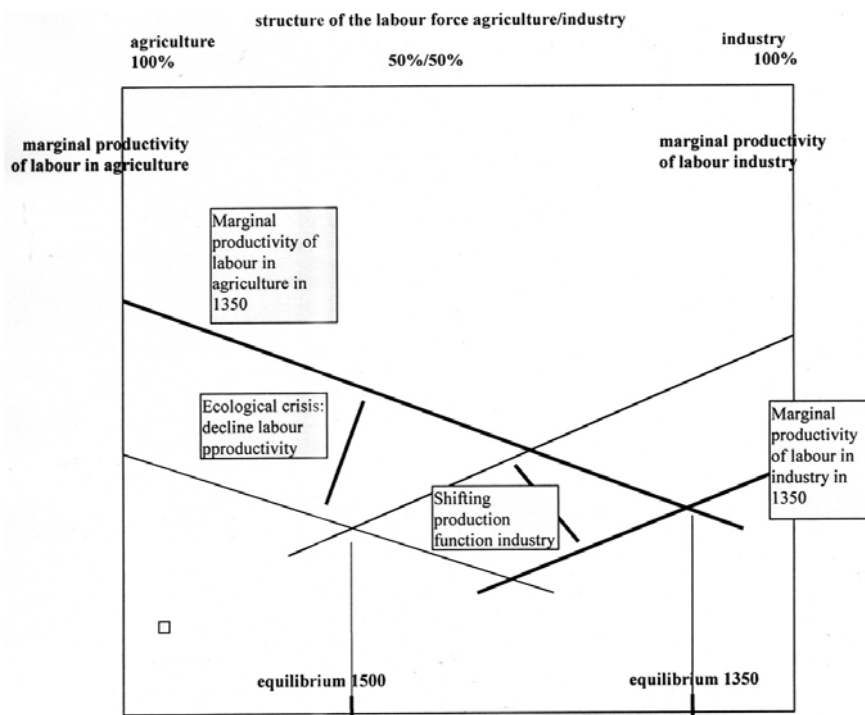
Figure 2 contains a schematic interpretation of the changes between 1350 and 1500. The structure of the labour force is represented by the horizontal axis, the vertical axis shows the marginal productivity of labour (in agriculture and industry). Labour productivity in the short run declines when the number of workers in a sector increases, and the structure of the labour force is determined by the level and slope of these two functions (derived from the underlying production functions). At the 1350 equilibrium agriculture dominates the economy. But between 1350 and 1500 two shifts occur: the 'ecological crisis' results in a decline in labour productivity in agriculture, but the shift to the industry leads to a strong increase in productivity outside agriculture (via learning effects, economies of scale etc.) as a result of which the marginal productivity of industry increases a lot. The end result is the new equilibrium of 1500. If the contraction of agriculture had not been followed by a strong increase in productivity in industry (and services, but for analytical reasons both sectors are taken together), marginal productivity and wages would have declined strongly between 1350 and 1500 (and the degree of transformation would have been much more limited). In fact, real wages went up during the 15th century, and were probably higher at about 1500 than in 1350, which could only be the result of a strong increase in productivity in the non-agricultural sector.²²

The structural transformation of the economy between 1350 and 1500 could also only be realized by changing the position of the Holland within the international economy. It became a large net-importer of grains during the 15th century (in 1510/14 about half of total grain consumption was imported, but also more than

21 Cf. J.L. van Zanden, *The Rise and Decline of Holland's Economy* (Manchester 1993) for more details.

22 Cf. J.L. van Zanden, 'A Third Road to Capitalism?' in: P. Hoppenbrouwers and J.L. van Zanden, eds., *Peasants into farmers? The Transformation of Rural Economy and Society in the Low Countries (Middle Ages-19th Century) in Light of the Brenner Debate* (Turnhout 2000) 85-102.

Figure 2. *The relationship between the marginal productivity of labour in agriculture and industry and the structure of the labour force (changes in Holland between 1350 and 1500)*



50% of this consumption was used in the brewing industry, which exported about 55% of its output – more than one quarter of total consumption was therefore re-exported in the form of beer), and these imports were paid for by large exports of herring, textiles, beer, and shipping services. These industries therefore had to get an increasing share of exports markets. This was not based on the low level of wages (as far as we can tell wage levels in Holland were on par with those in Flanders), but must have been based on a superior institutional infrastructure and organization of the economy.²³

23 For evidence on this point, see J.P.B. van Bavel, 'Early Proto-Industrialization in the Low Countries? The Importance and Nature of Market Oriented Non-Agricultural Activities on the Countryside in Flanders, Guelders and Holland, c. 1250-1570' in: *Revue Belge de Philologie et d'Histoire*, 81 (2003).

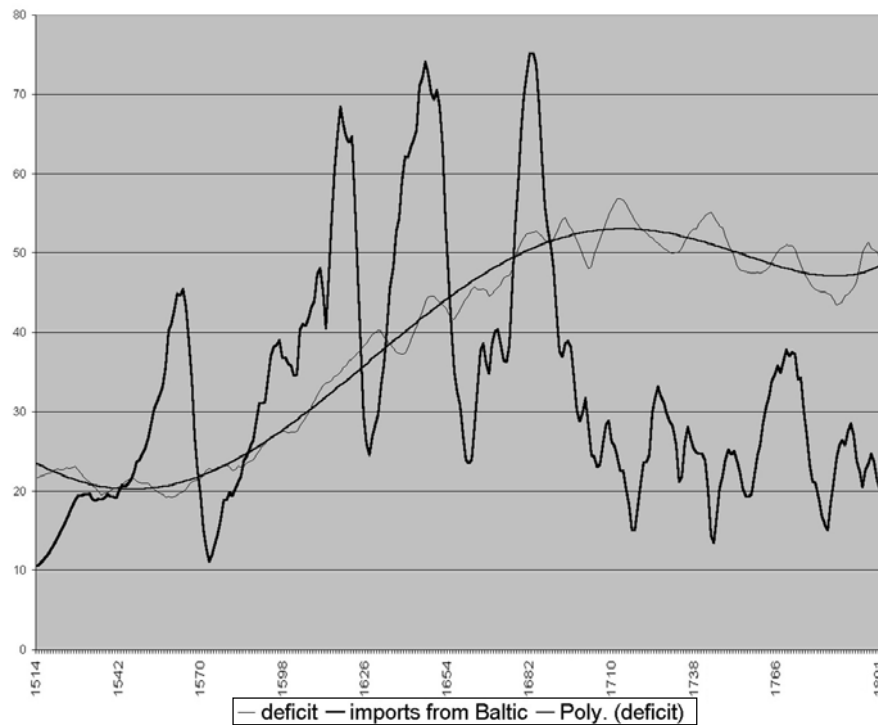
3. The grain economy 1500-1800

In sum, the economy of Holland had broken through the ecological ceiling by specializing on products of which the (long term) production function was characterized by increased returns to scale, and which used large amounts of (specialized) labour and capital, but no land. At the same time it became dependent on the supply of grains from abroad, which, at about 1500, in particular meant northern France and the Baltic. This was quite a unique phenomenon: it is not easy to find a previous example of a highly developed/urbanized economy totally dependent on markets and imports for its food supply. But the end-result of this transformation was an economy with a much higher level of GDP per capita (than in 1350, or than its 'less developed' neighbours) which showed a remarkable degree of dynamism. Moreover, the economic expansion during the 16th and 17th centuries – the period of the Golden Age – can in my view be interpreted as an extension of the growth path set in after 1350. Between 1500 and 1670 the Dutch economy managed to increase productivity in its most dynamic sectors, and to position itself increasingly into the core of the international economy, specializing on high-productivity activities such as finance, trade, shipping, and high-value, often port-related industries (such as diamond-cutting, sugar refining, and gin distilling). What changed after 1500 was that the agricultural sector was able to respond more positively to the pressures from the growing demand from the cities: investment in agriculture went up rapidly, in particular after 1580, drainage was improved, lost land was reclaimed, and output and productivity of the primary sector expanded too.²⁴ Yet population growth accelerated even more after 1580, and the gap between internal supply of grains and domestic demand increased (see figure 3). But imports from the Baltic rose even more dramatically during the 16th century (whereas imports from other countries, such as France, declined in absolute and relative terms). The economy of Holland therefore became increasingly dependent on the Baltic supply, but this was quite elastic, and Amsterdam could from the 1540s onwards (when it began to play a role in the provisioning of the cities of Flanders and Brabant – Antwerp in particular) become the most important centre of the European grain trade.

Figure 3 summarizes the main trends of the grain economy of Holland. The net deficit rose from about 20.000 lasts during the first half of the 16th century to about 50.000 lasts after 1670; they can be compared with the huge swings in Baltic imports which between the 1530s and the 1670s were grosso modo more than sufficient to cover the deficit, although during some war periods, such as the early 1570s, the blockade of the Sont, or of Amsterdam, led to a sharp decline in imports. Between 1540 and 1565, and during the 'long' 17th century (1590-1690)

24 The classic study is J. de Vries, *The Dutch Rural Economy in the Golden Age, 1500-1700* (New Haven 1974).

Figure 3. *The grain deficit of Holland and the imports from the Baltic, 1514-1807 (in thousands of last, nine-years moving average)*



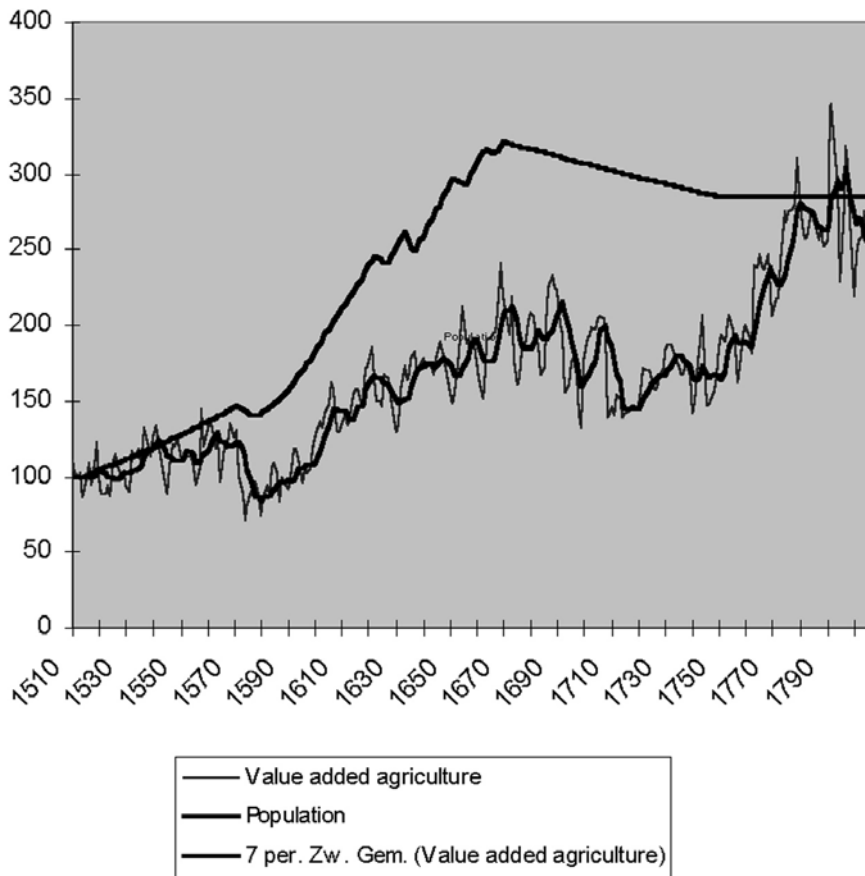
Baltic imports exceeded domestic deficits by a substantial margin, and large re-exports from Amsterdam occurred. The most famous (and profitable) were perhaps the large scale exports to the Mediterranean between 1590 and 1620. After 1690 the picture changes dramatically: demand for Baltic grains declines sharply due to rising exports from England and the province of Zeeland (which is estimated to export about 20.000 lasts annually after about 1670).²⁵

The increasing deficit of Holland is also evident from a comparison of the evolution of the population and the growth of agricultural value added (figure 4).²⁶ In

25 Cf. Van Tielhof, *The Mother of All Trades*, op. cit.

26 The estimates presented in figures 3, 4 and 5 are preliminary results of a project to reconstruct the regional accounts of Holland between 1510/14 and 1807; see J.L. van Zanden, 'Taking the Measure of the Early Modern Economy. Historical National Accounts for Holland in 1510/14', in: *European Review of Economic History*, 6 (2002) 131-63 for the first published results of the project.

Figure 4. *Indices of the population and the real value added of the agricultural sector (1510/14 = 100), 1510-1807*



spite of the large changes that occurred in this sector between 1500 and 1700, it was unable to keep pace with the rapidly growing population, in particular in the period after the Revolt of 1572.²⁷ During the 18th century the gap between population and food supply narrowed again, but Holland remained dependent on imports from overseas (although, much like in the 16th century when more than half of

27 J.L. van Zanden, 'A Third Road to Capitalism?' in: P. Hoppenbrouwers and J.L. van Zanden, eds., *Peasants into farmers? The Transformation of Rural Economy and Society in the Low Countries (Middle Ages-19th Century) in Light of the Brenner Debate* (Turnhout 2000) 85-102.

imports were re-exported in the form of beer, in the 18th century a large part of imports was used to manufacture a product that was exported, i.e. gin).

It can be concluded that the economy of Holland continued to solve the ‘problem’ of the short supply of foodstuffs by concentrating on other (export-oriented) activities. Thanks to the favourable position it had manoeuvred itself into during the 15th century as a large scale exporter of services and industrial products, it could buy as much grains as it needed.

4. Energy supply

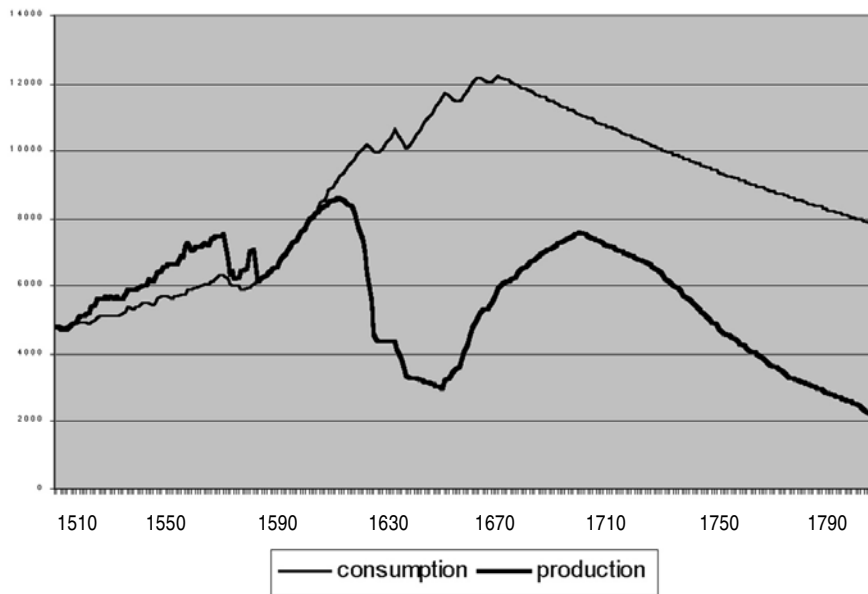
In section II it was argued that the negative supply shock during the 1350-1450 led to the growth of non-agricultural activities on the countryside, and fuelled the expansion of the cities. One of the most dynamic branches that developed rapidly in this period was peat digging, and the cheap supply of low cost peat was without doubt an important factor behind the rapid expansion of a number of export industries in this period (in particular beer brewing was relatively energy intensive, but other sectors such as brick making and salt production must also have profited from it). This was, however, not a completely new development: the big Flemish cities had already in the 13th and 14th centuries been dependent on nearby peat supplies; when these dried up, they began to develop new sources of peat in neighbouring Brabant. In the course of the 16th century Flemish entrepreneurs expanded their supply area, and developed large scale projects of peat extraction in parts of northern Brabant and Utrecht (near present day Veenendaal).²⁸ At the same time, Holland also began to export large quantities of peat to this southern destination.²⁹

The example of the Flemish cities shows that peat was a non-renewable source of energy, which – much like coal – was geographically concentrated in large quantities, and of which the exploitation would, in the long run, result in the exhaustion of these supplies. Yet, it was feasible to import peat from relatively large distances, provided that waterways connecting the production and consumption centres were already present or could be constructed profitably (the most important expenditure of the projects directed at the exploitation of new peat resources was the construction of a canal for the transport of the peat). In Holland as well, the most accessible layers of peat were becoming relatively scarce during the 15th and early 16th century (according to the Ricardian logic that the most ‘productive’ sources of peat will be exploited first). In Flanders new techniques for the exploitation of peat layers below the water surface had been developed to cope with this problem,

28 T. Stol, *De veenkolonie Veenendaal. Turfwinning en waterstaat in het zuiden van de Gelderse vallei 1546-1653* (Zutphen 1992).

29 W.J. Diepeveen, *De vervening in Delfland en Schieland tot het einde der zestiende eeuw* (Leiden 1950).

Figure 5. *The long term trends in the production and consumption of peat in Holland 1510-1807 (in 1000 peat-tons)*



which were further refined in Holland during the first half of the 16th century. This (and the growing demands from the south) led to a renewed growth of peat production and exports after about 1530.

During the rapid expansion of the Dutch economy in the first half of the 17th century new sources of peat were developed in the northern part of the country – in Vollenhove (the northern part of Overijssel), Drenthe, Friesland and Groningen. In particular the crisis in the peat supply during the 1620s, when peat production fell dramatically, led to a sharp increase of supply from outside Holland and Utrecht (figure 5; the ‘gap’ between production and consumption consists of imports from the northern part of the country). In this way the shift of peat extraction to the north, that had begun already in the 15th century (when Flemish supplies began to run short), continued. De Zeeuw estimated that during the 18th century more than half of total peat production came from outside Holland and Utrecht, the ‘old’ core region.³⁰ My estimates (which are also based on the production estimates of Gerding) suggest that during the second quarter of the 17th century peat from the north dominated the market, but that after 1650 northern supplies began to de-

30 J.W. de Zeeuw, ‘Peat’.

cline, and peat from Holland became predominant again.³¹ During the 18th century (when a gradual switch to coal in certain key industries resulted in a strong decline in demand) production in Holland contracted again, and the north strongly increased its market share. Thus, strictly speaking, the economic ‘miracle’ of Holland during the first half of the 17th century was to a large extent based on imported peat.

The shift of the peat industry to the north did not lead to a strong relative rise in the price of this source of energy. In comparison to the consumer price index – a weighted average of all prices (and rents) – peat prices declined somewhat, which does not point to serious bottlenecks in its production (see figure 6).³² At the beginning of the 19th century there still existed large, almost ‘empty’ regions in the northern part of the country with vast resources of peat, from which cheap exploitation was still possible and feasible. But also in the old core region of peat exploitation, in Utrecht and Holland, substantial reserves of peat were still available for exploitation.

The issue in much of the literature about the role of peat in Dutch economic development is that it was a relatively cheap source of energy, which gave Holland a clear competitive edge over other nations. On the basis of the available information on peat and coal prices I have shown in another paper that this is not obvious relative to Britain. Per unit of energy peat in Leiden was probably more expensive than coal in southern England (i.e. London or Cambridge); the difference amounted to about 25% in 1620-1639.³³ Because of higher transport costs and English export taxes, coal was still more expensive in Holland than peat, but this gap declined gradually (during the first quarter of the 19th century peat was still cheaper than coal, however, but now import taxes on coal to protect the Belgian coal industry and Dutch peat digging increased the relative price of coal in Holland). During the early modern period per capita energy consumption in Holland was also less than in England, which also points to the fact the possession of peat did not give rise to significant comparative advantages.³⁴

Moreover, peat was a technological dead end. The production process consisted of relatively simple forms of unskilled labour, and the branch did not have strong backward or forward linkages (perhaps the exception are the canals that were constructed, which could open up new regions). Labour productivity probably stagnated in the long run (the relative price of peat versus labour increased in the 16th century and again in the 18th century, which does not point to significant increases

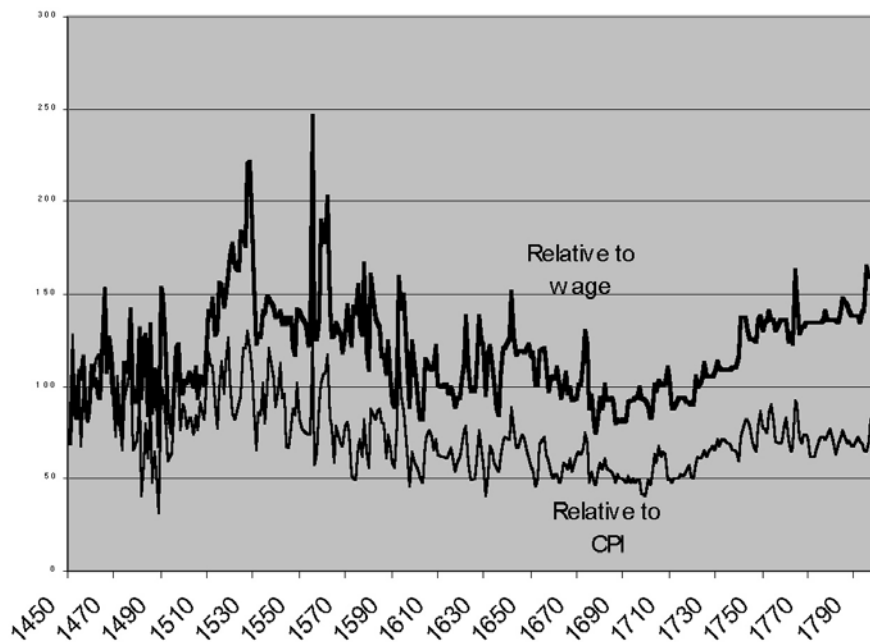
31 M.A.W. Gerding, *Vier eeuwen turfwinning. De verveningen in Groningen, Friesland, Drenthe en Overijssel tussen 1550 en 1950* (Wageningen 1995).

32 Source: the data base on prices and wages in Holland between 1450 and 1800 was put on the internet by the author: see www.iisg.nl/hpw

33 J.L. van Zanden, ‘Werd de Gouden Eeuw uit turf geboren?’, in: *Tijdschrift voor geschiedenis*, 110 (1997) 484-499, 496.

34 *Ibid.*, p. 495.

Figure 6. *The price of peat relative to the CPI and to the wage of an unskilled labourer in construction (1450/74=100)*



in labour productivity; see figure 6). Because the economy of Holland was focused on the use of peat, economic ties with the coal producing regions (Newcastle, the 'Belgian' Meuse-delta) remained underdeveloped, and the coal market stagnated relatively to the well developed market of peat. This became a serious handicap during the 19th century, and retarded the rise of 'modern', coal-based industry.³⁵ The one-sided focus on peat is therefore a fine example of the 'penalties' of the pioneer.

The (other) major drawback of peat exploitation in the low parts of Holland and Utrecht was that it literally destroyed the land. Already during the first phase of its expansion – between 1350 and 1500 – this led to the growth of internal lakes and the decline of the land under cultivation. Government regulations to limit the damage were undermined by corruption, which shows how large the profits involved in peat digging were. In the core region of southern Holland and Utrecht, large lakes came into existence as a result; in particular the Haarlemmermeer became a growing threat to cities like Haarlem and Leiden. In several ways did the state try

35 J.L. van Zanden and A. van Riel, *Nederland 1780-1914. Staat, instituties en economische ontwikkeling* (Amsterdam 2000).

to limit the process of land destruction – by taxing peat extraction (and exports), by restrictions in ‘sensitive’ areas (i.e. close to the cities and strategic roads), and by forcing entrepreneurs to put aside money for the drainage of the lakes after the peat had been taken away. During the first centuries of intensive exploitation (1350-1650) these measures were hardly successful, and the growing importance of the industry did much harm to the countryside. The first drainage of a peat lake occurred in 1648, and some followed during the third quarter of the 17th century. Only after 1750, however, when grain prices began to move up again, were a number of large lakes drained to create new polders for agricultural use; the most notorious lake, the Haarlemmermeer, could not be drained before the mid 19th century. Before about 1650 however, the ecological consequences of peat exploitation were the expulsion of men from the countryside, the loss of agricultural land and the contraction of the tax basis of the state.³⁶

5. Conclusion

How did the Dutch Republic c.q. Holland break through the ecological ceilings of the pre industrial economy? The answer formulated in this paper is that the fact that it possessed one specific resource (peat) or lacked another (grain) was not fundamental for its success. The fact that the countryside of Holland consisted to a considerable extent of peat soils was relevant, but peat, or any other source of energy (wood or coal), could also be imported from other regions as the Flemish example shows, and was done to a considerable extent after ‘domestic’ peat supplies began to decline. When Holland, during the late medieval crisis, was severely hit by a true ‘ecological crisis’ – when the supply of grains fell sharply due to changes in its ecology – it reacted in a similar way: it began to buy its foodstuffs elsewhere, in return for industrial products and services – goods that did not compete with grain for land. This early specialization on industry and services is the true miracle of Dutch economic history: how could peasants – and others – trust markets that much that they were prepared to become completely dependent on them for their supply of foodstuffs? This assumes that markets had already acquired a degree of robustness, of ‘modernity’, that made it possible to rely on them as much as the inhabitants of Holland did. By taking this course, the economy of Holland became part of the ‘core’ of the European/World economy that was developing in the 15th and 16th centuries. The rules of the game for countries that were part of this core, were quite different from those of the peripheral regions. It is likely that in the latter ecological ceilings still constrained the development of the economy. A region that could specialize on industry and services was, however, not restricted in its development path by these constraints.

36 Van Dam, *Vissen in veenmeren*, op. cit.