On the road to modern economic growth: the Holland economy, ca. 1510-1807

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Abstract

Much discussion has centered round the question whether Early Modern Holland indeed had factors characterizing it as the "First Modern Economy" as suggested by De Vries and Van der Woude (1998). Clearly, Holland was no longer a Malthusian society, economic growth and population growth going hand in hand, combined with relatively efficient institutions.

In this paper we use a newly available dataset with annual estimates of GDP, physical and human capital to test the interrelations among these variables and find out if Holland indeed departed from the Malthusian trap from the 16th century on. We find evidence of the importance of physical capital for economic growth, but only limited evidence for technology. This suggests that human capital did little to enhance growth directly. It did work through physical capital though: more capital leads to more human capital. This suggests a strong effect of factor substitution as found in the 18th century. We also found that higher human capital leads to a lower fertility as argued in much of the (unified growth) literature.

In sum, we found that the economy was not modern in its production structure: technological development, and relatedly, human capital were not causing economic development. However, the increased welfare from investments and trade led to increasing capitalization, factor substitution, which increased human capital levels as well. This in turn decreased fertility.

1. Introduction

Since the seminal work of De Vries and Van der Woude (1998) in which they posed the thesis that Holland was the "first modern economy", much discussion is going on about the character of early modern economies (e.g. Mokyr 2009). In this discussion, most economic historians would agree that 'modern economic growth' – as defined by Simon Kuznets (1966, p. 1) as the sustained increase of income per capita, accompanied by shifts in the structure of the economy – began with the British Industrial Revolution of the second half of the 18th century. Kuznets (1966, p. 10) himself was explicit about this, and a lot of the research carried out by scholars working on historical national accounts suggests the same: in large parts of Western Europe, long term economic growth began during the first decades of the 19th century. [1] Only in England it probably started at some point in the 18th century, but before the 1830s growth was still quite slow (less than 0.6 percent per capita per year).

There is problem with this view, however. Kuznets' definition links two changes in the economy – per capita growth and structural change – that are not necessarily the same. In fact, as has been discussed in some detail by Crafts (1985, p. 115ff), the development path of the pioneer of 'modern economic growth', England, had already been before 1800 characterized by relatively large structural changes in the composition of the labour force (see also Shaw-Taylor and Jones, 2009a; Shaw Taylor and Wrigley 2009b) and of GDP (Broadberry et al. 2009), whereas the increase of real income had been rather limited. He explained this 'mismatch' between growth and structural change as the result of (amongst others) the special features of English agriculture, which was increasingly concentrated in large farms using wage labour, which lead to a strong economizing on labour in the agricultural sector.

Hence, from the British evidence it seems that growth slowly started to increase in the 16th century (Broadberry et al. 2009) while structural change only took off during the industrial revolution. This evidence suggests that the structure of growth in this phase before the industrial

[1] The best summary of the quantitative work on this in Maddison (2003).

revolution is probably different from both modern economic growth and the old Malthusian-type (not Malthusian as such) societies. Indeed, De Vries and Van der Woude (1998, pp. 693-710) arrived at their conclusion that the Dutch economy already during the 17th century generated a first wave of 'modern economic growth', resulting in substantial gains in income per capita and in real wages, only by using a much broader definition of modernity including to the role of government, institutions, as well as pointing to the substantial increases of real incomes that must have occurred during the Dutch 'Golden Age' (De Vries and Van der Woude 1998, p. 693). They however also conclude that economic growth stopped after 1670, and that the phase of expansion was followed by a possible decline of income per capita, which is probably problematic from point of view of Kuznets' definition. Therefore, they argued that the post 1670 crisis was not a traditional, Malthusian crisis, caused by overpopulation and scarcity of agricultural resources (and foodstuffs), but a modern crisis, the result of overproduction (De Vries and Van der Woude 1998, p. 698).

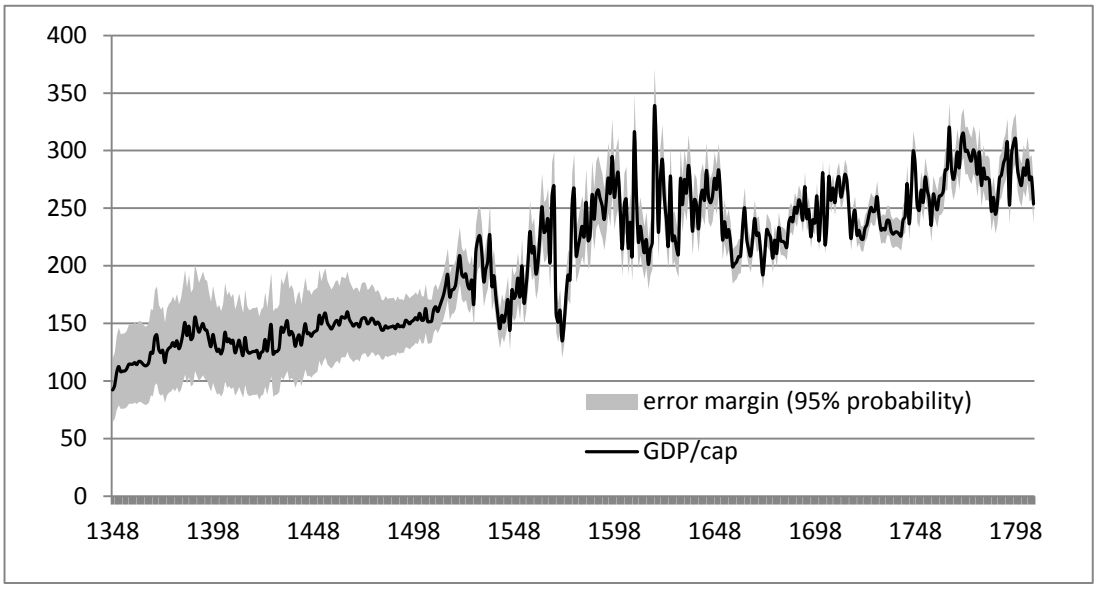
The problem we try to deal with in this paper is: did the economy of Holland generate a process of 'modern economic growth' in the early modern period, or was its growth another example of pre-modern growth that could only exist for a limited period of time? How important were 'modern' drivers of economic growth such as technological change and the accumulation of human and physical capital? And how was the relationship between structural transformation and economic growth?

2. The Holland economy

Research has been based on various indirect indicators of economic performance. 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, which pointed at a serious decline in demand for inter-city transport in the 1670-1750 period (De Vries 1981). His study appeared to confirm the long cycles known from the demographic history of the region, with peaks in

performance during the 1660s and 1670s, and sharp declines of income levels in the first half of the 18th century. His view on the 18th century was more pessimistic than that of Johan de Vries (1968) in his thesis on the Dutch economy in the 18th century, who concluded that until the 1780s the level of economic activity more or less remained stationary. The only author pleading for continued economic growth during this period was James Riley, who tentatively suggested that there may have been continuous growth during the 18th century (Riley 1984).[2] This view has been criticized by almost all participants in the debate.[3] However, recently it has been argued that per capita GDP growth indeed continued also in the 18th century: Van Zanden and Van Leeuwen (2011) present an

Fig. 1 Per capita GDP (1800 constant guilders, including error margins)



estimate of per capita GDP that shows continuous, albeit rather volatile growth, over the entire period between 1347 and 1807 (see Figure 1).

A related debate focuses on how dynamic the Holland economy actually was. How strong was growth in the late-medieval period; did Holland go through a late-medieval crisis – and if so,

[3] See Van Zanden (1987) for an overview.

what was its nature? Do we see almost continuous economic expansion between 1350 and 1500, as has been suggested by Van Bavel and Van Zanden (2004)? This latter seems to be the case if we look at Figure 1. A similar discussion also takes place about the Holland economy before and during its take-off during the Golden Age.

The discussion summarized here suggests that Holland is an excellent case study for an analysis of the roots of the process of modern economic growth. It was undoubtedly one of the most dynamic parts of Europe in the centuries before 1800 and did, as demonstrated by De Vries and Van der Woude (1998), already have a relatively modern institutional framework. This article sets out to explore these issues and test ideas about the growth performance of the economy of Holland in the early modern period. What was the character of the 'modern economic growth' that already started in the Netherlands way before the Industrial Revolution? Can we describe it as modern, sustained growth, or rather Malthusian type or some sort of combination?

3. A model of the Holland economy

The data for this analysis are taken from Van Zanden and Van Leeuwen (2011). The estimated a extensive set of GDP estimates between 1510 and 1807 for Holland. In the same paper they also provided estimates of population, average years of education and the residential physical capital stock.

Using these data, we estimate a macroeconomic model, consisting of four equations. In all equations we use dynamic specification (ARX) for two reasons. Firstly, dynamic specifications are immune to the problem of spurious regression (the residuals are all stationary). Secondly these relationships are better modelled dynamically, that is, changes in factors or shocks in error terms should have an effect exerting itself over more than a single period. Capturing this dynamism improves the explanatory power of the model.

The first equation represents the production or real income per capita. Here we assume a Cobb- Douglas technology:

$$\ln y_t = \ln A_t + \beta_{11} \ln y_{t-1} + \beta_{12} \ln k_t + \beta_{13} S_t + u_{1t} \quad (1)$$

where *y* and *k* denote the per capita income and capital stock, S is the average years of education (which is used as a proxy of human capital stock per person). *A* represent the Total Factor Productivity, which we approximate by a loglinear time trend as follows: $\ln A_t = \beta_{10} + \beta_{14} \cdot t$. If there were any systematic improvement in productivity during the sample period, α_4 should yield a significant coefficient. u_{1t} is an error-term, with the usual assumptions.[4]

While we expect capital stock in regression 1 to yield a positive, significant coefficient, our expectations are more ambivalent in case of education. Whether education should have a positive impact on per capita income depends strongly on the structure of economy. We should expect a positive impact in case of a technology intensive economy, where more educated workers are needed in order to learn new technologies and operate machinery. But prior to Industrial Revolution, the role of human capital may have been very different from our modern age concepts.

The second equation captures the process of capital accumulation. We also allow for a possible effect of human capital accumulation here. The motivation for this is a possible trade-off between investments in capital (savings) and investments in education. Such a relationship may arise from a dynamic optimization as put forward by Barro and Sala-i-Martin (1995). Since both types of investments come at the expense of foregone consumption, one can expect that at optimum the representative agent is going to choose both stock of human capital so that their marginal utility equalizes.

[4] The area of cultivated land is strongly correlated with the linear trend (a simple deterministic trend model of the logarithm of cultivated area yields an R-squared of 0.917) so its inclusion would cause a strong multicollinearity (and, what is the same, it would be redundant). In an alternative specification we use the log of land area while omitting the time trend, but the results did not change significantly, and the land coefficient is not significantly different from zero.

$$\ln k_t = \beta_{20} + \beta_{21} \ln k_{t-1} + \beta_{22} \ln k_{t-2} + \beta_{23} \ln y_t + \beta_{24} S_t + \beta_{25} \Delta \ln pop_t + u_{2t} \quad (2)$$

where $\Delta \ln pop_t$ approximates the growth rate of the population, and u_{2t} is the error term.

The third equation describes the accumulation of human capital (or rather that of education), this is assumed to be affected by per capita income and capital stock.

$$S_t = \beta_{30} + \beta_{31} S_{t-1} + \beta_{32} S_{t-2} + \beta_{33} \ln y_t + \beta_{34} \ln k_t + u_{3t} \quad (3)$$

where u_{3t} is the error term. Here we expect the capital stock yields a positive, significant coefficient, for the same reason as in the second equation.

And finally the fourth equation captures the interaction between population growth and economy. It incorporates the effect of income on fertility and mortality, which plays a crucial role in the Malthusian model, but also allows for an effect of human capital endowment on the number of offsprings as suggested by the Unified Growth Theory by Galor (2011).

$$\Delta \ln pop_t = \beta_{40} + \beta_{41} \ln pop_{t-1} + \beta_{42} \ln pop_{t-2} + \beta_{43} \ln y_t + \beta_{44} S_t + u_{4t}$$

where u_{4t} is an error-term. The Malthusian logic implies that higher per capita income leads to a growth of population (β_{43} should be significant and positive), but if more education indeed leads to less children, β_{44} should be negative and significant.

In this system there is simultaneity, which causes OLS being biased and inconsistent. In order to take care of this we apply a GMM estimation procedure with predetermined variables as instruments. Using the Hansen test of over-identifying restrictions it cannot be rejected at any conventional level of significance that our instruments are valid (not endogenous themselves). The results from the OLS are not very different than the GMM estimates, but the latter are consistent in the presence of simultaneity, so we prefer those results.

Table1 Results from system estimation, GMM

	lny	lnk	S	Δlnpop
const	2.28 (8.05)	0.03 (0.95)	0.03 (1.91)	-0.01 (-0.72)
lny_t	-	-0.0096 (-1.61)	-0.005 (-1.51)	0.005 (1.68)
lny_{t-1}	0.61 (13.5)	-	-	-
lnk_t	0.19 (2.41)	-	0.005 (3.24)	-
lnk_{t-1}	-	1.72 (28.4)	-	
lnk_{t-2}	-	-0.73 (-12.6)	-	
S_t	0.01 (0.14)	0.007 (5.04)	-	-0.002 (-1.94)
S_{t-1}	-	-	1.80 (56.3)	-
S_{t-2}	-	-	-0.80 (-24.7)	-
$\Delta lnpop_t$		0.296 (3.52)	-	-
$lnpop_{t-1}$	-	-	-	0.77 (21.0)
$lnpop_{t-2}$	-	-	-	-0.77 (-21.0)
trend	-0.00001 (-0.02)	-	-	-
R^2	0.565	0.997	0.999	0.777
residual ADF test p-value	0.000	0.000	0.000	0.000
residual Q-stat (2), p- value	0.634	0.188	0.060	0.030
instruments	lny_{t-1}, $lnk_{t-1,}$ $lnk_{t-2,}$ S_{t-1}, S_{t-2}, $lnpop_{t-1}$, $lnpop_{t-2}$, $\Delta lnpop_{t-1}$			
Sargan-test of overid. restrictions	0.0475 (df=11) (p=0.999)			

N=256

We also report the results from OLS for comparison:

Table 2 Results from system estimation, OLS

	lny	lnk	S	Δlnpop
const	2.22 (3.35)	-0.036 (-1.60)	0.033 (2.60)	-0.013 (-1.25)
lny_t	-	0.003 (0.75)	-0.005 (-2.33)	0.005 (2.75)
lny_{t-1}	0.612 (12.2)	-	-	-
lnk_t	0.17 (1.58)	-	0.006 (1.72)	-
lnk_{t-1}	-	1.69 (38.1)	-	
lnk_{t-2}	-	-0.71 (-16.5)	-	
S_t	-0.013 (-0.19)	0.004 (2.22)	-	-0.002 (-2.41)
S_{t-1}	-	-	1.80 (49.2)	-
S_{t-2}	-	-	-0.80 (-21.9)	-
$\Delta lnpop_t$		0.019 (0.24)	-	-
$lnpop_{t-1}$	-	-	-	0.78 (20.0)
$lnpop_{t-2}$	-	-	-	-0.78 (-20.0)
trend	0.0002 (0.38)	-	-	-
R^2	0.579	0.997	0.999	0.778
ADF test p-value	0.000	0.000	0.000	0.000
Q-stat (2), p- value	0.540	0.095	0.061	0.032

N=256

Looking at the first equation, we find no evidence in favour of any long-run, monotonous change in the total factor productivity. Since this should happen either as a result of profound institutional changes, or a stable productivity improvement due to innovations, this result is not surprising at all. Capital seems to play a role in the production process, its long-run effect can be calculated as 0.19/(1-0.61)=0.311, which is close to the generally assumed value of one-third in modern economies. This is an indication that capital was an important factor of production in the

early modern Holland, but should not be understood as the effect of capital stock only. Our specification does not capture all possible factors of production while capital is surely correlated with these, and the effect of omitted variables are also included in the coefficient. Neither is it surprising that the average years of education does not yield a significant coefficient, meaning that we are very uncertain if education had any impact on per capita income directly.

The production function holds no surprises: it reflects what one expects in an early modern economy, with expanding capitalist sectors, but prior to Industrial Revolution.

The second equation (capital accumulation) suggests that even though per capita income has no effect on capital stock, both the growth of population and education has a positive impact on the growth of per capita capital stock. If the autoregressive coefficient added up to a number between -1 and 1, we should conclude that an increment of any of these factors had a temporary effect on the growth rate of capital stock, and causes an increase in the level in the long-run. This is not the case, however: adding up the autoregressive coefficients (1.71-0.73) yields a long-run coefficient close to one. That is, the process has a long-memory and the effect of innovations (or changes in the explanatory variables) does not fade away with time. More education led to a higher growth rate of physical capital, and so did an increase in population growth. The latter is possibly not so surprising, given that our capital stock contains residential capital as well.

The third equation can be interpreted in a similar way. The sum of the two autoregressive coefficient is again one, so the rest of the right-hand side variables have impact on the growth of average years of education. Strangely, per capita income has no significant effect, but the per capita stock of capital does yield a significant and positive coefficient. Higher level of capitalization in the economy caused a permanent shift in the growth of educational level.

The fourth equation tells us a story of a society that has already left the Malthusian epoch: higher income still causes population to grow, a feature crucial in the Malthusian model, but education already has a negative impact. More educated people chose to have less children, which is

more characteristic of the demographic transition, usually set at the second half of the 19th century. Still, we find evidence that such a substitution between the quality and the quantity of offspring appeared already in the early modern Holland.

4. Comparison with the literature

We find that economic growth between 1510 and 1807 was on average around 0.15% per annum. It needs no explanation that this growth was much lower than the ca. 0.6% that took place in the 19th century. This suggests that the factors underlying this growth must have been less pronounced than for later periods. But what was driving this economic growth? The standard neoclassical model (Solow, 1956) does not even try to explain long-run growth but rather takes it as exogenously given. New growth theories essentially argue that human capital drives technological development (or the implementations of technology in the productive process). A more or less similar claim has been made by the Unified Growth Theories. They essentially argue that during the Malthusian era there was marginal growth of technology which required a small level of human capital. This led to a small increase in economic development until the point that the household budget constraint was relaxed. After that point, people started to invest more in education of their children (as well as restricting the number of children), which increased per capita income, which in turn again increased education making the whole process endogenous.

On first sight, this indeed seems to be true for Holland as well: average years of education increased slowly before the Industrial Revolution from 0.9 in 1564 to 2.1 in 1807 (Van Zanden and Van Leeuwen 2011) while in the 19th century for the Netherlands this growth went from ca. 2 in 1800 to over 6 in 1900 (Albers 1997; Foldvari, Van Leeuwen, and Van leeuwen-Li 2010). Likewise, as shown by Klemp and Weisdorf (2011) for Early Modern England, decreasing the number of children (by economic incentives) increases their literacy. However, equation 1 from Table 1 shows that education does not directly affect growth.

The lack of relation between human capital and economic growth stems from two sources. First, as argued by Mokyr (2009, 21), technological innovations did take place, but they were one-off events. Technological development, as we know it today, was still unknown and any technological development was rather a process of hit and miss. Such development thus hardly required much human capital. Nevertheless, the reason why some development in human capital did take place was because of socio-political reasons. Indeed, as argued by Galor (2005, 194) "[e]ducation was motivated by a variety of reasons, such as religion, enlightenment, social control, moral conformity, sociopolitical stability, social and national cohesion, and military efficiency. The extensiveness of public education was therefore not necessarily correlated with industrial development." Indeed, a similar argument has been brought forward in the educational sociological literature (e.g. Ramirez and Boli 1987; Boli 1989; Nuhoglu Soysal and Strang 1989).

This is not to say education did not play a role. Equation 4 says that population growth was driven by per capita income, a typically Malthusian trait, while education had a negative effect on population growth. The latter has also been argued by Klemp and Weisdorf (2011) who argue that higher levels of education reduce fertility (quality-quantity trade off).

It thus looks like physical capital accumulation was a main driver of per capita growth. However, human capital and population positively affected capital accumulation, so thise factor seems to have had an indirect effect on per capita income. The contribution of population to capital accumulation can be explained by the build-up of residential capital. More interesting is the positive effect of human capital. We find that a one-off rise in the stock of education permanently increases capital formation. It is possible that here we see another by-effect of the demographic transition in work: households with more educated parents spent more on their children, and had less offspring. Altogether these led to more savings, increasing physical capital stock.

The most interesting feature is that there was no similar effect: human capital increased physical capital growth, which increased temporarily the growth rate of per capita income, but the

latter did not affect human capital growth. This can be a prime candidate to explain why capital accumulation (in the wider sense, including both physical and human capital) could not trigger a self-sustaining process of economic growth.

5. Conclusion

In this paper we examined the growth patterns in Holland in the Early Modern period. What we find is probably the prototype of an economy that had just escaped the Malthusian-trap, but is not in the condition for sustained economic growth. We find that an increasing level of human capital already reduced population growth, placing one important pre-condition of take-off in place. Also, it seems that capital already played a fundamental role in economic growth, and human capital accumulation contributed to physical capital accumulation. What we fail to find is that per capita income directly affected human capital accumulation. Without this final link, economic growth was finally dependent on exogenous factors affecting human capital accumulation.

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