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The growth of capital: Piketty, Harrod-Domar, Solow and the long run development of the rate of investment

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> After considerable hesitation by many of our traditionally inclined and appropriately cautious colleagues, the desirability and feasibility of an integrated comprehensive system of national accounts, which includes a balance sheet as a necessary component, seems now to be generally accepted (R.W. Goldsmith, 1966).

Introduction

Piketty and Zucman use a concept of capital based upon the System of National Accounts (SNA) definitions which, like the concept used by Harrod-Domar and Solow, includes fixed depreciable capital, but which also encompasses 'land', 'natural resources' and financial capital. This makes it fit to estimate the flow of capital income including rents. Which is what Piketty and Zucman do: it's an income flow consistent concept. Unlike the Harrod-Domar model the ideas of Piketty and Zucman are not expenditure flow consistent as they do not contain an explicit link to measured investment expenditure and, therewith, the level of aggregate demand. A first step towards making the Piketty-Zucman concept of capital expenditure flow consistent is made comparing the long term historical flow of investment with the development of the stock of capital which shows that the 'U' shaped development of total capital, measured as a percentage of GDP, identified by Piketty and Zucman is inversely related to the rate of investment while the stock of depreciable capital – part of total capital - seems to show a slight positive relation with the rate of investment. A comparison with 'Piketty consistent' long term capital estimates for the Netherlands shows that the 'U' shaped pattern as well as the inverse relation with investment is robust. The declining part of the 'U' can be explained by technological and market developments in agriculture which caused a large decline of the value of agricultural land. The increase can be explained by increases of the price of land underlying buildings induced by money-creating lending and borrowing and is, i.e., inflationary. Neither the decrease nor the increase shows a large and direct connection with either 'r', or capital income and 'i', the rate of investment. Depreciable capital however does show a small positive relation with the rate of investment. The decrease and the increase are, however, connected with changes in the concept of capital and the distribution of wealth and power.

1. Growth theory and the concept of capital

The 'workhorse' concept of capital used in mainstream economics is largely based on growth theory and, therewith, limited to fixed depreciable capital. In 1946 Evsey Domar stated that a high rate of net fixed investment does not only lead to an increase of the stock of capital and therewith potential supply but also contributes to aggregate demand which, as investments increase potential supply, has to increase, too, to ensure full employment. As such, this was a clear and conscious attempt to write down an intertemporal stock/expenditure flow consistent model which related the (change of) the stock of capital to expenditure and potential as wel as

actual production as defined and estimated in the new national accounts (Domar, 1946).[1] Somewhat earlier, Harrod was less explicit about this but he, too, tied investment expenditure to the stock of capital, therewith connecting the demand side of the economy to the intertemporal development of the supply side (Harrod, 1939). In more modern parlance: Harrod and Domar used a 'perpetual inventory method' to estimate the macro stock of capital using the flow of fixed investment to estimate the stock of capital *as well as* to analyse aggregate demand in relation to potential output - an important theoretical step for economics. Domar as well as Harrod however used a restricted definition of capital as they only took depreciable fixed assets into account, though their method holds as well when non-depreciable and/or unproduced assets like 'land' or 'oil' are added to their stock of capital. They also discarded the liability side of the balance sheet as well as financial flows and stocks, which disabled a genuine analysis of the distribution of capital income.

The same restricted concept of capital was used by Solow who, in his famous 1956 article, however purged flow consistency from growth theory by *assuming* neoclassical general equilibrium: whatever the flow of monetary investment expenditure, full employment would be maintained as wages and interest rates and employment and profits would change, miraculously, just enough to assure 'knife edge' full employment (see also Fazarri e.a., 2012). This decoupling of investments from aggregate demand was a clear scientific retrogression as it made a lot of questions difficult to pose. And while Harrod and Domar *chose* to use a limited concept of capital and to discard unproduced assets, the general equilibrium view of Solow *forced* him to do this as wages and profits would only change with the right magnitude when no rent incomes would exist. He therefore had to state: "*The community's stock of capital takes the form of an accumulation of the composite commodity*" and "*there is no scarce nonaugmentable resource like land*" (Solow, 1956, pp. 66-67).[2] Aside: the very idea behind distinguishing 'capital' from consumer and intermediate goods is of course the fact that the composition, use , span of life and 'span of production' of fixed depreciable assets is *not* equal to the composition, use or span of life of either final consumption goods or intermediate inputs. A bridge is not a strawberry. But even understanding Solow's definition of capital as a convenient modelling strategy instead of a serious definition it still seems to exclude houses, roads and other buildings, including the land below these structures. More than thirty years after the publication of his article Solow cited the empirical long run estimates by Wolff (at that time still preliminary) very approvingly in his Nobel lecture (Solow, 1987). Checking the work of Wolff it turns out that he uses long term estimates of capital obtained from Maddison (Wolff, 1991, footnote 5). Checking the Maddison estimates it turns out that these exclude houses, land, natural resources, international assets, gold, and farm animals (Maddison, 1982, Annex D).[3] Restricting our attention to the seemingly trivial item 'farm animals' it turns out that, around 1885 and according to Goldsmith, these still made up about 13% of the total stock of reproducible assets (Goldsmith, 1985, table 45) – and the importance of the other items not included in the operationalization of capital used by Wolff was often even larger. Considering this importance it's clear that any long term estimates of capital and labour productivity, like those of Wolff, should include not just the wagons but the horses, too. The Wolff estimates don't. And a quick check of a number of macro textbooks reveals that the Harrod/Domar/Solow/Wolff approach to tangible capital, i.e. implicitly restricting it to (a subset of) produced depreciable capital and discarding the liability side of the balance sheet, is still dominant in economic thinking. Modern growth theory of course often does include 'human

[1] He already used the phrase 'embodied technological progress'.
[2] It's interesting to know if this last remark was inspired by Solow's friend Paul Samuelson – it has a very Samuelsonian ring to it.
[3] Maddison continuously revised and extended his data, however (Maddison, 1992; Maddison, 1994).

capital' or even 'health' in the definition of capital, I'll pay more attention to this below. The point here is that many kinds of capital are left out of the equations, just like balance sheets. Which leaves us with the conclusion that, despite early attempts at stock/flow consistent estimates of capital which combined the demand and the supply side of the economy serious, the modern concept of 'capital' applies to a subset of the total amount of tangible capital only while it's, despite excellent data on the flow of investments and capital income as well as, much more recently, the total stock of capital, focused on the supply side only. Clearly, this concept does not have solid macro-foundations.

2. Combining different concepts of 'capital' with flows of income and expenditure: Piketty-Zucman and Harrod-Domar

2.1 The contrarian results of PIketty and Zucman

Modern national accounts, unlike those of the days of Harrod and Domar, do not only contain data on monetary flows of expenditure and income but, since about 10 years, also on (net) financial flows as well as stocks of financial and non-financial assets. This information is the basis of the estimates of Piketty and Zucman (Piketty and Zucman, 2013; Piketty 2014). They base their approach hook, line and sinker on the concept and definition of capital as stated in the 'System of National Accounts' (SNA) (SNA, 2008). Following the pioneering work of Goldsmith, who in 1985 still had to base his approach on his own estimates of balance sheets of different countries (Goldsmith 1985), they extend SNA estimates of capital backwards to 1800 and even further. They frame these data in a theory of distribution, which is possible as their concept of capital is much broader and more conceptually consistent (i.e. balance sheets based, note the plural here) than the 'growth theory' concept described above. This leads to some 'textbook ready' results. They show that the long term development of 'total capital', or wealth, expressed as a percentage of GDP, shows a 'U' shaped historical pattern: high in the nineteenth century, low between about 1910 and 1985 and high afterwards with the development in the USA as the exception (Piketty and Zucman, 2013; Piketty, 2014).[4] They combine data on the flow of capital income ('r') with these estimates and state that 'r', especially when growth is low, might(!) lead to an increase of the wealth/GDP ratio and a self-perpetuating pattern of high and /or increasing wealth/GDP ratio's and maybe even to the rise of a powerful class of rentiers: back to the 'régime ancienne'. And, not entirely coincidental, to a science of economics which, once again, pays serious attention to the relation between 'wealth' and the distribution of income.

These findings are however critically dependent upon the concept of capital used by Piketty and Zucman (and the national accounts statisticians). The U-shaped pattern might indeed be surprising to people accustomed to the concept of capital used in growth theory. The period between 1910 and 1985 is (in the west) characterized by uniquely high rates of economic growth *as well as investment* and mainstream growth theory suggests that this process should or at least could have led to *higher* instead of *lower* capital/output ratios. A rise in the

[4] Compare Maddison, 1992, on savings (i.e. investment plus the surplus/deficit on the current account): "US long run experience has not conformed to the norm for the other countries. In most of the other cases it is possible to discern an upward trend in the long term savings rate, whereas in the USA this is not the case. The atypicality of US experience is important because a good deal of the theorizing about savings (or consumption) behavior emanated from the USA and was clearly influenced by the historical evidence (see Friedman … and Modigliani… explaining how they came to reject Keynes' notion of that savings rise with income - because there was no upward trend in the savings estimates developed by Kuznets)".

investment ratio will, according to the neoclassical model of capital accumulation engineered by Solow, lead to a transitory period of higher growth and, eventually, also to a higher capital output ratio, even more so (though Solow does not stress this) when a larger share of investments ends up in capital goods with a low rate of depreciation like houses (Solow, 1956). The combination of a 'U' shaped pattern of the capital/output ratio as estimated by PIketty and Zucman and an 'Λ' shaped pattern of the rate of fixed investment however suggests an *inverse* relation between 'capital' and the rate of fixed investment, a suggestion which gains credibility when we realize that the Λ-pattern of gross fixed investment was quite but not entirely universal: the USA, with a flat long run rate of investment was, *again*, the exception while the Netherlands, not included in the Piketty and Zucman estimates, *also* showed the same investment and capital growth pattern as the other countries, as will be shown below. Arithmetically, the problem of investments leading to a lower capital:output can, using the Solow growth model, easily be solved. Just assume that high rates of investments also lead to high rates of technological progress and/or positive returns to scale and add a positive relation between the rate of investment and the technology parameter of the Solow model to your spreadsheet – anything which makes the denominator increase faster than the numerator (see also the statements of Piketty and Zucman about this (Piketty and Zucman, 2014, p. 38)). But Wolff's 'vintage' models of (part of) the stock of fixed depreciable capital show that though productivity of capital often does increase, while high rates of investment do seem to foster these productivity increases the capital/output ratio as measured by him did not decrease. To the contrary: he had to state: "*On average, capital:output ratios trended upward between 1880 and 1979"* (Wolff, 1991, p. 577) while countries with relative low investments (the UK, see below) showed less increase than other countries – the very opposite of the results of Piketty and Zucman, whose main results include a *downward* trending capital/output ratio*!* How come?!

2.2 The modern , flow consistent concept of capital

This remarkable difference in findings might well be due to the differences in the concept of capital used. As we've seen, 'growth economists' tend to restrict 'capital' to (part of) fixed depreciable capital, though they sometimes also extend it with 'human capital', i.e. education and/or training on the job. Piketty and Zucman however use the SNA definition. To be able to show the differences, it's necessary to discuss this definition at some length. The SNA defines assets as:

> "a store of value representing a benefit or series of benefits accruing to the economic owner by holding or using the entity over a period of time. It is a means of carrying forward value from one accounting period to another. All assets in the SNA are economic assets" (SNA 2008, 10.8).

'Value' relates to future benefits (more precisely: to the ownership rights of these benefits) but also to the future monetary value of the asset itself, 'carrying forward' means that an asset can (1) either be kept by the owner until the next period and/or can be sold and used in the next period (land, ships, planes, vehicles, buildings, military equipment) and/or can be transferred to the 'next generation' (city roads, dykes and levees are default examples). This definition encompasses the 'fixed depreciable assets' of growth theory but is much broader. Items like 'human capital' and 'health' *(*Arrow e.a., 2010*)* are however excluded, as these are neither transferable nor tradable. A distinction is made between a legal owner (the landlord) and the economic owner (the tenant farmer) who decides how an asset is used and runs upside and downside economic risks connected with the way the asset is used. In this case,

the landlord is economic owner of the rent contract, a financial 'unproduced asset'. The SNA definition also includes net financial assets which, on the national scale and as domestic debts and liabilities cancel out (at least in an accounting sense…) means that the national stock of fixed capital is augmented with the (positive or negative) 'net international investment position' of its inhabitants, its companies and the government of a country. Non-financial assets are distinguished into produced assets (houses, roads, machinery, equipment, stocks, livestock) and non-produced assets, like stocks of hydrocarbons, agricultural land, land underlying buildings, 'goodwill' and some contracts and leases. Which is necessary to ensure accounting consistency and which, de facto, is a return to the classical dichotomy between capital and 'land'. Ponder that sentence. As the estimates of Piketty and Zucman are totally consistent with the concepts of the national accounts they are stock consistent and enable, unlike analyses just based upon fixed depreciable capital, an analysis of capital income. As a very important part of their analysis indeed hinges on 'r', the return to capital, they are also flow consistent – quite a step ahead compared with mainstream growth models, which, as they do not distinguish unproduced capital from other kinds of capital, disable a proper analysis of rent incomes. When it comes to expenditure flows, Piketty and Zucman however scarcely pay attention to the level of investment, which means that their ideas are not flow consistent with the expenditure side of the accounts. Just the opposite situation as with the Harrod and Domar models which did not pay attention to capital income but which do encompass the flow of investment while the Solow model is neither income or expenditure flow consistent . There is however nothing that prevents us using Harrod-Domar kinds of ideas about the relation between capital and investment while also using the SNA concept of capital. The SNA concept of capital can, i.e. be flow consistent on the income as well as on the expenditure side. And it's also totally possible that the difference between the findings of Piketty and Zucman on one side and Wolff on the other side are caused by the difference in the concept of capital used. An increase in the rate of fixed investment can, theoretically, be *positively* related to the stock of depreciable capital but *negatively* to the total stock of capital (or, looking at the other side of the balance sheet, wealth) which of course means that there should be a quite strong though negative relationship between 'non-depreciable capital' and high rates of investment . It is, however, also possible that the 'U' shaped- pattern is just a historical coincidence. The rest of this article will be devoted to an investigation of this problem which, on a meta level, can also be understood as a somewhat rude attempt to impose investment flow consistency upon the estimates of Piketty and Zucman.

To do this we will first establish the long run pattern of fixed investments, i.e. those kinds of expenditure which lead to an increase of the stock of fixed capital, to investigate if there indeed a Λ-shaped pattern of addition to the stock of depreciable capital. As we're interested in capital as a percentage of GDP we will express investment as a percentage of GDP, which means that, as fixed investment is part of final demand, we'll also get some information about the changing importance of fixed investment to GDP. We will compare this data with data on the long run development of the stock of capital as established by Wolff and Piketty and Zucman. As we need in-depth knowledge about the metrology behind this information to establish if any relations are spurious or not and as, in my experience, such knowledge can best be gained by constructing such series yourself and as Piketty nor Goldsmith present long term series for the Netherlands I also constructed long term capital series for the Netherlands, using the same methodology as Piketty and Zucman. With the help of this information, the problem posed above (is there an inverse relation between the total stock of capital and fixed investment but a positive relation between the stock of depreciable capital and the rate of investment) will be discussed.

3. The rate of investment: a long run view

3.1 Introduction

Piketty and Zucman present data on capital for about two centuries. This means that we have to assemble investment data for about the same period. Knowledge about the rate of investment is not just important in relation to the change in the amount of depreciable fixed capital (the Solow approach) but, as (business) investment is the most volatile component of total aggregate demand, also for the level of aggregate demand (the Harrod-Domar approach). *Knowledge about long run changes in this ratio is i.e. crucial to our understanding of capitalism as we know it* – and it was something of a surprise that constructing comparative long run series required a bit of an effort. The countries shown were chosen because of their size (Italy, Spain), because they were included in the long run Piketty sample (USA, Britain, France, Germany, Sweden) or because of data availability and their proximity to other countries in the sample (the Netherlands, Denmark, Finland). Together, these countries clearly show the 'Atlantic' investment experience during the 1807-2013 period. The data are from before the 2014 GDP revisions, i.e. do not include R&D investment.

3.2 Intermezzo: capital, innovation, revolutions and all that

Before presenting these data a little more has however to be said about capital, especially because the very nature of capital and investment might change over a two century period. Like Piketty, we will stick to the SNA definition which, as stated, enables a much better understanding of the distribution of capital income but also of production than the mainstream definition. Several aspects of 'capital' are however not encompassed by the SNA definition. One is 'liquidity'. Over the centuries, the liquidity of 'capital' on the asset as well as the liability side of the balance sheet has increased, think of the rise of the stock market, securitization of mortgages and even the merger between precious metals and the unit of account, which led to: coins. *All of these innovations led to major economic and social changes* – which underscores the crucial position of capital and wealth in our society. An example of such a change is the connection between the introduction of tradable shares and the rise of the first privately owned listed multinational, the Vereenigde Oostindische Compagnie, after 1602. Without tradable shares, this company, which lasted two centuries, would never have lived that long as the owners would have had to 'liquidate' the company instead of selling the shares to get their money back. But as they could sell their shares liquidation was not necessary and, with its own private army, the VOC could take its time to establish a true commercial empire.[5] Another important aspect is 'revolution'. The protestant revolutions of the sixteenth and seventeenth centuries, the French revolution, the USA civil war or the Russian revolution al led to fundamental redistribution of ownership or de-owning of land, slaves or other kinds of capital – in the United Kingdom it was Cromwell who seized the monasteries for the crown, in the Netherlands the government (not 'the crown'!) also seized the lands of the catholic clergy. It's a bit too much to state that our present concept of capital was forged with blood and iron – the historical reality often was much more mundane. North and Weingast use the phrase 'evolution' in the title of their 1989 article about the capital consequences of the Glorious Revolution for a reason – an evolution which was however directly based upon the revolutionary expropriations of the monasteries executed by by Cromwell, more than a century earlier (North and Weingast, 1989). Biologists use the phrase 'punctuated evolution' to describe such processes, Marx and Engels simply called these punctuations: 'revolutions'.

[5] I owe this insight into liquidity to the posts by J.W. Mason on his slack wire blog, even though Mason does not relate liquidity to innovation but to capitalist behavior.

Somehow and sometimes, these revolutions did redistribute property and create the room for these mundane developments which contributed to the growth of interest bearing loans between 'burghers', stock exchanges, orphanages endowed with the land of the former catholic monasteries, a class of small farmers in France or larger farmers in the UK and the Netherlands ('The crown' in the UK as well as the Dutch government had to sell a lot of the seized lands). Early sixteenth century national sector accounts would not have had a separate sector 'Monetary financial Institutions' but they would have had distinct sectors 'The Crown' and 'The Church'! Note that these redistributions often did not lead to long or even medium term declines of production – even cotton production in The South of the USA recovered fairly fast, after the civil war! To use a Piketty device: one is reminded of the last scene of 'Gone with the wind', when Scarlett discovers that 'land' is an unproduced asset. A further, related aspect of the evolution of capital is the increasing dichotomy between private/communal and public capital. Revolutions, glorious or not, led to an ever sharper distinction between the property of the ruler and the property and the state while states, in a very uneven and punctuated process and in exchange for ever higher and surer taxes increasingly acted as guardians of private property (Wilterdink, 1984). In the Netherlands, the loss of wealth caused by Indonesian independence (1948, according to the Dutch, 1945 according to Indonesian historiography) and the nationalization of remaining Dutch property in 1958 comes to mind (Baudet, 1975). At the moment, the fight about the value of the financial assets of banks is clearly an example where the state levies ever higher taxes to protect the property of a limited number of companies and exemplifies the shift from a state which protects the property of its citizens to a state which protects the property of creditors. Below, I'll return to this.

3.3 Data

Standardized information about the rate of investment in current prices is one of the standard items in public macro-economic databases. These databases however cover relatively short periods (about the last 40 years for Eurostat) or do have somewhat longer series (the Penn data go back to 1950) but use international 'PPP' price-estimates which, partly because roads and houses are not really tradable on the international markets, are often quite distinct from data in national prices. A comparison of the Penn data with current price estimates yields that, except for the USA and Germany, differences between PPP-fixed investment ratio's and current national price ratios are often quite large (up to 7% of GDP). As the stock of capital as measured in the national accounts is, as far as possible, expressed in current prices the Penn data are discarded and Eurostat data were spliced to 'historical' estimates of the investment ratio in current prices. Eurostat data on investments are almost invariably a little higher than the historical data, possibly because they include changes in 'stocks' while historical series often don't. To account for this, the historical series have been increased with the difference between the series (see the Annex for the sources of the historical series). As the difference is bound to be variable, this does give a bias to the series: a 17,5% level in 1880 will only be roughly equal to a 17,5% level in 2012.

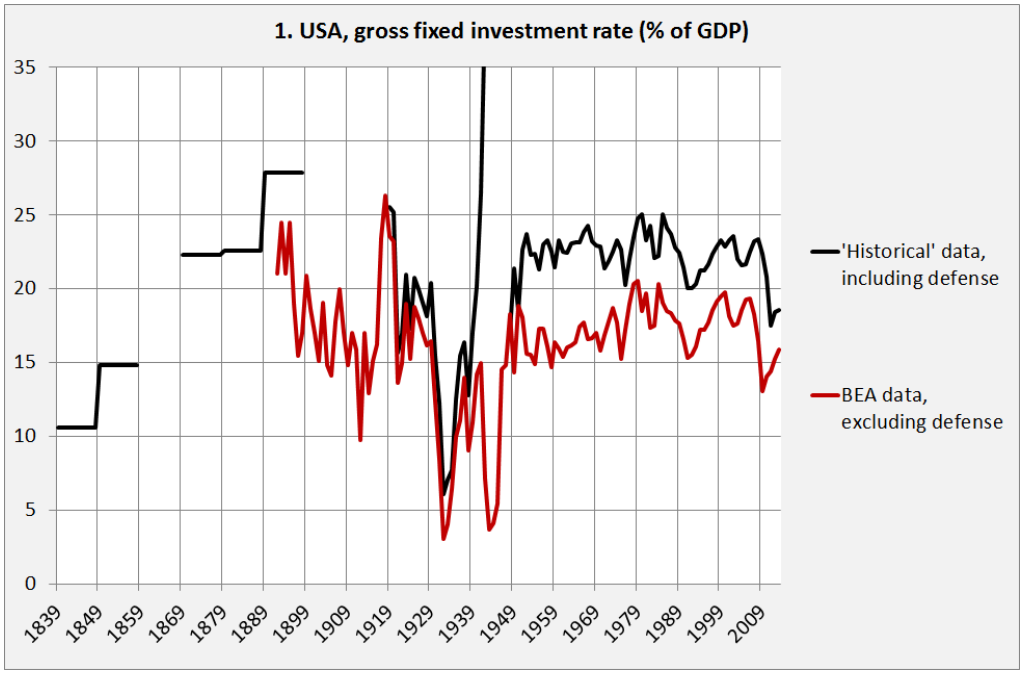
3.4 Results

The five graphs below cover 10 countries: the USA, France, Germany, the UK, the Netherlands, Sweden, Finland, Denmark, Italy and Spain. Some highlights:

A. The USA: exceptionalism

I. The USA graph shows series including and excluding military equipment – which clearly makes a difference and sometimes even a stupendously large difference. This serves to highlight a conceptual problem: how to define investments? As there is a clear primary and second hand market in military gear while countries replace equipment lost in wars, tanks and planes do have 'economic' value, which means that, *according to the SNA logic*, they have to be included in our concept of capital. The transfer of redundant material from the USA army to the USA police, which in an accounting sense is an economic transaction, underscores this idea. Not all historical series below however seem to include military equipment (Germany!). It also serves to highlight the importance of stock/flow consistent estimates of capital – these military investments did not increase the stock of productive capital (to the contrary) but they did end the Great Depression.

Graph 1



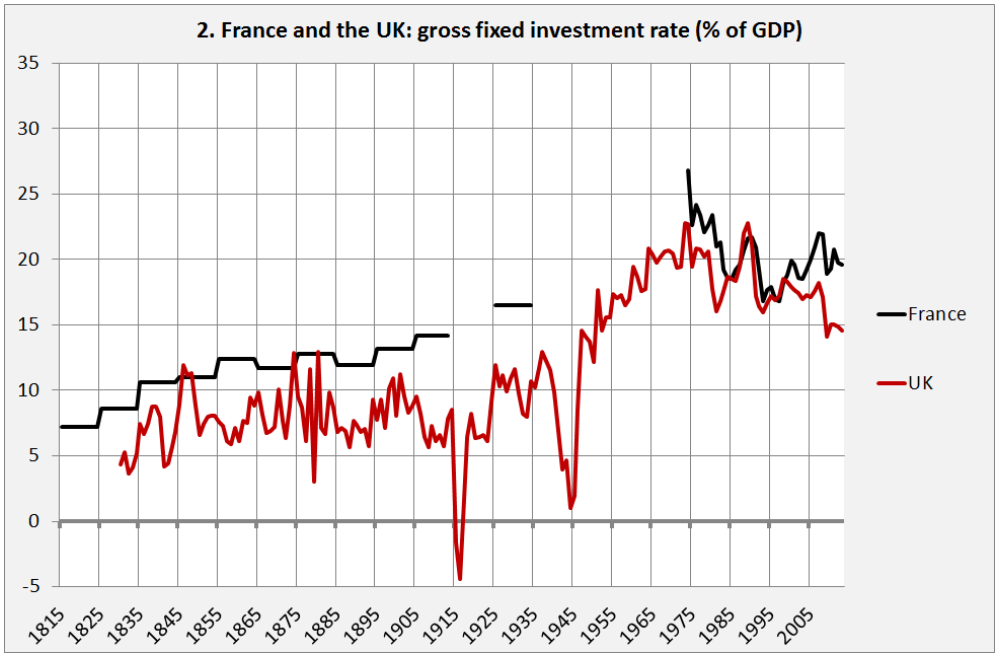
II. The most remarkable aspect of the USA series is the comparatively high rate of investment in the nineteenth century, mainly caused by a rapid increase of the urban as well as the agricultural population in combination with the extension of the system of railways. This finding is consistent with the finding of Wolff (1991) of a comparatively high as well as stable {fixed depreciable capital /labour} ratio in the USA during this period. A clear sign of things to come! A more surprising aspect is the long run stability of the rate of (gross) investment. In the short run, gross investments were quite volatile and net investments even became negative during the Great Depression. In the long run it's the stability of the investment rate that catches the eye. However – as we will also see for Finland, Spain and, to a lesser extent, France – the post 2000 level of investment was driven by a housing bubble and as such unsustainable. The low post 2008 levels might be a clearer sign of things to come

than the 2000-2006 levels. Investment levels which were sustainable in the sixties and seventies might not be sustainable today.[6]

B. France and the UK: catching up versus falling behind

France shows rather low but gently rising levels in the nineteenth century, followed by further increases post 1920 and, again, post 1945 which led to very high investment ratios in the sixties and seventies. Up to about 1930, this pattern might have been caused by a process of catching up. The UK experience is slightly anomalous: it shows, in a comparative perspective, low rates up to as late as 1920. Initially, these low rates might be explained by the already quite high {fixed depreciable capital/labour} ratio in the nineteenth century, but the increase of this ratio during the nineteenth century and up to about 1920 was clearly lower than in other countries. As a result, 1979 UK {fixed depreciable capital/labour} ratios were, contrary to the situation around 1870 and even 1890, way lower than for instance German ratios (Wolff, 1991). This serves to underscore the long run consequences of (changes in) the fixed investment rate as well as the relation between the investment rate and the stock of depreciable capital. The high French rate after especially 2005 is remarkable, too. Considering the, very recent, dramatic decline in housing starts in France it is to be expected that the French rate will go down soon.

Graph 2



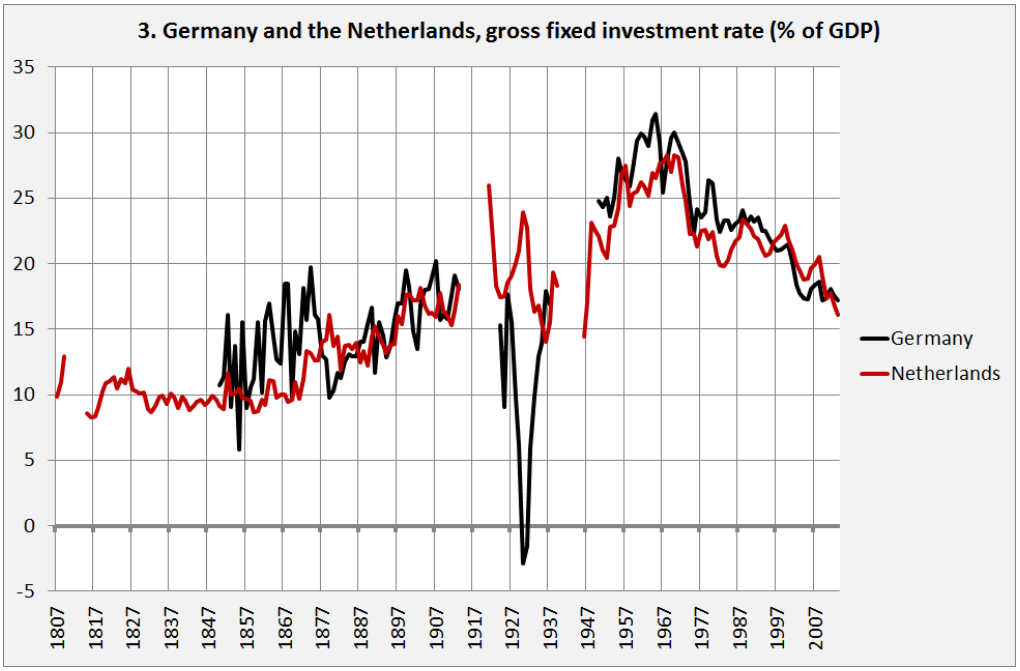
C. Germany and the Netherlands: archetypes

Note that the borders of Germany changed quite a lot during this period. Despite this the patterns are consistent: the rather late take-off of the Netherlands but a rather high level of investment before this period, the high German level during the German

[6] An argument can be made that 'bionics' (artificial hips, teeth and the like) have to be included in the concept of investment. An investment rate including bionics might show a somewhat different development. The remarks made in the text are clearly conditional on the definition of fixed investment – which does not make them less true.

'Gründerjahren' and a relatively high German level after World War II. The most remarkable aspect of the graph is the large and sustained post 1973 decline of the German and to a lesser extent Dutch investment rate – even despite German re-unification. The low level of German investments post 1991 corresponds with the glacial and for a decade even non-existent decline in the East-German unemployment ratio, this contrary to the fast decrease of West-German unemployment post 1950. As such, the 150 year wave-like pattern of German and the Netherlands seems to be rather typical for 'latecomers' to modern economic growth while the high level of German unemployment indicates a consistent pattern of underspending. After decades, this spending gap was filled by a large external surplus – a strategy which for obvious reasons can't be used by all countries at the same time. Note that the length of this wave corresponds with the length of the patterns identified by Piketty and Zucman. As net government investment in Germany is, at the moment of writing, negative a slight uptick might be expected.

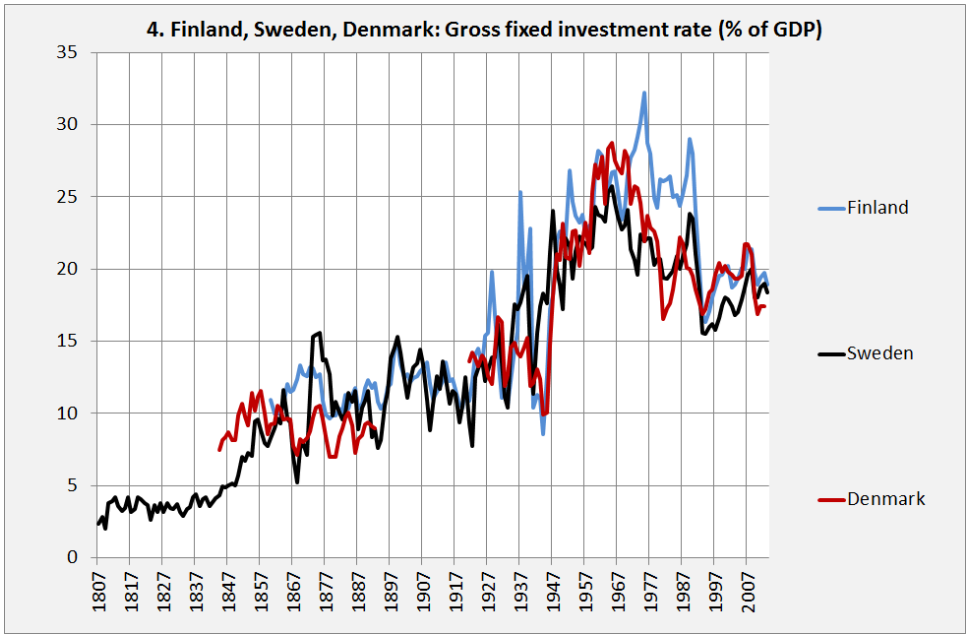
Graph 3



D. The Nordics. More archetypes

The same long wave is visible in Denmark, Sweden and Finland. Take note of the 'Finnish bubble' after 1990, which, again, indicates that investment ratios which were sustainable in the sixties were unsustainable post 1980, maybe due to slower population growth.

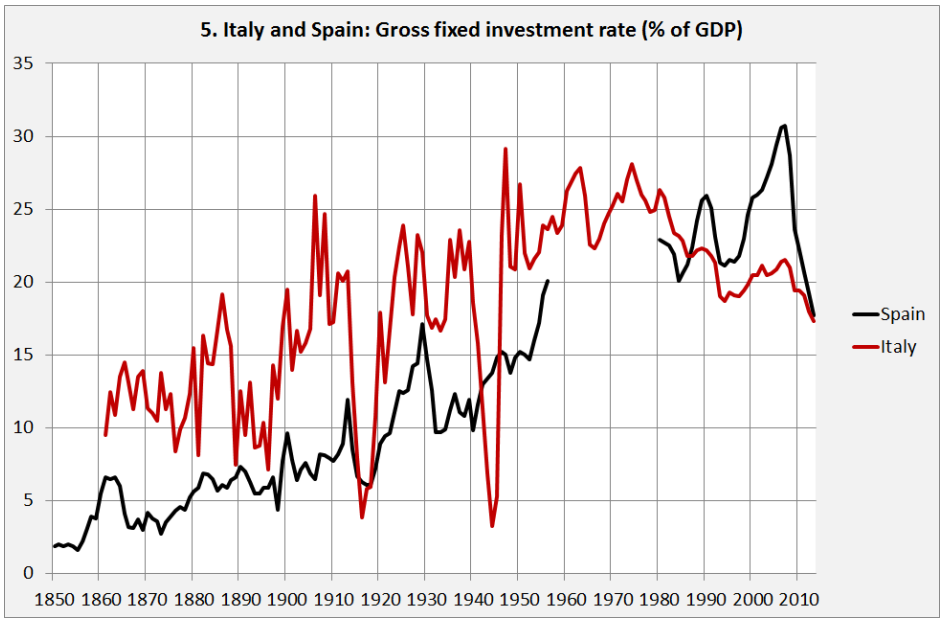
Graph 4



E. Italy, Spain

Both Italy and Spain show the same wave, albeit with Spain as a latecomer and, like Finland, at the end of the series clearly showing an investment bubble. The gap for Spain between 1958 and 1980 can be filled with the Penn series, which (as mentioned above) often show quite some differences with current price rates. These data suggest that, after a severe decline during the 1959-1960 depression, investments were relatively high throughout the sixties and especially in the seventies, declining a little thereafter. The Italian series show, especially after the Second World War, basically the same pattern as the Dutch, Swedish, Danish and German series.

Graph 5

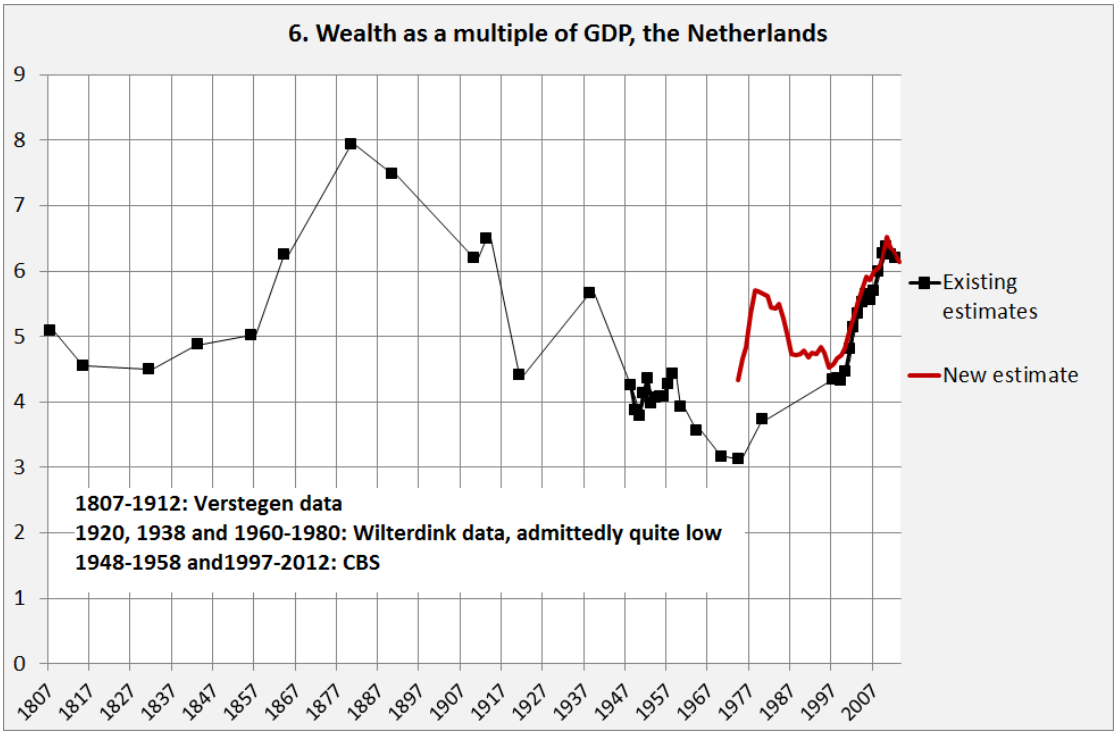


Summarizing: except for the USA all countries show, with relatively little difference in timing, a 150 year wave like pattern of the investment ratio, with exceptional high investment ratios during the period when, according to Piketty and Zucman, the {*total capital*/output} ratio is lowest but when, according to Wolff, the {*depreciable fixed capital*/output} ratio increased. Most countries show a decline of the investment rate after somewhere in the seventies or eighties, countries which managed to keep a stable or even increasing rate of investment after this period turned out to have had severe financial bubbles. There indeed seems to be an inverse relation between the investment rate and the total capital/output rate, spurious or not, while, according to the Wolff data, the relation with the stock of depreciable capital is, more predictable, slightly positive and even more so when we look at comparative data. To investigate these relations in more detail we will, in the next paragraph, present data on total as well as depreciable fixed capital/output ratios for the Netherlands, investigate if these show the same properties as the 'Piketty' and 'Wolff' data and, if so, investigate why the 'total capital' ratio behaves in ways contrary to the 'fixed depreciable capital' ratio.

4. Capital series for the Netherlands

Graph 6 shows the long term total capital/output ratio for the Netherlands. The series is, considering the goal of this article, only an intermediate result but for obvious reasons it is worthwhile to investigate it.

Graph 6

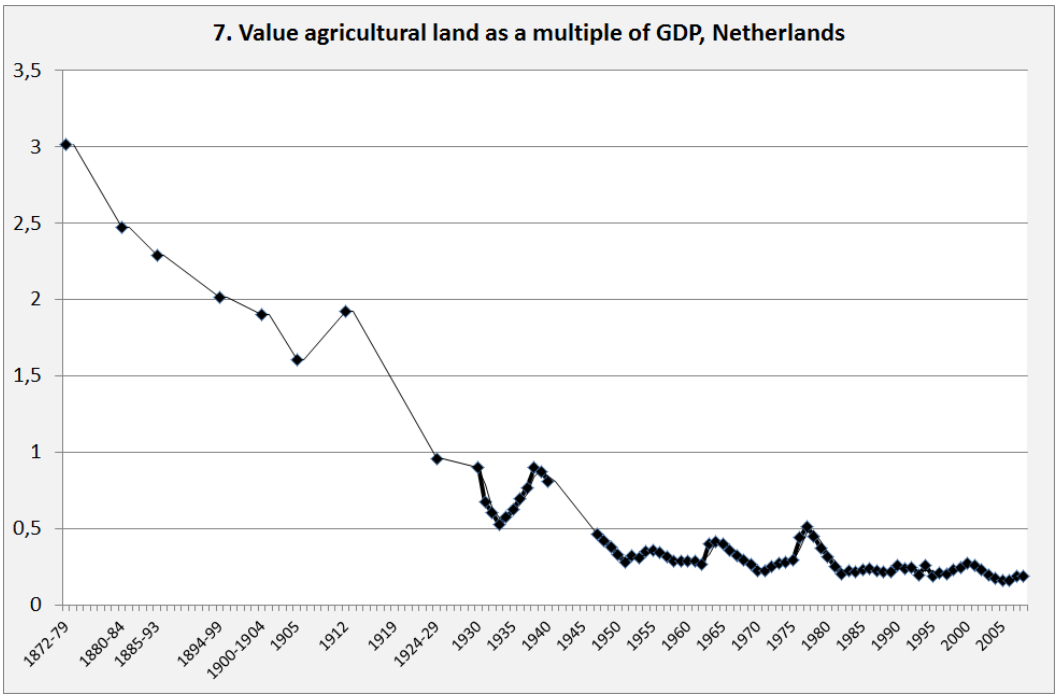


Sources: see annex.

The elephant in the room: however one mistreats and tortures the data the series clearly shows the same 'U' shaped pattern identified by Piketty and Zucman, albeit with a somewhat

higher value during the fifties-seventies period.[7] Some minor anomalies show. The somewhat low level of and the decline after 1807 can be explained by the consequences of the French occupation of the Netherlands in combination with the demise of the Vereenigde Oostindische Compagnie and the loss (to the UK) of a number of territories like Sri Lanka (which became a crown colony) and the (rather small) Cape Colony owned by this company. Even then, the rise between 1852 and 1880 is remarkable and asks for an explanation. This period was characterized by increasing and high agricultural prices and high gross land rents, 1882 marking the apex of nineteenth century agricultural prices in the Netherlands (Knibbe, 1993 and 1999). These increase led to an increase of the value of land. Decreasing land prices after 1882 clearly caused a rapid and marked decline of landed wealth and, therewith, of the total wealth to GDP ratio with about 300% of GDP, which is enough to explain the total decline of this ratio after 1880 (graph 7) and which, therewith, requires some special attention.[8]

Graph 7



Sources: see graph 6

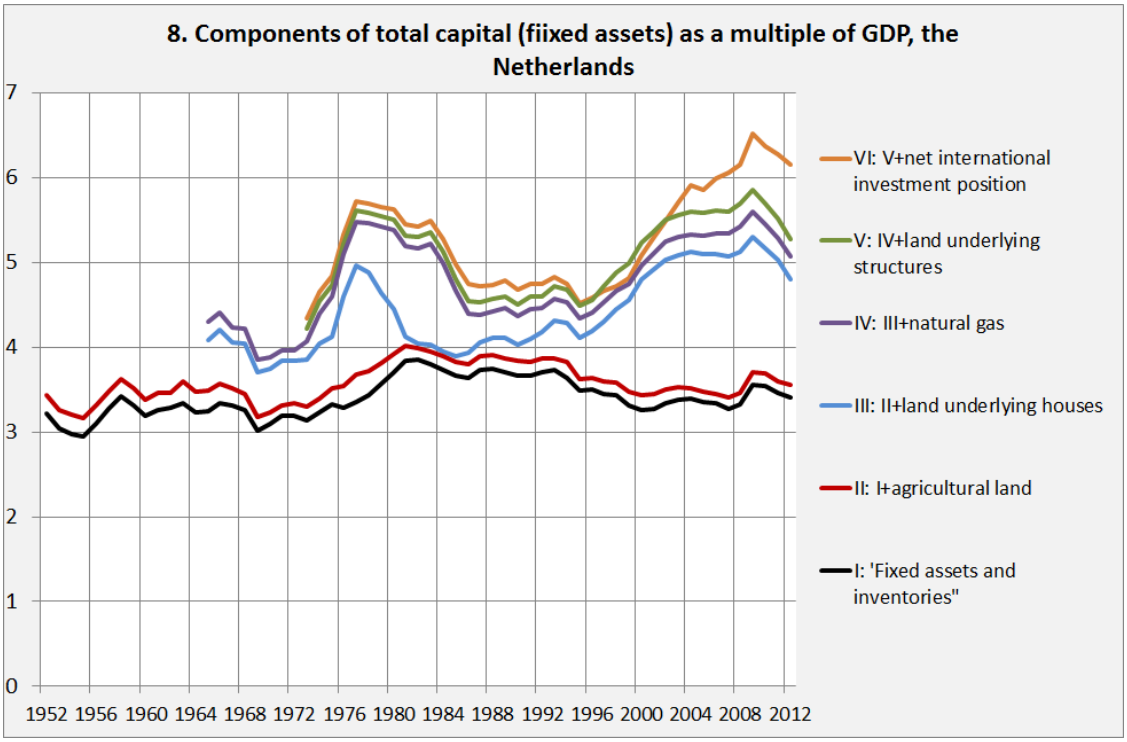
The decline of landed wealth is totally consistent with the findings of Piketty and Zucman. Was this decline in any way connected to the increasing rate of investment? This question is too simple and we have to reframe it, giving center stage to more complicated historical developments which were annex to what we measure as increasing investments in fixed depreciable capital (Knibbe, 1993 and 1999). It's clear that on one hand investments in ships and railroads enabled the development of hitherto virgin lands in countries like the USA, Argentina and India and, earlier, the Crimean area, which enabled an improvement in the food situation of the European population and (*almost* the other side of this coin) a decline of food prices vis-à-vis wages and, i.e., a lower share of the value of land as a share total production (or income). This is however only part of the story. Increased use of intermediate

[7] Contemporaneous estimates show lower capital/output levels, mainly as houses are not valued at market but at a much lower 'collateral' value. See Wilterdink, 1984.
[8] My specific estimate of the value of agricultural wealth is not part of the estimates of the period before World War II, which are based upon Verstegen (1996) and Wilterdink.(1984).

inputs (feed, artificial fertilizer) not only enabled an increase of the productivity of European agricultural land but *also led to increases in labour productivity* as, for instance, the gathering, storing, mixing and spreading of a multitude of organic fertilizer often required loads and loads of labour. In for instance the Netherlands this process led, despite a relatively fast increase of the population, to a near stability of the amount of per capita calories produced domestically. Dutch imports of food *improved* the availability of food but were not needed to compensate dwindling per capita production – as per capita production did not dwindle (Knibbe, 2006). In combination with rapid mechanization after 1950 and ever lower prices for purchased inputs (except for energy) this process enabled a decline of the cost price of the production of food and (much) lower prices for food products. This is a story about technical and organizational change which was only to an extent 'embodied' in new capital. Anyway – relative agricultural prices declined dramatically – and the price of land vis-à-vis the general price level declined, too. The total stock of fixed depreciable capital (ships transporting grain, railroads, roads) increased – to an extent as a consequence of a process which ultimately led to lower land prices and therewith to (considering the very large share of land in total wealth around 1880) much lower wealth/GDP ratios. As this (international) decline of the wealth/GDP ratio was concentrated in landed wealth it also led to large changes in the distribution of wealth which, especially in countries with some quite large land owners, of course led to large social and political changes.

The decline of the capital/GDP ratio up to about 1940 can be accounted for by looking at an *unproduced* asset: land. After World War II, capital/output ratios however stayed low for several decades, despite (at least in Europe) unprecedented fixed investment ratios – while they increased, depending on the country, after about 1970 or 1980, exactly when the investment rate started to decline. Graph 8 sheds a little more light on this process for the Netherlands.

Graph 8



It shows total capital/output ratio using a consistent methodology for the 1965-2012 period as

well as series on fixed depreciable capital including houses but excluding the value of land under houses back to 1952. To be honest to Solow, Harrod and Domar: when they wrote their classic articles, depreciable capital was by far the most important part of total capital. Since, then the situation has changed. Up to 1976 this depreciable capital series is more or less stable but after 1976, exactly when fixed investment ratio started to decline, this series started to *increase* a bit. This increase was mainly caused by a relative increase in the number and quality of houses (the average number of inhabitants per houses declined from 4 in the beginning of the twentieth century to three around 1965 to 2 around 2010).[9] But it was also caused by an increase in house prices triggered by deregulation of the banking sector, higher leverage and other events eerily similar to the recent housing bubbles (Frederik, 2012). Just like in the 1995-2008 period (the second Dutch housing bubble) this increase in house prices was enabled and to an extent even caused by a large increase in credit and (the other side of the balance sheet) the supply of money, not by an increase in the savings ratio. Which means that changes in the capital/output ratio can't be explained with a non-financial model which 'only' takes flows of income (i.e. the rate of capital income, Piketty's 'r') and expenditure (i.e. the rate of investment) into account. A 'flow of funds' kind of analysis which also looks at changes in (mortgage)credit is in place. As the housing bubble coincided with the oil crisis and higher oil and natural gas prices, and as the Netherlands had just discovered huge reserves of natural gas, this led to a kind of double Dutch total capital/output bubble – a clear sign of things to come. The 1982 Volcker crisis, characterized by the combination of high interest and high unemployment, in combination with lower prices for energy led to the deflation of this bubble. At the moment, the second Dutch bubble is deflating – at least when it comes to house prices. Just like in Ireland and Spain, mortgage debts however do not decline in tandem with house prices which means that the collateral of mortgage debts (which are about equal to GDP) is dwindling. This puts pressure upon the government to act to save banks or refinance banks or to prevent (in an environment with record low policy rates!) refinancing of mortgage loans – another example of the state functioning as the guardian of the property rights of creditors – to the detriment of the income of households.

Special mention has to be made of the development of the net international investment position (NIP) of the Netherlands. After 1971 the Netherlands had, except for 1978-1980, a persistent and often large surplus on the current account. This should, at first sight, have led to ever increasing net international wealth. As can be seen the NIP however deteriorated after 1990 and even became negative, due to revaluations of assets (Nieuwkerk and Sparling, 1985; Nieuwkerk and Sparling, 1987; Boonstra, 2008). It's worthwhile to summarize the data of Boonstra:

Table 1. The relation between the current account and the net international investment position of the Netherlands, 1987-2006 (Euro, billions)

Cumulative surplus on the current account, 1987-2006	321
Capital account balance	-19
Errors and omissions	- 63
Capital losses	-285
Resulting net change in international investment position	-46

Source: Boonstra, 2008, table 2

[9] A quality index of houses is missing, but each year around 0,5% of the total stock of houses was scrapped. These scrapped houses were often small and simple.

Clearly, 'saving' explains only a part of what happened and even for this twenty year period price developments trumped volume developments. These data are however influenced by accounting methods (i.e. valuing shares of foreign subsidiaries owned by Dutch companies at book value instead of market prices and not counting retained profits by foreign subsidiaries) as well as by somewhat neglecting Special Purpose Entities. Data might understate the true value of the Dutch NIP (Vandervyvere, 2012; Claassen and Van den Dool, 2013). The NIP data are, therewith, opaque as well as unreliable.

Conclusion

The broad and national accounts oriented concept of capital used by Piketty and Zucman enables an income and investment flow consistent analysis of 'capital', this is contrary to the concept used in 'text book' growth theory. The 'U'-shaped pattern of the long term evolution of the capital-output ratio established by Piketty and Zucman is robust to new data: it's also clearly visible in the Dutch data (not included in the Piketty-Zucman sample). Looking at the details and SNA definitions it however turns out that the U-pattern is totally driven by changes in the value of unproduced assets. In the decades around 1900, land prices declined because of a process of intensive and extensive growth of agriculture which, in the end, was strongly land and labor saving and led to lower agricultural prices and, i.e., a lower value of land. Flows of capital income (Piketty's 'r') had little to do with this and flows of investments (ships, railways), though crucial, explain only a limited part of this process. After around 1880 an increase in the investment rate probably led, *despite the decline of the {total capital/output} ratio,* to slightly *increasing* {fixed depreciable capital/output} ratio's. After around 1985, the fixed depreciable capital/output ratio seems to have declined a little (at least in the Netherlands). Because of credit fuelled increases in the price of houses and land below houses and buildings the {total capital/output} ratio however increased which, however, has to be understood as a sign of the credit bubble of the nineties and noughties and not as a consequence of re-invested capital income, as Piketty and Zucman suggest. Which means that a expenditure flow consistent analysis of capital output ratio's should, in a state backed bank-money monetary environment, not just look at capital income but also at credit creation and all kinds of innovations which influence the credit-process and, therewith, the value of capital.

Annex: data and methods

I. General principles

The literature mentions four basic ways to estimate nominal 'wealth' or 'capital' which are used next to each other and which relate to different concepts of investment (as outlined by Gallman, 1986) and different kinds of capital goods:

- **Using book value** including the perpetual inventory method (and extensive description of this method in Groote, 1995). This method is, also known as valuing capital at acquisition costs, is based upon past investments. It uses the notion of capital as piled up savings, like retained profits, in the sense of consumption foregone (Gallmann, 1986). A problem with this method is that the capital stock consists of different 'vintages' with different implicit price levels and explicit use of price indexes has to be made to make prices of different capital goods comparable. It also requires

the use of a depreciation rule. An advantage: it forces researchers to assemble scores of data on prices and volumes of investments and to be explicit about this.

- **Using reproduction costs**. This is of course not possible for non-produced capital goods. These estimates '*express the capital stock in terms of current productive resources rather than historical forgone consumption'* (Gallman, 1986, p. 174) and is related to the present. In that sense, it is closest to the concept of value added of the national accounts. A problem with this method is that worn out equipment with a low book value often might have high reproduction cost (consider the $14 billion costs to repair the New Orleans levees).
- **Using market prices** of capital goods (which are not always available). This is a future oriented method as the price is somehow related to benefits yet to come, either of a monetary or (in the case of houses) non-monetary. Sometimes, these future monetary benefits (or the estimated monetary value of non-monetary benefits) are discounted which, however, often (like in the case of natural gas) leads to unacceptable swings in the value of capital when the interest rate changes (Veldhuizen, Graveland, Van der Bergen and Schenau, 2009; Rossum and Swerts, 2011). In the case of houses, the monetary price of houses does not seem to be connected to future *benefits* but to the, considering incomes, regulations and the interest rate, maximum amount which can be borrowed, i.e. to future outlays.
- A fourth method is calculating depreciation (in fact a variant of the book value method) by using the discounted value of the stream of income of depreciable capital goods which, as it has to be equal to the present market, book or or reproduction value of a capital good, is *not* the same method as the discounting method mentioned above and in fact only one of many ways to calculate non-linear depreciation.

II. Sources for graph 1 to 5

Except for the USA, Eurostat data on 'gross capital formation' which include changes in inventories and which go back to somewhere between 1974 and 1980 are spliced to historical series. For Sweden, the Netherlands and the UK long run series on gross fixed investment were available via the websites of the Centraal Bureau voor de Statistiek (2, the Netherlands), The Bank of England (3, Great-Britain) and Sveriges Riksbank (1, Sweden).

1) http://www.riksbank.se/en/The-Riksbank/Research/Historical-Monetary-Statistics-/Historical-Monetary-and-Financial-Statistics-for-Sweden-Volume-II-House-Prices-Stock-Returns-National-Accounts-and-the-Riksbank-Balance-Sheet-16202012-/
2) http://www.cbs.nl/nl-NL/menu/themas/dossiers/historische-reeksen/cijfers/extra/historische-reeksen.htm
3) http://www.bankofengland.co.uk/publications/Documents/quarterlybulletin/threecenturiesofdata.xls

For the USA, NBER data were used back to 1919 (4, 5). For the 1897-1919 period, data from Levy, 2000 (which are ultimately based upon partial series from a 1955 study by R.W. Goldsmith not used in this article) were used. For the 1839-1900 period, data from Davis and Gallman, 1978 and Gallman, 1986 are used.

4) http://www.nber.org/databases/macrohistory/rectdata/08/a08165.dat
5) http://www.nber.org/databases/macrohistory/rectdata/10/a10037.dat

Additional data for Spain, Italy, Germany, Finland and Denmark were obtained from Mitchell (2005). Data for France are from Lévy-Leboyer (1978).

III. *Sources for graph 6 to 8*

The estimates presented in this study are somewhat preliminary and quite some improvements are possible. Care has been taken to stick as much as possible to the methods used by the Centraal Bureau voor de Statistiek (CBS), see below, but the specialists of the CBS can, no doubt, improve these series quite a bit. Aside – many of the background reports about estimating capital are nowadays available on the internet, which facilitates studies like this one more than a little bit. At this moment my estimates are, despite all possibilities to improve them, however, the best (in fact: the only) long run estimate of Dutch wealth available and the fact that quite different estimates from different authors (i.e. CBS, 1960, this study, Verstegen 1996) show comparable developments or developments consistent with my findings indicates that there is some merit to the data.

Systematic endeavors to estimate balance sheets for the Netherlands start with Tinbergen (1942). These comparative estimates for six countries are characterized by Maddison (1994, p.1), using a German translation, as: “His ‘Kapitalmenge’ could better be characterized as a heap than as a stock’. For the Netherlands, these estimates were however quickly replaced by a regular statistic of national balance sheets, see Derksen, 1946; CBS, 1947 and ultimately Korn and van der Weide, 1960 which contains consistent balance sheets for the 1948-1958 period. These estimates were, alas, discontinued (is there a relation with the Indonesian nationalizations of remaining Dutch property in Indonesia in 1957 and 1958 (Baudet, 1975)?) and it would not be until the end of the nineties when, spurred by the growing international consensus about the importance of balance sheets, new attempts ultimately culminated into national and sectoral balance sheets consistent with the SNA methodology. Two methodological studies: Pommeé and Maris, 1996 and Verbiest, 1997. See also Lith, 1999, about the interrelation between the capital value of houses and the estimation of imputed rents. In the meanwhile, however, Wilterdink had published his still monumental study ‘*Vermogensverhoudingen in Nederland*’ (Wealth and its distribution in the Netherlands) which clearly sets out the relation between both side of the balance sheets (i.e. the value of assets and the value of property claims) and relates these to distributional issues (Wilterdink, 1984). One crucial aspect of this study is the analysis how, in the very long run, capital evolves – economists do have to pay attention to this. Eventually, the Dutch Centraal Bureau voor de Statistiek has published, in the national accounts, financial sectoral balance sheets which stretch back to 1990 as well as physical balance sheets stretching back to 1997. Though they have not published these, their series of depreciable fixed capital however stretch back to 1952 (to an extent using the information of the 1948-1958 series), which were kindly provided to me.

In this study, data on agricultural land, the value of houses, the value of land below houses, the Net international investment position, the value of natural gas have been added to the 1948-1952 data using sources and methods which are as comparable as possible with sources and methods used by the Centraal Bureau voor de Statistiek for the post 1997 series.

More specifically, the next methods have been used:

1) **Natural gas**. The amount of known reserves were based on interpolating existing data of the CBS, interpolation was based upon data on production which stretch back to 1946 (before the end of the sixties, production was very low). On the internet, a spreadsheet of the Centraal Plan Bureau (CPB), a kind of (semi) public financial watchdog, can be found which contains data about government natural gas income,

including sales taxes and the like. As prices differ quite a lot between different kind of customers, households often paying a price which is multiples higher than prices paid by industrial companies, a unit value price has been calculated using these CPB data. Following the methodology of Veldhuizen e.a. (2009) and Rossum and Swerts (2011), a three year average has been used to calculate the value of reserves of natural gas; Veldhuizen e.a. explicitly do not use a discounting method as changes in interest rates (as well as, of course, future 'benefits') make such estimates extremely volatile.

2) **Agricultural land**. CBS methods for estimating the value of land are described in Bergen, Van den and De Haan, 2009. CBS series were extrapolated backwards by using volume data from Knibbe, 1993 and the CBS. Price data on the value of arms per hectare (including buildings) were obtained from Luijt and Voskuilen (2009). A comparison with post 1997 CBS data on the value of agricultural land yielded a very consistent difference of about 20% (my estimates being higher) which means that I calibrated my series by applying a 20% haircut to distract the value of farm buildings.
3) **Land below houses**. The CBS data contain data on the value of houses back to 1952. Comparing these with the 1948-1958 series mentioned above yields that for the 1952-1958 period the recent data are neatly in between the two series provided in the older estimate. Multiplying house prices with the number of houses shows, back to 1990, a very good correspondence with the CBS series for the value of houses plus the value of land despite the fact that the CBS uses tax value (WOZ-waarde) of houses instead of market prices (Bergen, Van den and M. den Haan, 2009). This tax value is however, with a lag and somewhat smoothed, based upon market prices. This means that the value of land below houses was calculated by multiplying house prices with the number of houses for the period 1965-1989 and subtracting the value of houses. Data on house prices back to 1965 were kindly provided by Jesse Frederik, dependable older macro-series do not seem to be available (though the 'Kadaster' should have archives with data on literally all house transaction back to somewhere in the nineteenth century).
4) **Land below other structures**. This was extrapolated backwards from 1990 onwards, using official data on land below structures, price data are however missing.
5) Net international investment position. This is a tricky statistic as it is influenced by the net surplus or deficit on the current account (which is well known) but also by large changes in the value of shares and bonds as well as by earnings retained by foreign subsidiaries which do not show in the book value of these subsidiaries. According to Boonstra (2008) and Vandervyvere (2012) this means on one hand that surpluses on the current account can easily be offset by swings in the value of foreign capital (hence the negative value of the Dutch IIP during the 1997-2001 period) while, on the other hand, the value of foreign capital may be severely understated by book value. The 1973-1983 data are however based upon direct observation (though only of the value of foreign capital owned by companies, not of capital owned by individuals) while the more recent data also seem to be of ever higher quality as, for instance, more care is taken to take Special Purpose Entities into account. See Claassen and Van den Dool (2013).
6) Data from earlier studies. Nineteenth century data (up to 1910) are based upon Verstegen (1996). The Verstegen data are mainly based upon extrapolation on wealth data obtained from inheritances. Data for the 1910-1980 period other than my series are based upon Wilterdink, who however states that private capital is severely understated, mainly due to tax evasion pratices. The 1948-1958 data are based upon Korn and Van der Weiden, 1960.

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