

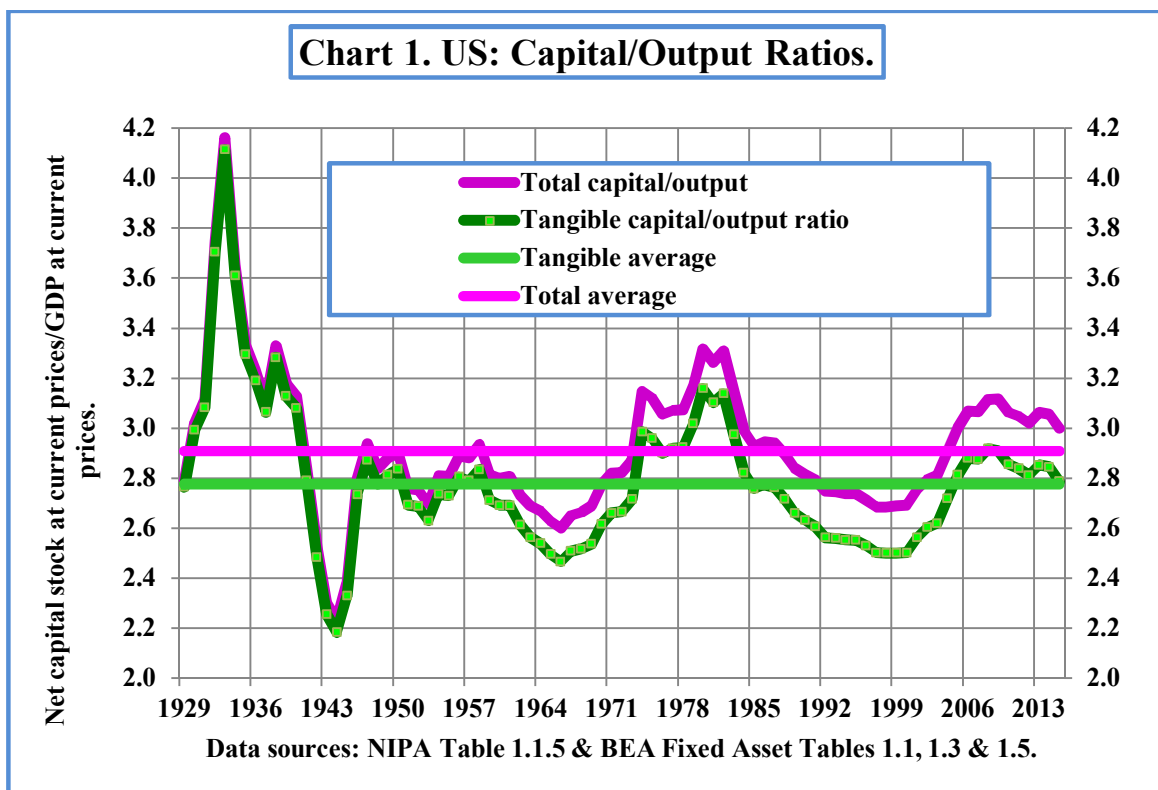
Paper for the Industrial Strategy Commission. February 2017.

1. Summary.

The UK's key economic problem is poor productivity. This is the result of low investment in tangible assets. The fall in such investment predates the financial crisis and subsequent recession by many years. Its prime cause was the disincentive to invest induced by the change in the way senior management is remunerated (the "bonus culture"). A strategy to improve productivity thus needs to reverse the perverse incentives of the bonus culture. A small improvement should follow if companies were required to publish their UK outputs and hours worked i.e. their productivity. They already have this data and its publication would have a nugatory cost. A greater step would be to empower the competition authorities to approve only those bonus schemes which made improved productivity a condition of payment. Unapproved schemes should suffer seriously disadvantageous tax consequences.

2. Productivity Depends on the Net Capital Stock.

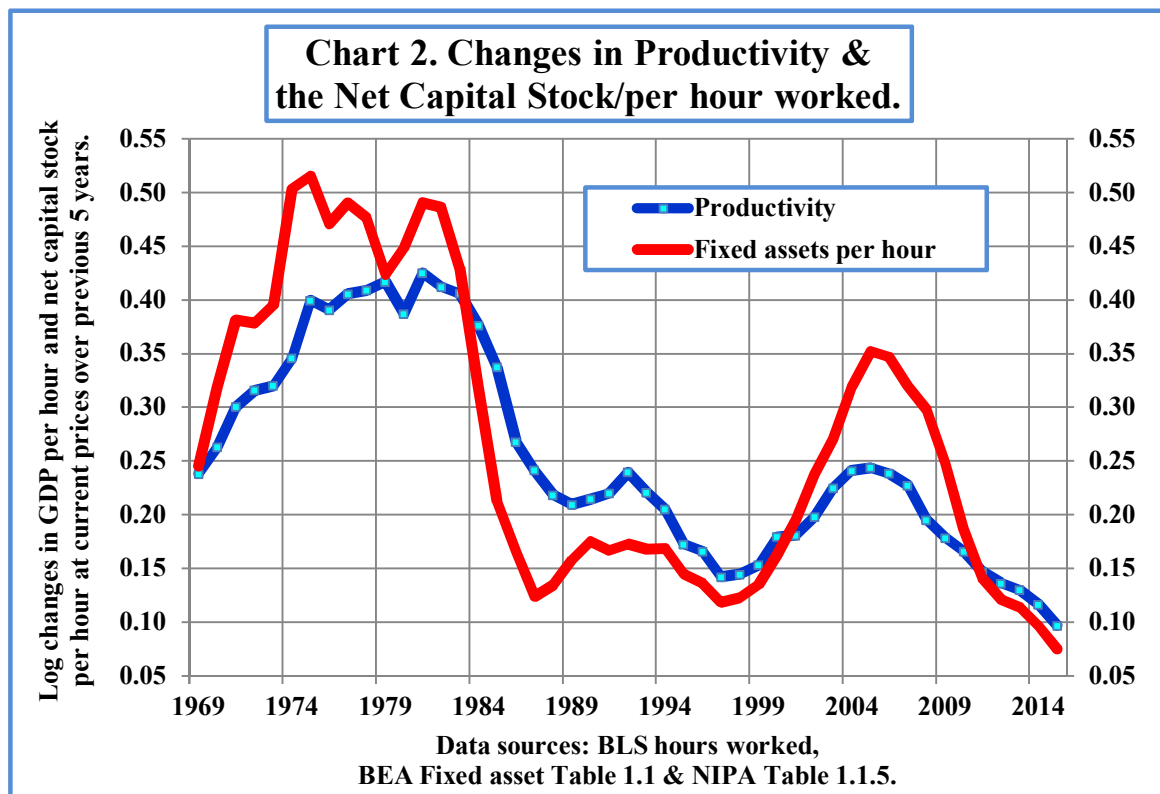
My first hypothesis is that productivity depends on the net capital stock. We do not have long term data to test this hypothesis in the case of the UK but we do have it for the US and I show the ratios of the total and tangible capital stocks to GDP for the US in Chart 1.



As the chart shows, these ratios clearly rotate around a stable average and are thus mean reverting. It follows that productivity (GDP per hour worked) must depend

on the net capital stock available to support each hour worked (GDP per hour worked). The hypothesis that productivity depends on the level of the net capital stock per hour worked is thus testable for the US and robust when tested. Although we lack sufficient data to be able to test this for the UK, the assumption on which the hypothesis is based is just as applicable to the UK as it is to the US and it is therefore reasonable to assume that it is valid for both countries.

As GDP has the stable relationship with the net capital stock shown in Chart 1, we must expect the rate at which productivity changes to be related to the rate at which the net capital stock/per hour worked changes. Chart 2 illustrates that this expectation is fully met.¹ The data therefore make it clear that the reason that productivity has been so poor is the slow growth in the net capital stock, which has in turn been caused by the decline in tangible investment.



3. The Growth of the Net Capital Stock.

We only have data for the UK's net capital stock since 1995, but as Chart 3 shows its growth has fallen sharply over this limited period. In the US, for which we have data since 1925, the growth of the net capital stock has been on a long declining trend since 1967, as shown in Chart 4.

¹ Both changes are measured at current prices, and while they are comparable in relative terms they do not show the rates at which productivity has grown if measured in constant prices.

Chart 3. UK: % Additions to the Net Capital Stock.

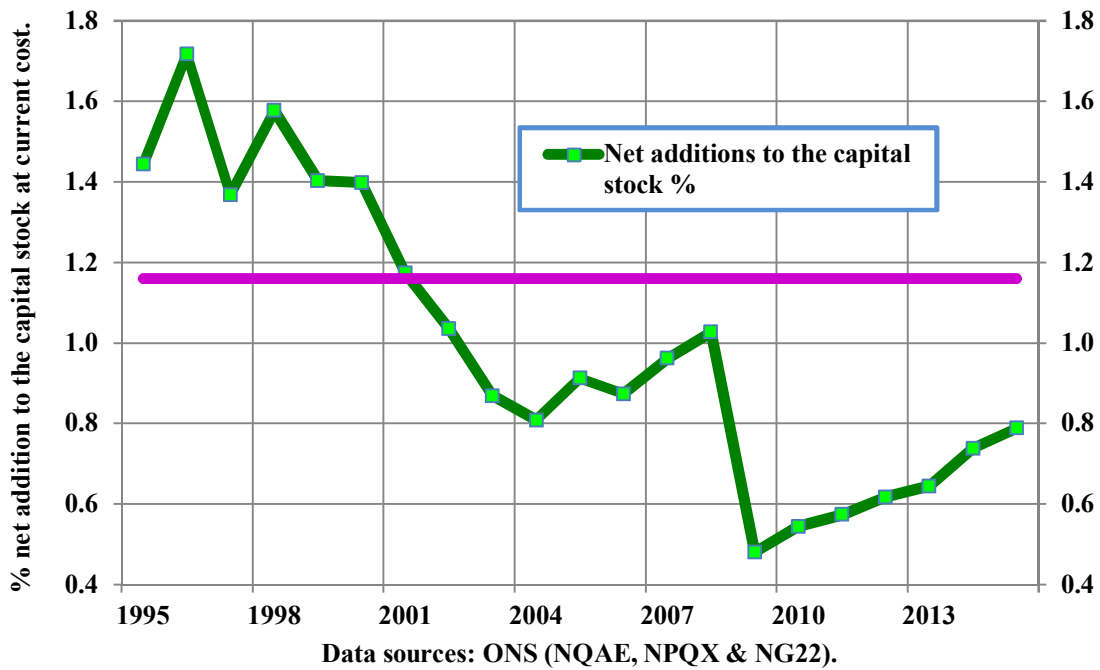
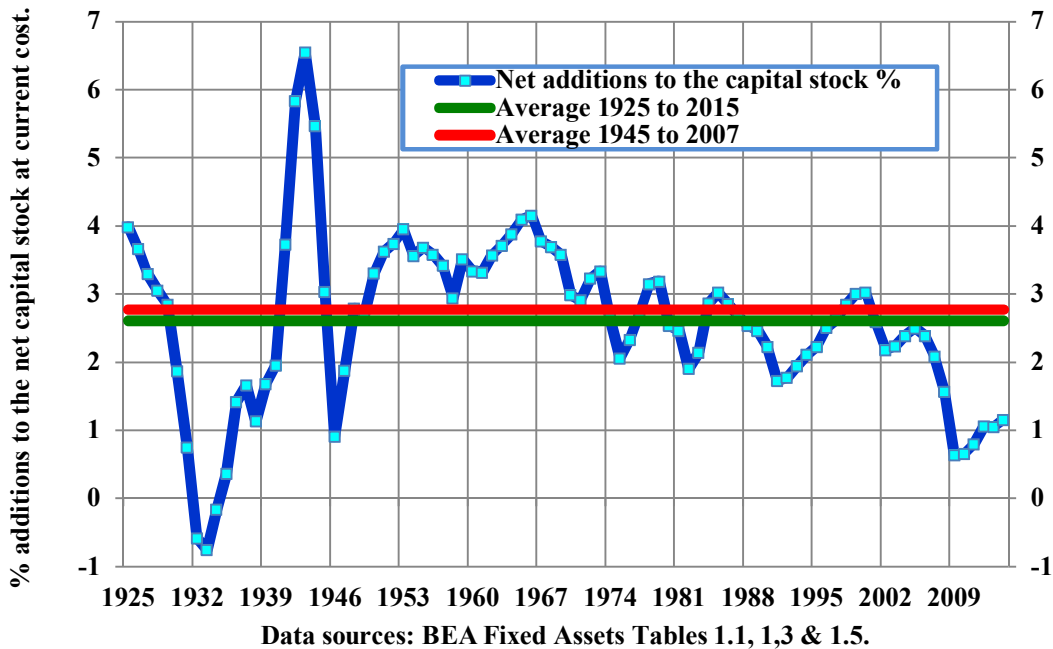
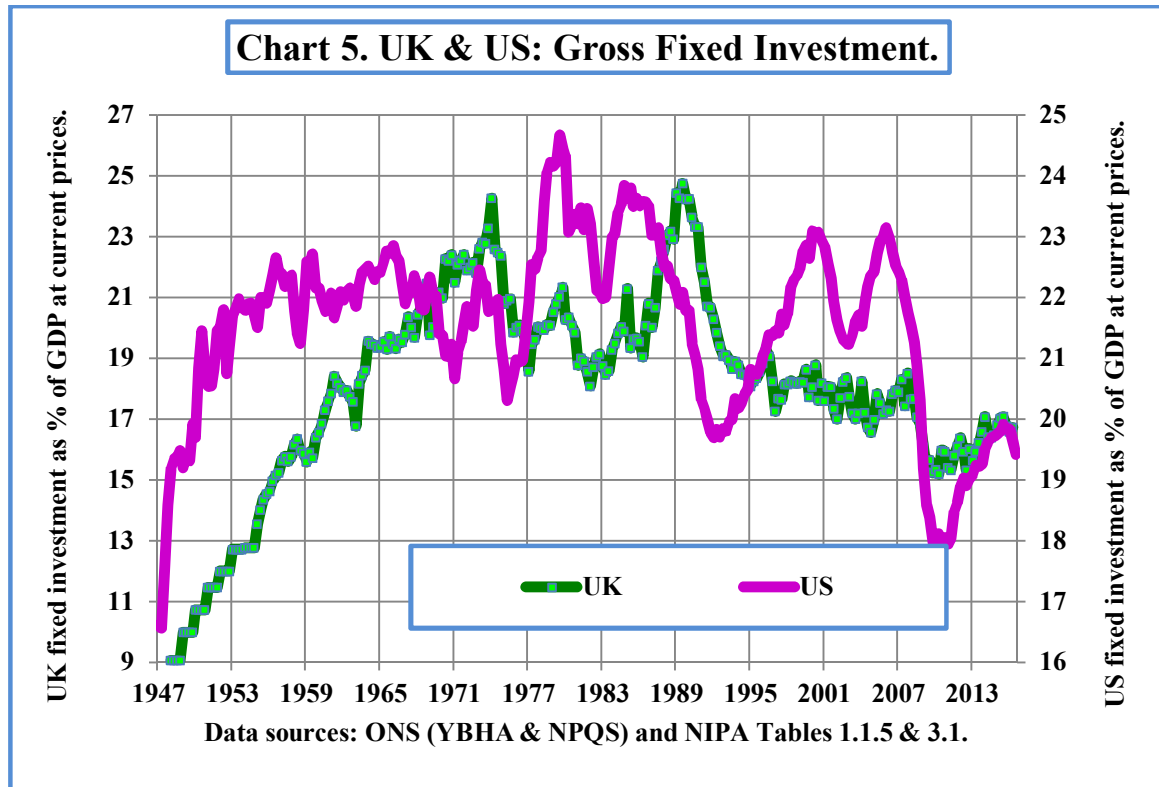


Chart 4. US: % Additions to the Net Capital Stock.



4. The Slow Growth in the Net Capital Stock.

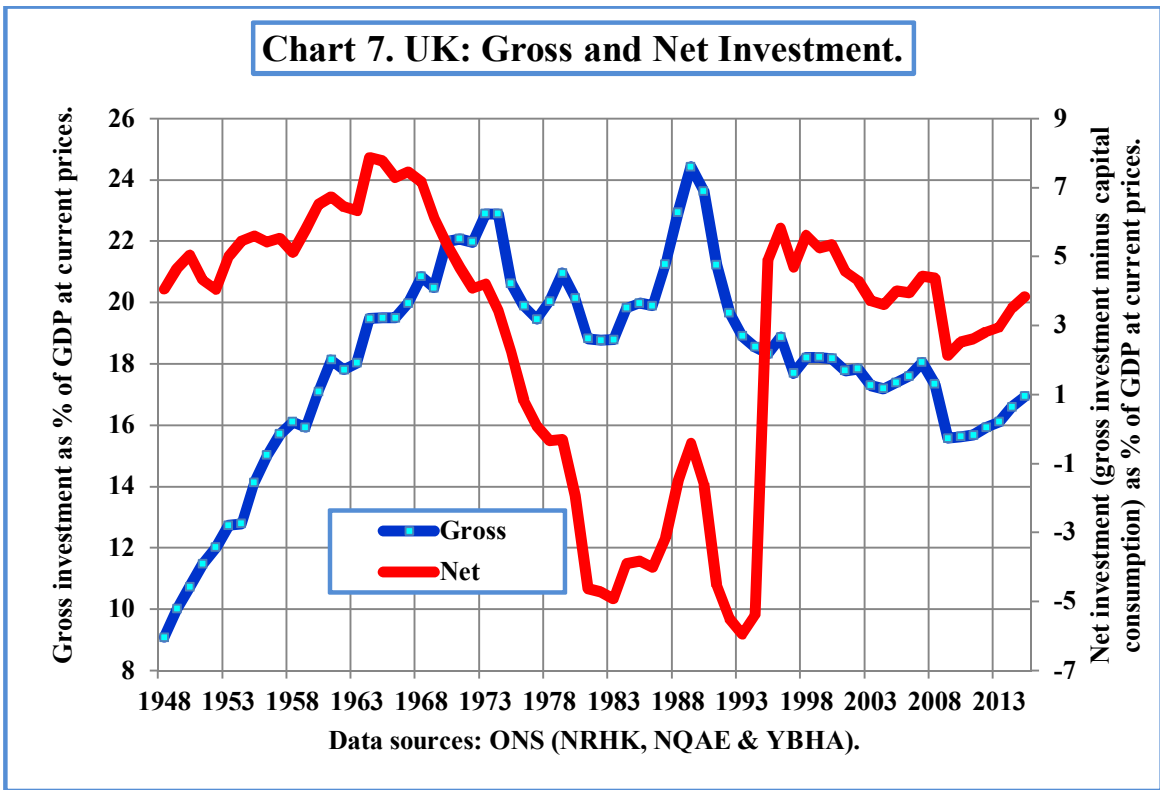
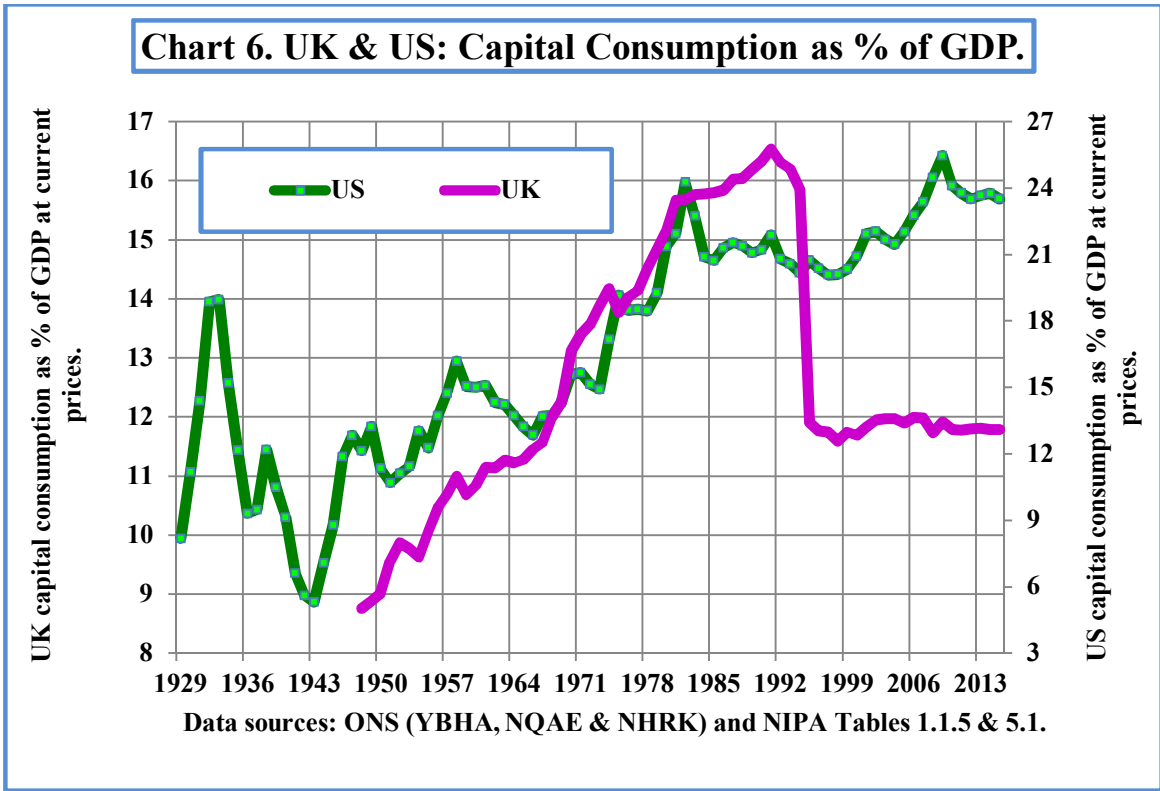
The growth of the net capital stock has slowed because gross investment has declined and capital consumption has risen.



Subject to changes in the value of the existing stock of capital, the net stock will rise when the level of gross investment exceeds the rate of depreciation on it. Changes in the net capital stock at current prices thus largely depend on both gross investment and the rate of capital consumption.

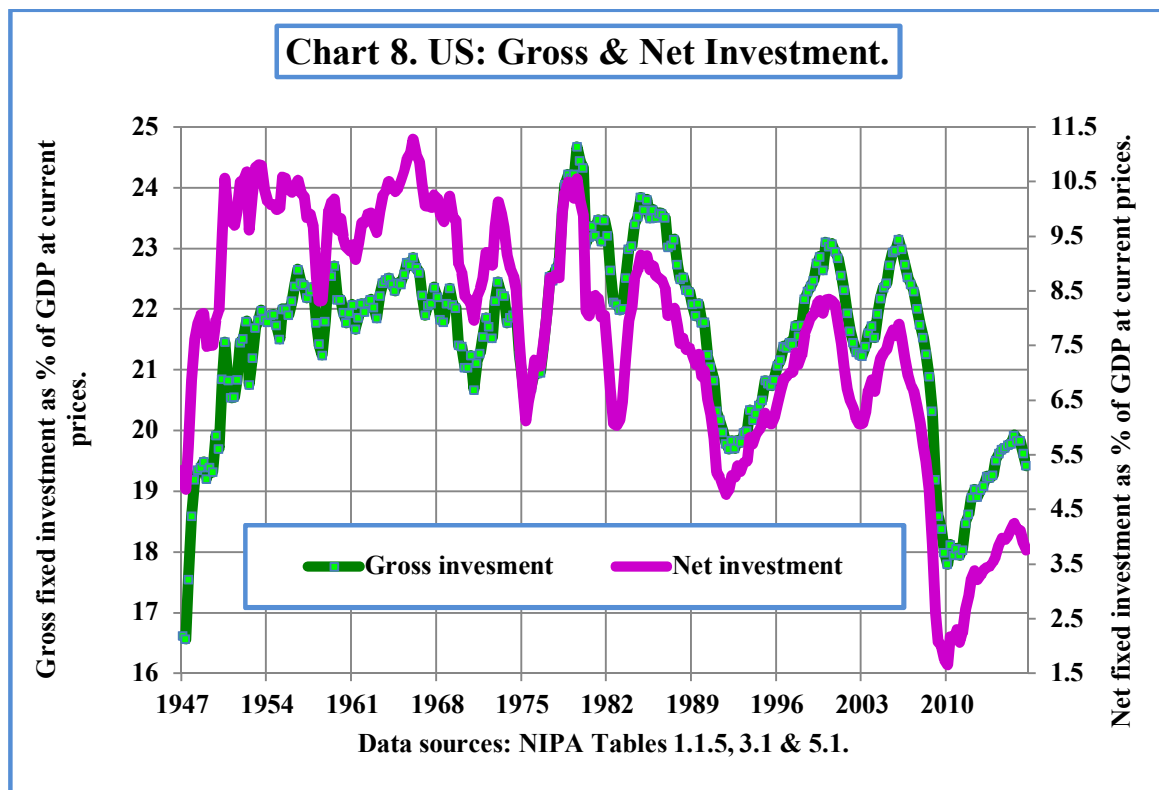
As Chart 5 illustrates, gross investment, which is measured before allowing for capital consumption, has been falling as a percentage of GDP in both the UK and the US for the past 30 to 40 years. Chart 6 shows that gross investment has fallen and capital consumption has risen over the long term in both the UK and the US. Both the fall in gross investment and the rise in capital consumption have thus contributed to the slowdown in the rate at which the net capital stock has risen.²

² The capital consumption percentage of the UK is calculated from the difference between net domestic output (NHRK) and gross domestic output (YBHA), expressed as a percentage of the latter. It can also be calculated after 1995 from capital consumption (NPQS) as a percentage of gross domestic output (YBHA). After 1995 the two series agree, but there is clearly a difference between the method used to calculate capital consumption and net domestic output (NHRK) before and after 1995. While we cannot therefore use long term data to measure changes in capital consumption, strong rising trend, shown by the available data from 1948 to 1995, indicates the capital consumption in the UK is likely to have risen strongly over the post-war period.



In the UK net investment data are only available on an annual basis. As shown in Chart 7, net investment peaked at 5.8% of GDP, using the revised series, which starts only in 1995, or at 7.9% in 1964 if the long term data are used. In 2015 it was 3.8% of GDP. In the US, where quarterly data are published, the peak level of net

investment was in Q1 1966 when it 11.3% of GDP, in Q3 2016 it was 3.8% as I illustrate in Chart 11. In both cases therefore net investment is less than half peak levels.



There has recently been a large change in the national accounts; earlier data as well as that for more recent years has been adjusted for the change. Previously R&D was treated as intermediary rather than final output. The change caused a significant rise in GDP and in capital consumption. The change has caused the extent of the decline in tangible investment to be often overlooked. Before the change the growth of the capital stock was more closely associated with the level of gross investment than it is with the current method for calculating GDP.

As Chart 9 shows, investment in R&D and other intellectual products (“IP”) has grown in the US from 4% of GDP in 1929 and 8% in 1948 to 31% in 2015, with a sharp rise occurring in World War II. We only have these data for the UK since 1987 when IP was 19% of total investment compared with 21% in 2015. The rate of capital consumption varies between different types of tangible assets but more between tangible and intangible assets, with the latter being written off more quickly. The rise in the proportion of intangible to total investment is thus the main reason for the rise in capital consumption.

Chart 9. UK & US: Intangible Investment as % of Total Fixed Investment.

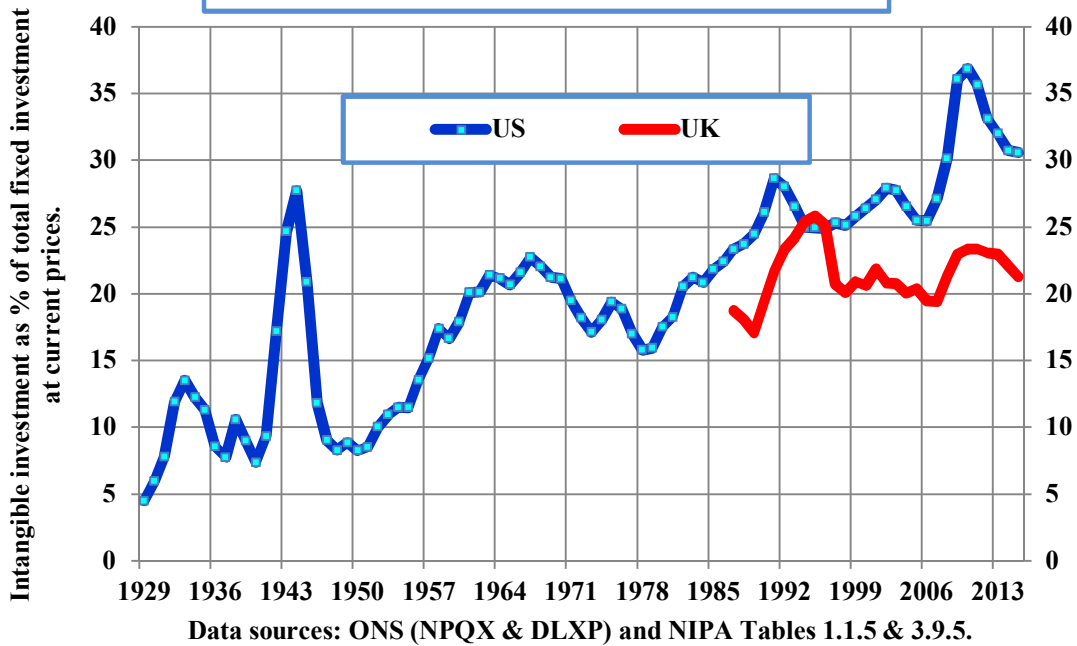
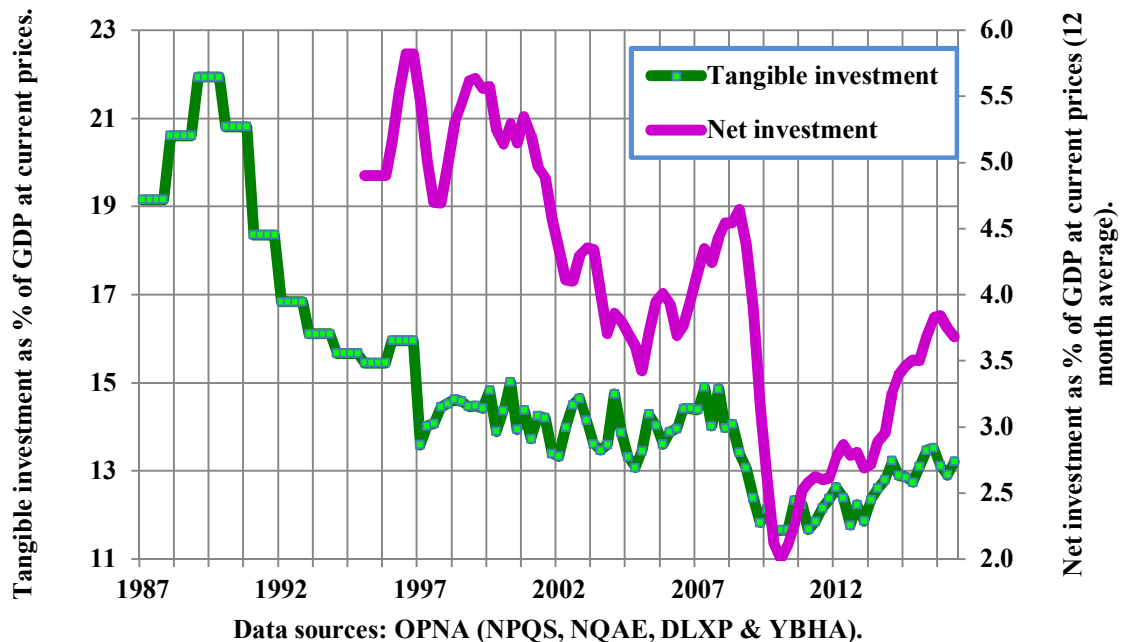
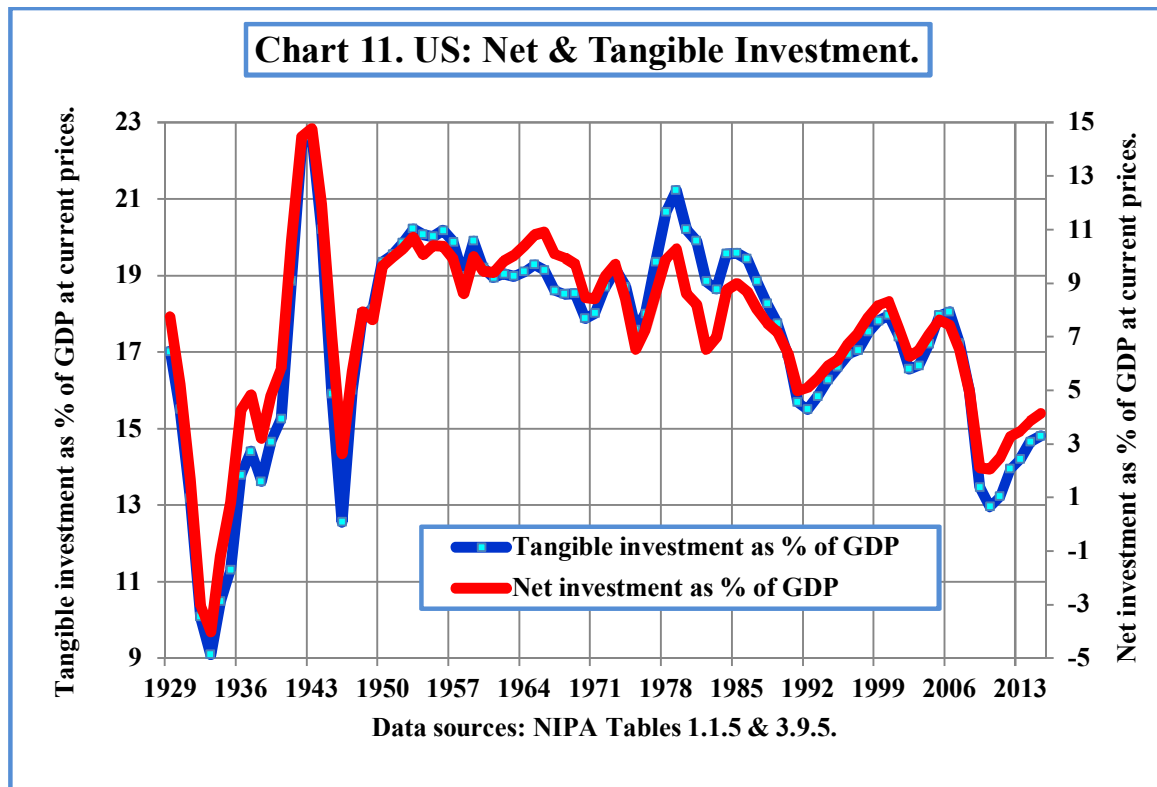


Chart 10. UK: Net & Tangible Investment.



Because intangible investment is written off quickly, the changes in net investment shown in Chart 7 for the UK and Chart 8 for the US largely reflect those that occurred in tangible investment, I illustrate the close relationship in Chart 10 for the UK and Chart 11 for the US. The relationship is closer in the case of the US than

it is for the UK, this seems to be due to the fact that the estimate for capital consumption is much more volatile in the case of the UK than for the US.



5. The Bonus Culture.

The weakness of investment which started before the recession began in 2008 cannot be explained by rising interest rates, poor economic prospects or poor returns on capital. It requires another explanation and my second key hypothesis is that the decline in investment was the result of the arrival of the bonus culture.

There has been a truly dramatic change in the manner and amount of management remuneration, as I illustrate in Chart 12 for the UK and Chart 13 for the US. Incentives change behaviour and we should not therefore be surprised by the marked change in management behaviour that has accompanied the change in the way management is paid.

Chart 12. UK: Management Cash Incentive Payments 1996 to 2013.

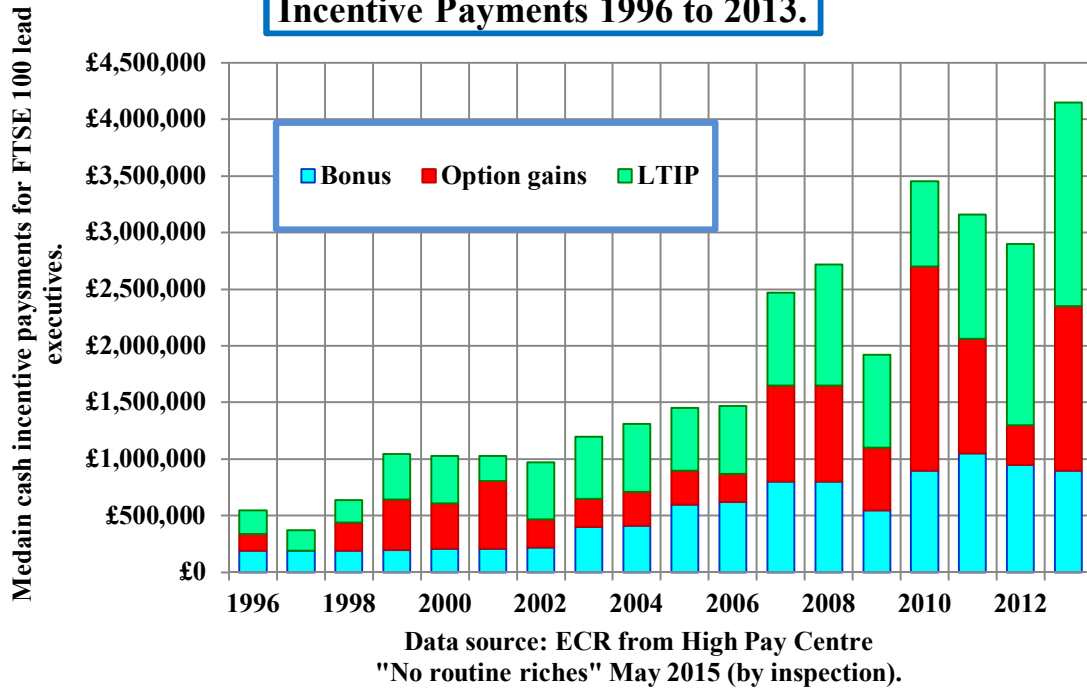
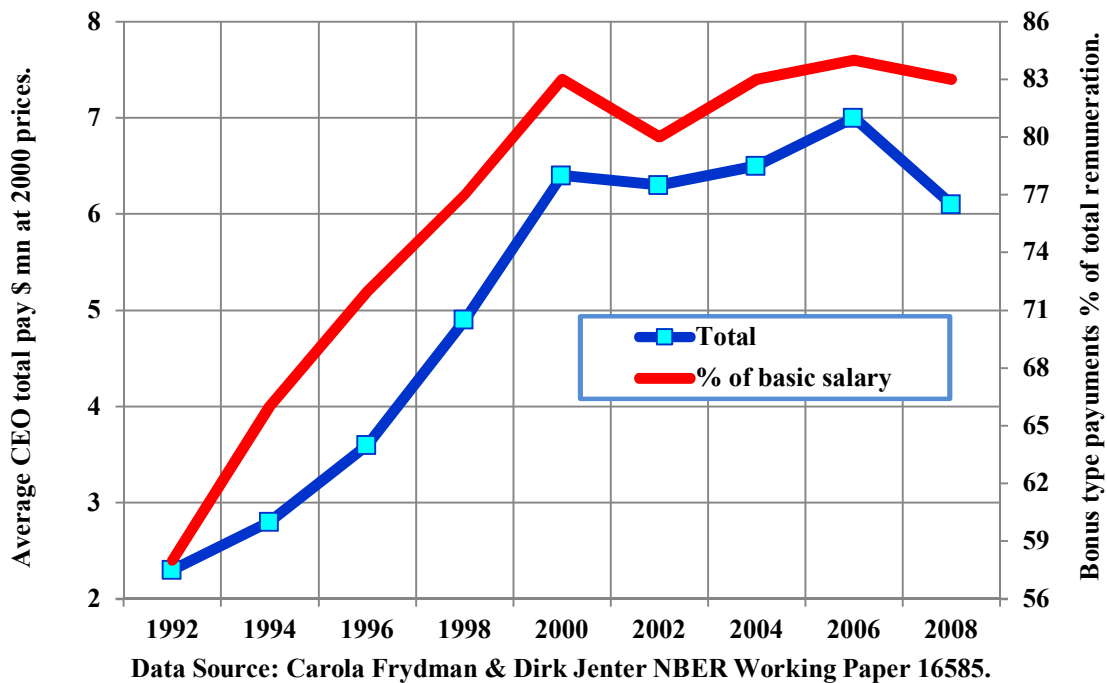


Chart 13. US: The Change in Management Incentives.



6. The Link between Low Investment and the Bonus Culture.

The change in US management remuneration shown in Chart 13 started in 1992 and escalated until 2000. This fits with the apparent change in corporate investment behaviour relative to the return on corporate equity (“RoE”) shown in Chart 13 and Table 1 (RoE and investment).

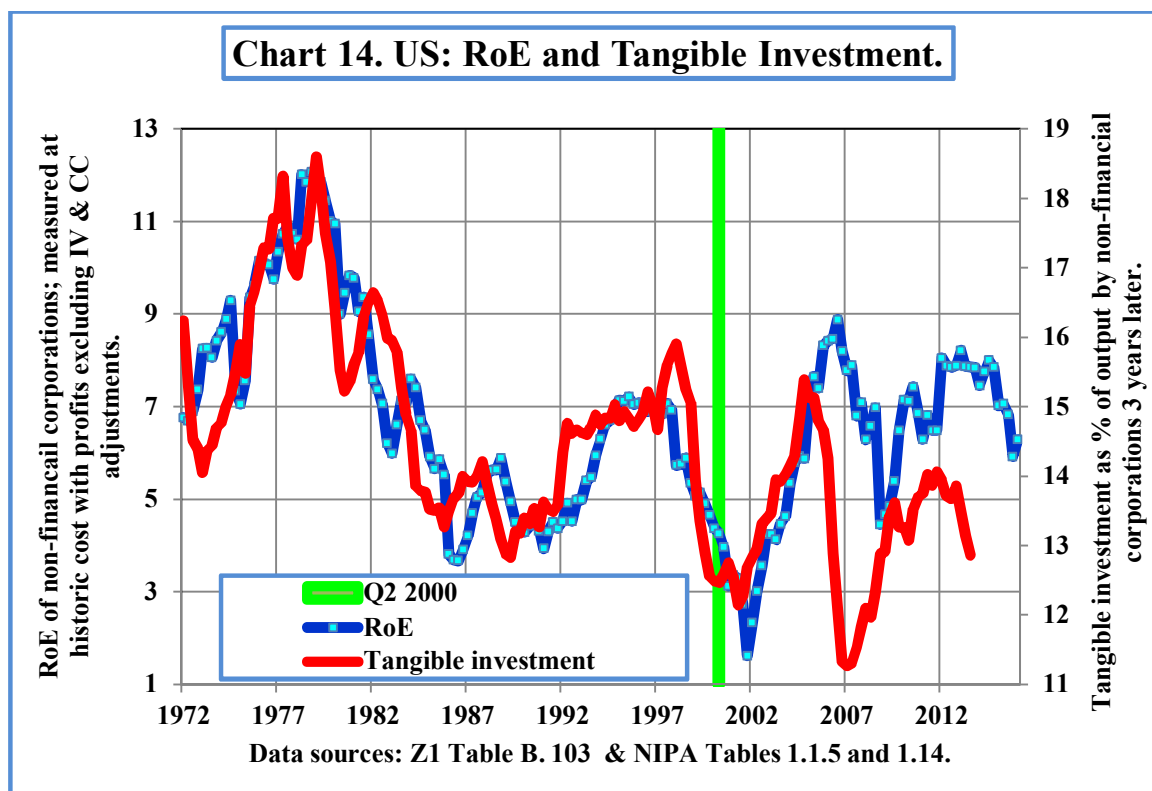


Table 1. R² Correlations between RoE and Tangible Investment for US non-financial corporations. (Data sources: Z1 Tables B 103 & F 103, NIPA Table 1.1.5)

Period	Coincident	Investment 3 years later
Q1 1972 to Q2 2000	0.274	0.713
Q3 2000 to Q3 2016	0.050	0.009

6. Implications for Industrial Policy.

Both hypotheses are testable and robust when tested. Productivity thus depends on the net capital stock whose slow growth is attributable to low investment in tangible assets. Industrial policy should therefore aim to increase tangible investment. As the fall has been caused by the perverse incentives of the bonus culture it would be sensible to change them.

7. Objections to the Net Capital Stock Hypothesis.

The first of my two hypotheses that output depends on the net capital stock has been queried on the grounds that it runs counter to the prevailing fashion. For example I have received the following email from a respected economic journalist. “The (long-standing) problem I have with your view is that it ignores the approach of modern economics to productivity (after the work of Bob Solow). In this, as you know, the growth of output is decomposed into growth of the labour stock, growth of the capital stock and the residual, also known as total factor productivity growth. The latter contains many elements, but the general view (as you also know) is that this embodies innovations not captured in the figures for investment. The important point in all estimates of the decline in productivity growth is that TFP growth has declined and, by definition, this cannot be explained by the decline in investment, since measured investment is not held to explain TFP.”

This objection is based on misunderstandings. The measurement of the net capital stock is not simply the accumulation of past physical investment but allows for innovations. Far from being contrary to the work of Bob Solow he is the co-author of a paper which shows that the value of net capital stock depends not only on amount of past investment but on advances in technology and the skills of the work force.³ These produce changes in productivity and Solow shows that such changes affect the rate of depreciation and, as the value of the net capital stock is after deducting depreciation, it allows for advances in technology and work force skills, as reflected in changes in productivity.

The email also remarked that “...you cannot simply ignore the entire corpus of modern economic analysis of the drivers of growth. You have to show why it is misleading.” This again is a misunderstanding. I am not claiming that this analysis is misleading simply that it cannot be used to explain why productivity has been so poor. This is implicitly acknowledged by those who look to detailed TFP analysis for explanations as they habitually argue that the decline in labour productivity is “inexplicable”. The net capital stock model is not at odds with TFP as an explanation of growth. It shows that change in GDP can be disaggregated into the change in employment and the change in the net capital stock, with the latter including both changes in the volume of past investment, and changes in technology.

TFP seems to me to provide a convincing and usefully simplified description of the main drivers of growth. Describing it as a simplification is not a criticism. Models are necessarily simplifications and we need them into to understand how the real world works. TFP is therefore a model in embryo. To be a valid model, however, it needs to be based on one or more hypotheses which are testable and robust. Although models have been produced which aim to follow TFP more directly than I do, I have not yet encountered one that claims to be testable let alone robust. If valid models of

³ *Neoclassical Growth with Fixed Factor Proportions* by R.M. Solow, J. Tobin, C.C. von Weizsacker and M. Yaari published in *The Review of Economic Studies* Vol. 33 No. April, 1966. .

this type could be produced they would be better than the net capital stock model I use, as they would exclude more possibilities, thereby contain more information, and be more severely testable:⁴ at the moment they not testable at all and thus inferior to the net capital stock model.

Another objection to the net capital stock hypothesis is that the national accounts do not use productivity to calculate capital consumption. While this is correct as a statement it does not prove that capital consumption estimates, from which the net capital stock is derived, do not correctly allow for changes in productivity and indeed for other variables. By their very nature shocks happen in unexpected and random ways. No fixed model for capital consumption is likely to be able to account accurately for the variations in value of invested capital.⁵ This problem is, however, circumvented in official estimates by the use of surveys.⁶

In the absence of a better valid model, it would be foolish to ignore the valid one we have. By ignoring the net capital stock we are neglecting what we know in favour of what we don't but would like to know. This is foolish and is a major inhibition on the introduction of sensible economic policy.

The robustness of the net capital stock hypothesis leads naturally to the observation that its low growth will lead to poor labour productivity. It therefore provides an explanation for it. It does not provide a guide to how much growth would rise if there was an increase in tangible investment by say 1% of GDP on a sustained basis, but it is almost impossible that a rise in such investment would have no impact on productivity.

8. More Detailed Explanation of the Bonus Culture Hypothesis.

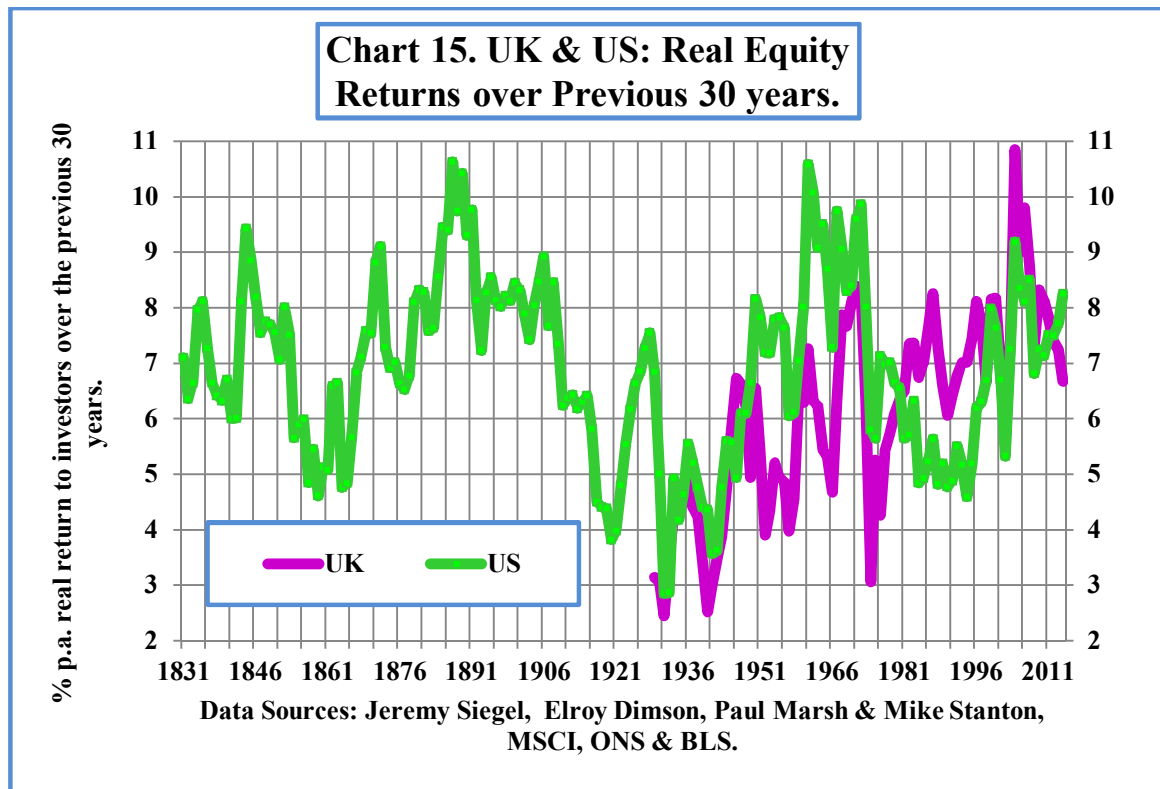
The real return on equity investment by shareholders has been rotated around a long term stable rate of about 6% (Char 15). As this must also be the long term return on corporate equity it appears that companies have a stable long term level of expected returns on equity and investment is thus likely to be affected by them. This is

⁴ They would be more informative and exclude more because they would make more predictions, for example about relationship of productivity with variables other than the level of the net capital stock. Reviewing the progress of scientific theories Karl Popper writes "In each case the progress was towards ... a theory which was more severely testable because it made predictions which, in a purely logical sense, were more easily refutable." *Conjectures and Refutations* published by Routledge and Keegan Paul 1963.

⁵ This is therefore, to me, an objection to the ONS and the Oulton/Davies models which seem to assume that the net capital stock can be accurately measured from data on gross investment allowing for assumed and stable rates of capital consumption. It should also be noted that these papers are based on an economic model originally proposed by Robert Solow, but they do not follow his model for capital consumption as set out in the paper, to which I refer in footnote 3, which ascribes capital consumption to the rate of growth of labour productivity.

⁶ Appendix. Measurement of the Net Capital Stock and Depreciation in the UK and the US.

strongly supported by anecdotal evidence which indicates that the hurdle rates required by companies to justify investment are based on RoEs.



It is usual, but not invariable, for expectations for the future to be heavily influenced by past events. A recent fall in returns on corporate equity (RoE) would thus provide a reason for fearing a fall in prospective returns even if economic growth was expected to remain robust. In addition to recent equity returns there are many reasons why companies vary their expectations for future returns. Chart 14 shows that from 1970 to 2000 recent RoEs appear to be the dominant determinant of the level of tangible investment by US non-financial companies, as this rose and fell with changes in RoEs. An explanation is therefore needed to explain the sharp change after 2000. The change in incentives with the bonus culture provides this. Furthermore there are no other obvious contenders. Interest rates after 2000 fell sharply and central bankers⁷ were among those who expressed great confidence in future growth. The apparent paradox of high returns and low investment in the US has been given space by Paul Krugman in his New York Times articles. He puts forward the idea that this may be the result of a fall in competition.⁸ The effects of a fall in competition and the bonus culture are in many ways similar but the bonus culture provides a much superior

⁷ For examples see Federal Reserve Governor Ben S. Bernanke, *The Great Moderation* remarks at the meetings of the Eastern Economic Association, Washington, DC February 20, 2004 and *Keeping the Keynesian Faith: Alan Blinder on the evolution of macroeconomics*. Interview by Brian Snowdon published in *World Economics* 2(2) (2001).

⁸ *Robber Baron Recessions* article by Paul Krugman published in the New York Times 18th April, 2016.

explanation because the evidence for it is independent of the combination of high returns and low investment while there seems no independent evidence for the presumed fall in competition. The similarity of some of the economic impacts of the bonus culture and a decline in competition, suggest that the competition authorities would be suitable people to assess remuneration systems.

Appendix 1.

Measurement of the Net Capital Stock and Depreciation in the UK and the US.

The approach of both the UK's Office of National Statistics ("ONS") and the US's Bureau of Economic Analysis ("BEA") are basically the same, the value of the capital stock and depreciation are estimated from historic investment and from survey data. The latter provide evidence for the value of second hand equipment and thereby for the value of installed capital stock and of the rate at which capital depreciates. As these values will fall in line with the return that can be derived by the purchaser they will reflect, inter alia, the expected profitability of the equipment and this will in turn reflect the rate of growth of real wages since the capital was installed. The use of survey data thus allows for the rate of growth of productivity when valuing the net capital stock and rates of capital consumption.

The ONS describes its approach as follows. "**Gross capital stock** tells us how much the economy's assets would cost to buy again as new, or their replacement cost. All of the fixed assets in the economy, that are still productive and in use, are added up to calculate this. ...This measure shows the value at the end of the year. This is mainly calculated as an intermediate step towards net capital stock.... **Net capital stock** shows the market value of fixed assets. The market value is the amount that the assets could be sold for, which will be lower than the value of gross capital stocks."⁹

The BEA uses both survey and historic data to measure the capital stock. "There are two basic methods for measuring net stocks. The physical inventory method applies independently estimated prices to a direct count of the number of physical units of each type of asset. The perpetual inventory method cumulates past investment flows to indirectly estimate the value of the stock."¹⁰ The BEA bases its estimates of depreciation on survey data. "BEA's estimates of depreciation are based on geometric depreciation patterns, which are supported by empirical studies of the prices of used equipment and structures in resale markets."¹¹

⁹ *Capital stocks, consumption of fixed capital* published in the ONS Statistical bulletin 2014.

¹⁰ *Fixed assets and consumer durable goods 1925 to 1997* published by BEA.

¹¹ Ditto

