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Abstract

The behaviour of labour productivity in the United Kingdom since the onset of the recession in early 2008 constitutes a puzzle. Over four years after the recession began labour productivity is still below its previous peak level. This paper considers the hypothesis that economic capacity can be permanently damaged by financial crises. A model which allows a financial crisis to have both a short-run effect on the growth rate of labour productivity and a long-run effect on its level is estimated on a panel of 61 countries over 1955–2010. The main finding is that a banking crisis as defined by Reinhart and Rogoff on average reduces the short-run growth rate of labour productivity by between 0.6% and 0.7% per year and the long-run level by between 0.84% and 1.1% (depending on the method of estimation), for each year that the crisis lasts. A banking crisis also reduces the long-run level of capital per worker by an average of about 1%. The corresponding effect on GDP per capita is about double the effect on GDP per worker since there is a long-run, negative effect on the employment ratio.

Key words: Productivity, financial, banking crisis, recession.

JEL classification: E23, E32, J24, O47.

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Summary

In the period before the Great Recession began in early 2008 the growth of labour productivity in the United Kingdom had been quite rapid and higher than in most other major economies. Labour productivity fell sharply during the recession proper (the period when output was falling) but this was not very surprising; the same pattern has been found in earlier recessions. What is much more surprising is that as the economy began to recover following the trough of the recession in 2009Q2, labour productivity did not also recover. In 2012Q1, four years after the onset of the recession, it was still below its previous peak in 2007Q4 and well below the level expected on the basis of the pre-crisis trend.

Some insight into the puzzle comes from breaking down the economy into 17 sectors. Excluding sectors where measurement is problematic does not explain the slowdown. Nor can it be explained by a shift in the labour force towards sectors with a low level of productivity.

Two main hypotheses have been proposed to explain the productivity puzzle. First, firms may be hoarding labour in anticipation of a recovery in demand. If so, productivity growth will recover when demand recovers and eventually the *level* of labour productivity will get back to where it would have been if the recession could somehow have been avoided. The second hypothesis is that the financial crisis and the recession to which it gave rise have permanently damaged the productive capacity of the economy. According to this hypothesis, even if the productivity *growth rate* returns to its pre-crisis value, the productivity *level* will always lie below the path which it would have followed in the absence of the crisis. This paper is mainly devoted to the second hypothesis.

In testing the capacity damage hypothesis it is important to allow for the possibility that financial crises have both short-run and long-run effects and that these effects may be on both the level and the growth rate of productivity. It will then be an empirical issue how large or small these effects are. A model with these properties is set out and tested empirically on a panel of 61 countries over 1955-2010 by combining data from two sources. Data on productivity (GDP per worker) are from The Conference Board's Total Economy Database of national accounts. The number and duration of financial crises come from the data underlying *This time is different: eight centuries of financial folly*, by Carmen Reinhart and Kenneth Rogoff. Reinhart and Rogoff define six types of crises: currency, inflation, stock market, external debt, domestic debt, and banking. Interest focuses on the last type, banking crises, since in the absence of a banking crisis the other types are found not to have significant effects on productivity.

The results suggest that banking crises as defined by Reinhart and Rogoff have on average a substantial and statistically significant effect on both the short-run *growth rate* and the long-run *level* of labour productivity. The short-run growth rate of labour productivity is typically reduced by between 0.6% and 0.7% per year for each year that the crisis lasts and the long-run level by between 0.84% and 1.1% (depending on the method of estimation). No such significant effects were found for the five other types of financial crisis distinguished by Reinhart and Rogoff.

One channel through which banking crises do their damage is through their effect on the long-run level of capital per worker. We find that this level is on average reduced by about 1% for each year of crisis. We also find that banking crises have a long-run, negative effect on the employment ratio (due to either higher unemployment or higher inactivity rates): the effect on GDP per capita is double the effect on GDP per worker.

Three qualifications should be noted. First, these results are for all countries combined — advanced, emerging and developing. If only advanced countries are considered then banking crises do not have a significant effect on the long-run productivity level. Second, the banking crisis variable is a zero/one dummy and there is no measure of the severity of any crisis, other than the circular one of looking at its consequences. Because of this second qualification, one should be cautious before taking too much comfort from the first one. It may be that the insignificant results found for the advanced countries just reflect the fact that advanced countries have up to now (and the data stop in 2010) not experienced crises severe enough to generate a statistically significant effect on productivity levels. And third, these are only average effects. No banking crisis is alike. In any particular country or particular period, the impacts may differ substantially from the mean.

Finally, even if the findings on the capacity damage hypothesis are accepted, this does not force automatic rejection of the rival labour hoarding hypothesis. The latter must be assessed on its own merits. However our finding of a *permanent* effect of banking crises on the labour productivity level cannot be attributed to labour hoarding.

1 Introduction

In the period before the Great Recession began in early 2008 labour productivity growth in the United Kingdom had been quite rapid and higher than in most other major economies. Labour productivity (GDP per hour worked or per worker) fell sharply during the recession proper (the period when output was falling) but this was not very surprising; the same pattern has been found in earlier recessions. What is much more surprising is that as the economy began to recover following the trough of the recession in 2009Q2, labour productivity did not also recover. In 2012Q1, four years after the onset of the recession, labour productivity was still below its previous peak in 2007Q4 and well below the level expected on the basis of the pre-crisis trend.

Two main hypotheses have been proposed to explain this puzzle. First, firms may be hoarding labour in anticipation of a recovery in demand. If so, productivity growth will recover when demand recovers and eventually the *level* of labour productivity will get back to where it would have been if the recession could somehow have been avoided. The second hypothesis is that the financial crisis and the recession to which it gave rise have permanently damaged the productive capacity of the economy. According to this hypothesis, even if the productivity *growth rate* returns to its pre-crisis value, the productivity *level* will always lie below the path which it would have followed in the absence of the crisis. These possibilities are illustrated in Figure 1. The optimistic picture fits better with the labour hoarding hypothesis: growth returns to its previous value and the economy also returns to its previous trend line. The pessimistic picture fits the damage hypothesis: growth returns to its previous value but even so the economy follows a track below the pre-crisis trend line. In the *very* pessimistic picture, the growth rate too is permanently lowered by a financial crisis. The percentage gap between the new trend line and the pre-crisis one grows without limit, though as argued below this outcome is unlikely.

1.1 Plan of the paper

The next section reviews the course of labour productivity growth before and after the recession which began in 2008Q1. Then in Section 3 the economy is broken down into 17 sectors to see whether any obvious pattern emerges. The question whether index number issues or compositional effects are influencing the aggregate picture is also examined. Productivity at the sectoral level turns out to be quite diverse and there are even sectors where it has completely recovered. But, despite this, the productivity slowdown is widespread. Section 4 considers the two major contending hypotheses for explaining the slowdown: labour hoarding and damage to capacity resulting from the financial crisis. Section 5 presents a theoretical model of productivity growth which allows for the possibility that a financial crisis will affect both the *short-run growth rate* of labour productivity and also its *long-run level*. The size of any such effects must be determined empirically. Section 6 introduces the two data sources used in a panel analysis of financial crises designed to measure these effects (if they exist). These sources are the Reinhart-Rogoff (2009) database of financial crises and the Conference Board's Total Economy Database (TED) of national accounts. Merging these two sources together gives data on 61 countries (rich, emerging and poor) over 61 years, 1950-2010. Section 7 reports the

econometric results of fitting this model to the data described in Section 6. Finally, Section 8 concludes.

2 Labour productivity in the United Kingdom: facts and puzzles

This section reviews the course of labour productivity in the United Kingdom before and after the Great Recession and compares it with that of some other major economies.

In the period before the Great Recession began in early 2008 labour productivity growth in the United Kingdom had been quite rapid and higher than in most other major economies. Chart 1 which shows the growth of GDP per hour in the market sector (i.e. excluding government which is not measured in a comparable way in different countries) in 16 countries over 1990-2007. At 2.87% per year the United Kingdom was ahead of amongst others France, Germany, Spain, Italy, the Netherlands and the United States and behind only Sweden, Finland and Ireland.

Chart 2 shows the course of quarterly labour productivity (GDP per hour worked) from 1997Q1 up till the latest date available when this work began, 2012Q1. This chart and succeeding ones have a common format. What actually happened (according to the most recent information) is shown as a solid line with a dashed line showing the trend estimated over the pre-recession period. The trend is calculated by the Hodrick-Prescott (HP) filter (with parameter set to 1600 since these are quarterly data) over the pre-crisis period 1997Q1-2008Q1 and extrapolated beyond then to the end of the period (2012Q1). The HP trend should not be taken too literally: it should not necessarily be interpreted as a forecast of what would have happened if the recession could somehow have been avoided. The charts also show the Great Recession (the period of falling GDP) marked by a red bar.

If GDP at market prices is taken as the aggregate measure, output started falling in 2008Q2 and continued falling in the subsequent four quarters up to and including 2009Q2. It began rising again in 2009Q3. 2009Q2 therefore marks the trough of the present cycle while 2009Q3 marks the end of the recession in a technical sense and the start of the recovery.[1] If instead GDP at basic prices is used, the recession began one quarter earlier, in 2008Q1, but the trough is the same on both measures, 2009Q2. (Source: Quarterly National Accounts). Labour productivity (GDP per hour worked) actually peaked in 2007Q4. From this peak till the trough, labour productivity fell by 4.7%. Comparing the latest available period, 2012Q1, with the previous peak, labour productivity was 1.6% lower. Relative to the pre-crisis HP trend, labour productivity in 2012Q1 was 10.0% lower.

In some sectors the measurement of output is problematic or idiosyncratic factors may be at work. These problematic sectors include for different reasons government, energy and financial services (see Section 3 below). If we exclude these sectors which accounted for nearly 40% of the economy in 2008, the picture for productivity growth is shown in Chart 3. The recession now looks a bit deeper but the productivity level is close to regaining its previous peak level.

[1] Recent GDP estimates suggest that the UK entered a second recession in the fourth quarter of 2011 from which it appears to have exited in 2012Q3.

Labour productivity on a "heads" basis, GDP per job, looks even worse than on an hours basis (Charts 4 and 5). This is because hours fell more than did jobs. Weekly hours per job were declining prior to the recession but have now fallen below their extrapolated trend (Charts 6 and 7).

The UK experience is in sharp contrast to that of the United States. There output per hour in the nonfarm business sector fell initially as the recession began but then recovered strongly. In 2011 growth weakened but was still positive. In 2011Q4 the productivity level was 8% higher than at its previous peak in 2007Q4. On average it grew by 1.9% per year between 2007 and 2011. By comparison productivity grew at 2.5% on average over 2000-2007 and 2.1% over 1990-2001.[2] So there is no crisis in US labour productivity, despite the fact that during the recession GDP fell by about the same proportion in the United States as in the United Kingdom. The UK productivity performance post-recession also seems to have been worse than in most EU countries (Hughes and Saleheen (2012)).

3 Explanations and hypotheses

Before getting on to what we consider to be the two main hypotheses to be explored, labour hoarding and damage to capacity resulting from the financial crisis (see the next section), we consider a number of other possibilities.

3.1 Lower capital input

One possible explanation for lower labour productivity is a decline in capital services per unit of labour, due to lower investment since the Great Recession began. The ONS has recently published estimates of TFP which go up to 2010 (Appleton and Franklin (2012)). From their figures it is possible to estimate that the contribution of the growth of capital services per hour worked (capital deepening) to whole-economy GDP was 1.02 percentage points in 2008, 1.64 percentage points in 2009, and 0.59 percentage points in 2010, i.e. it was positive in all three years. Estimates for the market sector have been provided by Goodridge *et al*. (2012) whose annual estimates go up to 2009. They show that the contribution of capital deepening to the growth of output per hour in the market sector was small and positive in 2008 and small and negative in 2009 (see their Tables 7 and 8). This was the case whether the contribution of capital is measured on the current national accounts basis or on an extended basis including additional intangible assets such as R&D stocks. So though investment has fallen, the fall was not large enough to cause a significant decline in capital services per worker (partly because hours worked have also fallen). So the fall in investment cannot explain the fall in labour productivity.

These estimates of capital services all assume that asset lives have remained the same as they were before the Great Recession. If the Great Recession led to premature scrapping then the growth of capital services might have been overstated. However, contrary to many statements to the contrary, there is little or no evidence that the Great Recession did lead to premature

[2] Source: US Bureau of Labor Statistics, www.bls.gov.lpc/prodybar.htm, accessed on 1st March 2012.

scrapping and some arguments to the contrary, e.g. Gordon (2000). Firms which experience falling sales and consequently go out of business will dispose of their assets before their expected life length is reached. The issue then is whether the capital is scrapped or whether it is acquired by some other domestic firm. On the other hand firms which continue in business may respond to financial pressure by replacing capital less frequently, i.e. for these firms asset lives get longer not shorter. There is no empirical evidence for the United Kingdom on the balance of these effects.

3.2 Sectoral analysis

Some insight into the productivity puzzle comes from breaking down the economy into sectors. Table 1, using data kindly supplied by the Office for National Statistics (ONS), shows a breakdown into 17 sectors; output in these sectors aggregates to GDP.[3] This table shows the share of each sector's value added in aggregate value added (GDP) in the last year of the boom, 2007. Also shown are the 2007 shares of each sector in aggregate hours worked. If we divide the share in GDP by the share in aggregate hours we get the relative labour productivity of each sector (value added per hour in each sector divided by aggregate value added (GDP) per hour); this is shown in the last column. The level of labour productivity varies widely across the 17 sectors, from a low of 0.39 in "Agriculture, forestry & fishing" to a high of 10.65 in "Mining and quarrying including oil and gas". So, hypothetically, holding the productivity growth rate in each sector at its observed value but reallocating labour towards (say) a sector with a low productivity *level* could lower aggregate productivity by a significant amount, a point to which we return below.

Charts 10 to 26 show the course of labour productivity in each of these 17 sectors. Included in each chart is a trend line estimated by the Hodrick-Prescott filter over the pre-crisis period 1997Q1-2008Q1 (with parameter set to 1600 since these are quarterly data) and extrapolated beyond then to the end of the period (2012Q1). In all these charts the vertical axis is on a log scale so that growth rates can be read off from the slopes of the lines. A red bar marks the period of the recession proper, i.e. the period when GDP at market prices was falling (2008Q1-2009Q1). A number of patterns can be distinguished:

1. Sectors where productivity was stagnant or declining before the recession began but where performance has deteriorated further since the recession: Agriculture, forestry and fishing (section A), Mining & quarrying including oil and gas (section B), Electricity, gas, steam, etc (section D), Water supply, sewerage, etc (section E), and Other services

[3] The data supplied were output (real and nominal value added), hours worked and workforce jobs (including the self-employed) for each of the 17 sectors. Real value added is single-deflated, i.e. the growth of real value added is proxied by the growth of gross output deflated by a price index for gross output. The basic data on output are derived from employer-based surveys done at the reporting unit level while jobs data are at the local unit level. Reporting units and local units are assigned to industries in accordance with what is declared to be their "principal product". Consequently not every local unit is necessarily assigned to the same industry as that of the reporting unit to which it belongs. For the purpose of productivity statistics, for consistency the ONS reclassifies local units so that they are all assigned to the industry of the reporting unit to which they belong. As a result the series for jobs and hours used to estimate labour productivity (which are partially published in the ONS's Productivity Bulletin) are not the same as the series for workforce jobs and hours published separately. Note also that total hours worked are derived from the Labour Force Survey (LFS), as is self-employment, and hours worked in each sector are scaled so that they add up to the LFS total.

and household activities (sections S-U). These sectors comprised 7.3% of GDP in 2007. See Charts 10, 11, 13, 14 and 26.

2. Sectors where the productivity *growth rate* had recovered to roughly its pre-crisis value, at least before the second downturn of 2011Q4 to 2012Q2, but where the productivity *level* is still below the previous peak (and a fortiori below the pre-crisis trend line): Manufacturing (section C), Accommodation and food services (section I), Professional, scientific and technical activities (section M), and Administrative and support activities (section N), which comprised 25.7% of 2007 GDP. See Charts 12, 18, 22 and 23.
3. Sectors where productivity growth is still below its pre-crisis rate and where the productivity *level* is still below the previous peak (and a fortiori below the pre-crisis trend line): Wholesale and retail trade (section G), Transport and storage (section H), Financial and insurance activities (section K), which comprised 24.6% of 2007 GDP. See Charts 16, 17 and 20.
4. A sector where both productivity growth and the productivity level are close to the pre-crisis trend: Information and communication (section J), comprising 6.0% of 2007 GDP. See Chart 19.

In addition there are several maverick sectors. In government services (sections O, P and Q) productivity growth was fairly flat pre-crisis but the current level is above trend. Arts, entertainment and recreation (section R) has seen quite rapid growth post-crisis so that its level is now above trend. Construction (section F) had very erratic productivity growth pre-crisis but is now above its (declining) trend. Finally, productivity growth has exploded post-crisis in Real estate (section L) but this is a statistical artefact. Most of the "output" of this sector is the imputed rent of owner occupiers which has not fallen but for which there is no associated employment. So if estate agents lose their jobs as there are fewer housing transactions then labour productivity rises automatically. These maverick sectors comprise 36.3% of 2007 GDP: see Charts 15, 21, 24 and 25.

3.3 Some explanations which do not work

We now consider a number of explanations which can be collectively referred to as composition effects.

1. *Reallocation effects*. As noted above, if as a result of the recession labour has shifted from high to low productivity sectors, then aggregate labour productivity will have taken a hit even in the absence of hits to individual sectors. We test for this by estimating what aggregate labour productivity would have been if the allocation of labour (the shares of aggregate hours) had remained the same as in 2007 for all subsequent quarters. That is, we assume that labour productivity in each sector grew at its observed rate but output was what a constant labour share would have produced.
2. *The influence of hard-to-measure or otherwise problematic sectors*. It is often suggested that banking output was overstated in the boom.[4] In the government sector (public administration and defence, health and education) great efforts have been made to improve output measurement, but nonetheless more remains to be done; in any case, the incentives in this sector differ from those in the rest of the economy. As just discussed there are some sectors

[4] See Burgess (2011) for discussion of the problems in measuring the output of financial services.

where labour productivity was declining prior to the recession for non-economic reasons and other sectors whose performance cannot be taken at face value. We test for the influence of the problematic sectors on the aggregate story by dropping all the sectors against which a question mark has been raised. This leaves us with a new aggregate, GDPex, which is about 60% of actual GDP.

3. *Index number issues*. The ONS estimates annual GDP by a chained Laspeyres index of real value added in the individual sectors, up to and including the reference year (currently 2009). That is, up to 2010 the weights shift each year. But for 2011 and 2012 the 2009 weights continue to be used. (Quarterly real GDP is estimated using the Denton method which ensures that for each sector the quarterly levels sum to the annual total. The Denton method is unnecessary when the weights are fixed). It is usually found that using fixed weights overstates output growth compared to using shifting weights (the latter is the chained volume measure). The reason is that empirically quantities and prices tend to be negatively correlated. So a fixed weight index gives too large a weight to rapidly growing sectors whose relative prices are falling. This raises the possibility that GDP has been overstated and that labour productivity performance has been even worse than official figures indicate. We test for this by estimating a pseudo-chained volume measure of GDP, using shifting weights for each of the 17 sectors. The "pseudo" part is because each of the sectors is an aggregate of many sub-sectors whose relative prices are being held constant at 2009 levels after 2009 and we cannot get inside each sector to reweight its components.

The results of these calculations are in Table 2. Column 1 shows the official figures for labour productivity (output per hour). In the trough of the recession (2009Q2), GDP per hour was 96.7% of its level in the previous peak (2007Q4). In the latest period available (2012Q1) it was still only 98.4% of its peak level. If we assume that the 2007 labour shares continued unchanged (column 2) then in the last period GDP per hour is 98.1% of the peak level, virtually the same as with the actual shares. Column 3 shows GDP per hour after hard-to-measure or otherwise problematic sectors have been excluded (sections A, B, K, L, O, P, Q and L: see Table 1). Productivity in the last period is now 99.0% of its peak level. Column 4 shows the effect of continuing chain-linking (at the section level) after 2009. Productivity in the last period is now 98.1% of its peak level. Finally, column 5 shows productivity in the "non-farm business" sector, an approximation of the US concept in which agriculture, government and real estate have been excluded. Productivity in the last period now looks worse than the official figure: only 95.9% of its peak level.

None of these composition effects can explain much or any of the productivity decline so the puzzle remains.[5] We therefore turn in the next section to other explanations.

[5] A shift away from high productivity to low productivity activities *within* (rather than between) sectors might have further explanatory power. Suppose that in the recession shoppers shift from high margin to low margin stores. The high margin stores offer a better shopping experience or better service but their prices for comparable products are higher (think of buying bananas in Harrods Food Hall compared to in your local Tesco). This shift would show up as a fall in output and productivity in the official statistics. The same effect could arise if there is a shift towards cheaper, own-brand products within a given store. Philip Clarke, Tesco chief executive, argues such a shift has indeed taken place since the recession began ("Lessons from the supermarket for austerity Britain", *Financial Times*, 19 October 2012).

4 The two main hypotheses

The two main hypotheses to be explored are (1) labour hoarding and (2) damage to capacity due to the financial crisis.

4.1 Labour hoarding

That output per hour should fall during a recession is not surprising. This is in fact the normal experience. One common explanation is labour hoarding: firms tend to hang on to labour during a downturn to avoid firing costs and then hiring costs during the subsequent upturn. An alternative explanation is that some labour has an overhead character, for example the security guards looking after a building (as long as the building continues in use and is not sold, abandoned or demolished). What is puzzling in the British case is that nearly four years after the onset of the recession labour productivity is below its previous peak and well below its previous trend. Certainly output too is below its previous trend but why have firms not adjusted to this by reducing labour input (either hours or jobs)? If potential labour productivity has been growing at something like the pre-crisis rate, it is hard to understand why firms should want to hang on to labour. In fact, jobs in the market sector have been increasing since 2010Q1. And evidence from business surveys (reviewed by Dale (2011)) suggests that there is little spare capacity.

The case for labour hoarding has been forcefully argued by Martin and Rowthorn (2012). Their argument mainly rests on the importance of overhead labour. They also point out that both human and physical capital per worker have increased during the recession, so on these grounds we would expect labour productivity to have risen not fallen. Human capital per worker has probably risen since it is the least skilled workers who are the first to lose their jobs. A rise in physical capital per worker is implied by estimates of capital services: though gross investment has fallen, net investment has still been positive. They also argue that the alternative, damage hypothesis is inherently implausible: why should disruption in the banking sector lead to loss of knowledge of how to produce output in the rest of the economy? (We return to this issue below).

The cost of making a worker redundant in the United Kingdom is quite substantial, about £12,000 or slightly less than half the average annual wage according to the CBI (cited in Faccini and Hackworth (2010)). So this could easily explain why firms are reluctant to fire workers at the beginning of a recession, especially if they expect to have to rehire the same or similar workers in about a year's time. But more than four years after the recession began this explanation looks increasingly thin. According to Faccini and Hackworth (2010) again, employment protection legislation (EPL) has not changed much since the mid-1980s on the OECD's measure, though it may now possibly be enforced more rigorously. They also find two other factors which go the other way. First, the flexibility of real wages has increased since 1993 (partly due to the decline in unionisation), which has helped to maintain employment in the downturn. Between 2008Q1 and 2012Q2 real consumer wages fell by 8%; real producer wages fell by a more moderate 4%.[6] Second, the costs of hiring may have increased since the average

[6] Unit wage costs however increased over this period (by 9%) as the fall in productivity more than offset the fall in wages.

skill level of the workforce is now higher than in previous recessions; this would make firms more reluctant to fire workers in the downturn.

Given the length of the productivity downturn the labour hoarding hypothesis must rely on firms retaining labour because of its overhead character. But (to use the earlier example) a building, say a shop, may require a security guard but at some point it is cheaper to sack the guard and close the shop down rather than keep it in operation in anticipation of an upturn in sales. However this argument is only qualitative and the question clearly needs more research.

Another possibility is that the relative price of labour has declined so much so that firms find it profitable to employ more labour. In fact employment has increased by over 400,000 since its trough in 2010. Martin and Rowthorn (2012) suggest that most of this increase has been in variable labour in low productivity industries (where adjustment costs are lower). But household data from the LFS suggests that the additional employment has been in skilled occupations and more experienced or older workers. This is at odds with the argument that these are low-skilled, low-paid workers.

4.2 Capacity damage due to the financial crisis and the ensuing recession

There is evidence that deep recessions tend to reduce GDP and productivity long after the recession has ended. Perron (1989) suggests that the Great Depression (which was also accompanied by a banking crisis) reduced the long-run level of US GNP by about 17%, but left the long-run growth rate unchanged: see his Table VII and his parameter θ in particular; Ben-David *et al*. (2003) report similar results. Recall that the US depression started in 1929, that the peak-to-trough decline in GNP was about 20%, and that real output did not regain its 1929 level till 1939. Broadberry and Crafts (1992) argue that the Great Depression cast a long shadow over the British economy too since it led to productivity-reducing policies such as protection and cartelisation of industries. By contrast the United Kingdom's Great Recession of 2008-2009 produced a peak-to-trough output fall of 5%. So the Great Depression in the United States was a vastly larger shock than we are currently experiencing in the United Kingdom and we would not expect such a large effect on the productivity level.

Reinhart and Rogoff (2011) argue that financial crises have a tendency to raise the stock of government debt relative to GDP, either because of the cost of recapitalising failed banks or because government expenditure is not cut in proportion to reduced tax revenues. High levels of debt require high levels of taxation to service the debt and this may lead to efficiency losses. Reinhart and Rogoff (2010) find that based on data for 44 countries spanning about 200 years, GDP growth rates fall when the gross central government debt/GDP ratio exceeds 90%. Above 90%, median growth rates fall by 1%, and average growth falls considerably more; the threshold for public debt is similar in advanced and emerging economies.

A number of other studies, e.g. Cerra and Saxena (2008), Furceri and Mouragane (2009), Barrell et al. (2010), Papell and Prodan (2011) and IMF (2009, chapter 4), also find that the recovery from financial crises is very slow. For example, Papell and Prodan (2011) argue that "The

preponderance of evidence for episodes comparable with the current US slump is that, while potential GDP is eventually restored, the slumps last an average of nine years." Like Barrell et al. (2010), they argue that advanced countries are different from developing ones: the latter can and do suffer permanent damage from severe financial crises. The claim that advanced countries are relatively immune to the effects of financial crises is based on the evidence for the period since the Second World War. However, based on a study of nearly 200 recession episodes in 14 advanced countries between 1870 and 2008, Jorda et al. (2012) find that more credit-intensive booms tend to be followed by deeper recessions and slower recoveries.

Why might we expect long-run effects from financial crises? A number of factors might reduce the long-run level of potential GDP, and of potential GDP per hour, even when recovery from the recession is complete (in the sense that GDP is growing at its long-run rate and unemployment is at a level consistent with the inflation target):

1. In the recent boom, real interest rates were very low, reflecting a mispricing of risk. When the recovery is complete and official rates return to normal levels, the rates at which firms can borrow are likely to be higher due to an additional risk premium. So they will want to hold a lower level of capital in relation to output. Suppose that the real interest rate (the required return on capital) rises from (say) 7% to 9%. The depreciation rate averaged over all types of capital can be taken to be 8%. Then the cost of capital rises from (7 + 8 =) 15% to (9 + 8 =) 17%, i.e. by 13.3%. The elasticity of capital with respect to its cost is minus 0.4 according to Barnes et al. (2008). And the elasticity of output with respect to capital is about 1/3 (the profit share). So the effect of the rise in the real interest rate on the long-run level of GDP is (13.3 x -0.4 x 0.3) = -1.8%. This calculation is only illustrative, but does suggest that the effect is not negligible.

2. Higher unemployment during the recession reduces the human capital of the unemployed, by preventing them from gaining the experience that would raise their productivity. Of course, this effect eventually disappears when the affected workers leave the labour force (through emigration, retirement or death) and are replaced by workers who enter the labour market after the Great Recession is over. But even if not permanent, this effect could clearly be long-lasting since youth unemployment has risen particularly sharply. Suppose that an additional 3.5% of the labour force becomes unemployed as a result of the Great Recession, that this higher rate of unemployment lasts for a period of 5 years, and that each additional unemployed person is unemployed for one year. This is equivalent to (5 x 3.5 =) 16.5% of the labour force losing one year's experience. If the rate of return to experience is (say) 7% per year (which is consistent with estimates of the return to schooling), then the effect on GDP is a reduction of (16.5 x 0.07 x 2/3 =) 0.8%.

3. There could be a long-run effect on the level of TFP. According to this argument the amount of innovation taking place in the economy is temporarily reduced by the recession. Innovation is implemented through or accompanied by investment in intangibles (e.g. R&D, in-firm training, or expenditure of management time on corporate restructuring) or it could take the form of new entrants into an industry bringing new

products, new technology or new business methods. All this is (arguably) what lies behind TFP growth as conventionally measured (Corrado et al. (2009); Marrano et al. (2009)). Now since innovation is a cumulative process and since the supply of workers and entrepreneurs capable of innovating is inelastic, a reduction in innovation in one period cannot easily be made up in a subsequent one: in other words, less innovation today means that the future *level* of TFP is permanently lower. For illustration, suppose that prior to a crisis, assumed to last one year, the economy is capable of generating a stream of innovations *a*, *b*, *c*, ... from the current year *t* onwards. As a result of the crisis the first innovation *a* is now delayed to year *t*+1; the subsequent innovations *b*, *c*, ... are now also delayed one year to years *t*+2, *t*+3, ... Though all innovations are eventually introduced the level of TFP will clearly be lower in every year after the crisis is over than it would have been in the absence of the crisis. A reduction in the TFP level will also lead to a secondary effect, a reduction in the desired level of capital, again reducing labour productivity.

These are of course just back-of-the-envelope calculations. What we need is a theoretical framework which would allow us to assess the size of any such effects empirically.

5 A theoretical framework

It is important to adopt a theoretical specification which allows for the possibility that financial crises have both short-run and long-run effects and that these effects may be on both the level and the growth rate of productivity. It will then be an empirical issue how large or small these effects are. A fairly general framework for productivity growth can be written as follows:

$$q_{it} - q_{it-1} = \lambda(q_{it}^* - q_{it-1}) + \beta(q_{it-1} - q_{it-2}) + (1-\lambda-\beta)(q_{it-2} - q_{it-3}) + \gamma crisis_{it} + \varepsilon_{it}, \quad 0<\lambda<1,\ 0<\beta<1,\ \lambda+\beta\leq 1,\ \gamma<0 \tag{1}$$

Here q_{it} is the log of the level of (labour) productivity in the *i*-th country, q_{it}^* is the log of the long-run productivity level in that country (long-run is indicated by a star (*)), $crisis_{it}$ is a one-zero dummy indicating the presence or absence of a financial crisis, and ε_{it} is a mean-zero error term. The first term on the right-hand side, $\lambda(q_{it}^* - q_{it-1})$, is a simple partial adjustment mechanism whereby a fraction λ of the gap between actual and long-run productivity is removed each period, presumably through investment in the broad sense. The second and third terms, $\beta(q_{it-1} - q_{it-2})$ and $(1-\lambda-\beta)(q_{it-2} - q_{it-3})$, reflect persistence in productivity growth: aggregate demand takes a while to recover from a recession so factor utilisation is lowered which reduces productivity growth till recovery begins; also investment is depressed for a while. The third term, $\gamma crisis_{it}$, is the short-run effect of a financial crisis on productivity growth. It may reflect a temporary disruption to credit which further reduces investment. We expect that $\gamma<0$. Note that for the equation to make sense in the long run, the sum of the coefficients on the first three terms on the right-hand side must equal 1 and the specification imposes this restriction.

A second lag in productivity growth is included in (1) since preliminary empirical investigation suggests that this is justified (but not a third lag).

A simple model of the long-run productivity level is:

$$q_{it}^{*} = \alpha_{i0} + \sum_{u=0}^{t-T} \alpha_{t-u} + \sum_{u=0}^{t-T} \zeta_{t-u} + \theta \sum_{u=0}^{t-T} crisis_{i,t-u}, \quad \theta \leq 0 \tag{2}$$

Here α_{i0} is a country-specific level effect, the α_{t-u} are time period effects, assumed common across countries, and the ζ_{t-u} are country-specific, time-varying shocks; all these shocks are to the productivity level. *T* is the base period from which all measurements are made. The effect of financial crises on productivity levels is measured by the parameter θ. In this specification financial crises can have a permanent effect on levels unless $\theta = 0$. A permanent effect could arise for example if a financial crisis raises the interest rate permanently leading to permanently lower capital intensity.

For any country the mean of the ζ_{t-u} will be non-zero (probably positive). So split this variable into its mean α_i plus a zero-mean error ξ_{it}: $\zeta_{it} = \alpha_i + \xi_{it}$. Then by subtracting equation (2) lagged once from itself, the long-run growth rate is found to be:

$$q_{it}^{*} - q_{it-1}^{*} = \alpha_i + a_t + \theta crisis_{it} + \xi_{it} \tag{3}$$

The long-run growth rate is influenced by a financial crisis only while the latter is ongoing. Once a crisis is over, it ceases to influence the long-run growth rate.

In summary, in the specification suggested here, a financial crisis may have a temporary effect on the productivity growth rate and hence a temporary effect on the productivity level. A financial crisis may also have a permanent effect on the productivity level. But there is no permanent effect on the productivity growth rate. The latter is assumed to be dependent on other factors such as the world-wide development of science and technology and the country's own institutions, all of which are assumed independent of financial crises.

To obtain an estimating equation, lag equation (1) once and subtract the result from (1):

$$\begin{aligned} \Delta q_{it} = {} & \lambda \Delta q_{it}^{*} + (1 + \beta - \lambda) q_{it-1} - 3\beta q_{it-2} + [3\beta + 2\lambda - 2] q_{it-3} + [1 - \lambda - \beta] q_{it-4} \\ & + \gamma \Delta crisis_{it} + \Delta \varepsilon_{it} \end{aligned} \tag{4}$$

Converting the right-hand side to growth rate terms:

$$\begin{aligned} \Delta q_{it} = {} & \lambda \Delta q_{it}^{*} + [1 + \beta - \lambda] \Delta q_{it-1} + [1 - \lambda - 2\beta] \Delta q_{it-2} - [1 - \lambda - \beta] \Delta q_{it-3} \\ & + \gamma \Delta crisis_{it} + \Delta \varepsilon_{it} \end{aligned} \tag{5}$$

(The coefficients on lagged, actual productivity on the right-hand side of (5) sum to $1 - \lambda$. So equation (5) has a sensible long-run solution). Using (3):

$$\begin{aligned} \Delta q_{it} = {} & \lambda a_i + \lambda a_t + (\lambda\theta + \gamma) crisis_{it} - \gamma crisis_{it-1} \\ & + [1 + \beta - \lambda] \Delta q_{it-1} + [1 - \lambda - 2\beta] \Delta q_{it-2} - [1 - \lambda - \beta] \Delta q_{it-3} \\ & + \Delta \varepsilon_{it} + \lambda \xi_{it} \end{aligned} \tag{6}$$

In econometric form this can be written as

$$\Delta q_{it} = \phi_{i0} + \sum_{u=0}^{T-1} \phi_{1u} D_{t-u} + \phi_2 crisis_{it} + \phi_3 crisis_{it-1} + \phi_4 \Delta q_{it-1} + \phi_5 \Delta q_{it-2} + \phi_6 \Delta q_{it-3} + \eta_{it} \tag{7}$$

Here

$$
\begin{aligned}
&\phi_{i0} + \sum_{u=0}^{T-1} \phi_{1u} D_{t-u} = \lambda a_i + \lambda a_t \\
&crisis_{it}: \quad \phi_2 = \lambda\theta + \gamma < 0 \\
&crisis_{it-1}: \quad \phi_3 = -\gamma > 0 \\
&\Delta q_{it-1}: \quad \phi_4 = 1 + \beta - \lambda > 0 \\
&\Delta q_{it-2}: \quad \phi_5 = 1 - \lambda - 2\beta \\
&\Delta q_{it-3}: \quad \phi_6 = -(1 - \lambda - \beta) < 0 \\
&\eta_{it} = \Delta\varepsilon_{it} + \lambda\xi_{it}
\end{aligned}
\tag{8}
$$

The sign of ϕ_5 is ambiguous. The relationship between the underlying parameters and the coefficients (the ϕs) is:

$$
\begin{aligned}
&\beta = (\phi_4 - \phi_5)/3 = (\phi_4 + \phi_6)/2 \\
&\lambda = 1 + \beta - \phi_4 \\
&\gamma = -\phi_3 \\
&\theta = (\phi_2 - \gamma)/\lambda
\end{aligned}
\tag{9}
$$

The first line of (9) shows that the specification imposes a restriction on the coefficients on lagged productivity growth:

$$\phi_4 + 2\phi_5 + 3\phi_6 = 0 \tag{10}$$

If this restriction is not imposed then there will be two possible estimates of the underlying parameter θ. From (9), these two estimates are

$$
\theta_1 = \frac{3(\phi_2 + \phi_3)}{3 - 2\phi_4 - \phi_5}
\qquad
\theta_2 = \frac{2(\phi_2 + \phi_3)}{2 - \phi_4 + \phi_6}
\tag{11}
$$

The main interest attaches to the size of the short-run and long-run effects of financial crises, i.e. the absolute sizes of γ and θ.

We also consider a simpler model with only two lags on lagged productivity growth, i.e. where $\phi_6 = 0$ so $\beta = 1 - \lambda$ and the coefficients on lagged productivity growth are

$$
\begin{aligned}
&\Delta q_{it-1}: \quad \phi_4 = 2(1 - \lambda) > 0 \\
&\Delta q_{it-2}: \quad \phi_5 = -(1 - \lambda) < 0
\end{aligned}
\tag{12}
$$

The coefficient on Δq_{it-2} (ϕ_5) is now unambiguously negative. The restriction on these coefficients is now

$$\phi_4 + 2\phi_5 = 0 \tag{13}$$

We now have two alternative ways of estimating λ:

$$\lambda = 1 - \frac{\phi_4}{2} \text{ or } \lambda = 1 + \phi_5 \tag{14}$$

and consequently two different estimates of θ (unless the restriction on the coefficients is exactly satisfied).

6 Productivity and financial crises: data

In the empirical work to be reported below we use the data on financial crises gathered and analysed by Reinhart and Rogoff (2009). The actual data are taken from spreadsheets accompanying their book which are publicly available at http://www.reinhartandrogoff.com/data/. The productivity data derive from The Conference Board's Total Economy Database (TED) for 2011 which is also publicly available online at http://www.conference-board.org/data/economydatabase. We discuss each of these sources in turn.

6.1 The Reinhart-Rogoff database of financial crises

Reinhart and Rogoff (hereafter R-R) have gathered data for six types of crisis which they define as follows: see their chapter 1 (our variable names are in brackets).

1. Currency crisis (*curr*): defined as an annual rate of decline of the exchange rate of 15% or more.
2. Inflation crisis (*infl*): defined as an annual rate of inflation of 20% or more.
3. Stock market crisis (*stock*): defined as a cumulative decline of 25% or more in real equity prices (R-R, chapter 16, page 150).
4. External debt crisis (*extd*): defined as "the failure of the government to meet a principal or interest payment on the due date (or within the specified grace period)." N.B.: "external" debt means debt incurred under the laws of some foreign jurisdiction. It is usually but not necessarily denominated in foreign currency and typically held mostly by foreign creditors.
5. Domestic debt crisis (*domd*): defined similarly to external debt crisis. N.B.: "domestic" debt means debt incurred under the country's own laws. It is usually but not necessarily denominated in domestic currency. An exception which they note is Mexican "tesobonos" which suffered a near-default in 1994-95 which required an IMF plus US Treasury bailout to avert. This was domestic debt since taken out under Mexican law though denominated in effect in US dollars. Domestic debt defaults have at times involved the freezing of bank deposits and the forcible conversion of such deposits from dollars to local currency.
6. Banking crisis (*bank*): defined as "(1) bank runs that lead to the closure, merging or takeover by the public sector of one or more financial institutions and (2) if there are no runs, the closure, merging, takeover or large-scale government assistance of an important financial institution (or group of institutions) that marks the start of a string of similar outcomes for other financial institutions."

Each crisis is measured by a dummy variable, equal to one when a country is judged to be in this type of crisis and 0 otherwise. As they note, the criteria just listed define the onset of a crisis. When a crisis ends is largely a matter of judgement. Their data cover 63 countries over the period 1800-2010. We use just the data from 1950 onwards, i.e. the potential number of observations is 61 x 63 =3843. Over this shorter period there are 860 missing values for the stock market crisis dummy and 3 missing values for the currency crisis dummy. To save observations, we have assumed that a missing value corresponds to a zero (no crisis).

Table 3 shows the frequency of financial crises. For each of the six types of crisis the percentage of total years for which countries were in crisis has increased between the first and second halves of the whole 61-year span 1950-2010. The increase in frequency is particularly sharp for banking crises: over 1950-1979 only 0.9% of country-years was spent in a banking crisis but this rose to 19.8% over 1980-2010. The major events were the Latin American debt crises of the 1980s, the Asian financial crisis of 1997-1998 and the current global financial crisis.

Table 4 shows the total number of years which each country has spent in financial crisis, sorted by the total number of crisis years. The results are a bit surprising. Canada, Guatemala, Taiwan and Morocco have spent the fewest years in financial crisis. Algeria has spent fewer years in crisis than the United Kingdom. But financial crises are less likely in countries which follow socialistic policies and cut themselves off from trade and foreign investment. And the fact that Argentina has spent more years in crisis than any other country will not be surprising.

Table 5 shows the persistence of crises, the number of crises lasting one year, two years, three years, ... , ten years, or more than ten years. Most crises are short-lived with most lasting less than three years and very few lasting more than six years. Stock market and currency crises have been the most frequent types and these two types have also generated the most crisis years. External debt crises are the most persistent when measured by mean duration; next come inflation crises. Currency crises have the lowest duration. Domestic debt crises are less frequent than other types. Banking crises do not stand out as being particularly frequent or persistent: stock market and currency crises are more frequent and external debt and inflation crises are more persistent, when measured by mean duration.

6.2 Productivity

The 2011 version of The Conference Board's Total Economy Database (TED) contains national accounts data for 128 countries covering the period 1950-2010, though with missing values for some countries. The original idea was to look at TFP growth. But the 2011 version of the TED has TFP data only from 1990 onwards. The 2010 version has TFP data from 1982 onwards. One possibility was then to merge the two datasets. But it turns out that where they overlap, the 2010 and 2011 estimates of TFP growth are not that closely correlated ($r = 0.83$): see Chart 27. This reduces confidence in the quality of the estimates, or at least of the earlier ones. In any case, restricting the analysis to the period from 1982 onwards would be too confining. So it was decided to consider instead the growth of labour productivity. Labour productivity is available for most countries over the whole 61 year period in heads form but for a much smaller number of countries in hours form. Hours are better than heads but again we do not want to confine the analysis to the richer countries with better statistics. So we have looked at GDP per person employed. For years where they overlap this is reasonably well correlated with TFP growth ($r = 0.86$): see Chart 28. The TED has two real GDP variables, one using 1990 PPPs and the other 2010 PPPs, but in growth rate form the two are identical. We use the one employing 1990 PPPs which is available for more years than the one employing 2010 PPPs.

After merging the R-R data in with the TED, we lose about half the countries included in the latter. There are now 61 countries for which we have both labour productivity and crises data for at least some of the 61 years. The 61 countries cover the whole globe, not just the OECD.

7 The effect of crises: regression results

7.1 Regression results using the R-R definitions of crises

Section 5 set out a framework within which the average short and long-run effects of crises across our sample can be estimated. We now seek to test this model using the dataset created by merging the TED data on labour productivity (GDP per worker) with the R-R crisis variables. As stated above, there are now 61 countries for which we have both labour productivity and crises data for most of the 61 years, in fact an average of about 53 years per country, with the missing years being mostly in the 1950s and 1960s. The 61 countries cover the whole planet, not just the OECD. We report results mostly just for banking crises. This is because some of the other R-R crises might be considered *consequences* of banking crises, eg a stock market crash. Or they might be thought of as *responses* (whether market-induced or policy-induced). For example, the sharp fall in sterling which accompanied the Great Recession and the UK banking crisis was a market response (though unlike many currency crises in developing or emerging countries it was against the background of an inflation-targeting rather than an exchange-rate-targeting monetary regime). So for the United Kingdom the fall in sterling was not a crisis but part of the adjustment process. Banking crises on the other hand are very hard to predict: models designed to do so have a poor fit even in sample (Corder and Weale (2011)).

Table 6 reports the results of running least squares regressions based on equation (7) with time dummies and fixed effects included. The first column reports the results for the whole sample. Just one financial crisis variable is included, a banking crisis (*bank*). All the interesting coefficients are significant and have the expected signs. Using equations (9), we can now solve for the values of the underlying parameters. There is just one solution for γ, but there are two sets of solutions for β, λ and θ, depending on whether we use the first or second solution for β in equations (9). In fact the estimates fail the test for whether the two solutions for β do not differ significantly from each other: see the row labelled "Coefficients on lagged Δq_{it}". So the model has failed to capture completely the dynamics of the growth process. But it turns out that the values for θ, which measures the long-run impacts of a banking crisis, are not much affected by the choice of solution for β: see the last two rows of column (1).

Still focusing on column (1) of Table 6, the solution for γ says that a banking crisis reduces productivity *growth* in the short-run by 0.7% per year. This is a substantial impact given that the mean value of labour productivity growth in our sample of 61 countries is 2.01% per year. The solution for θ says that a banking crisis has a long-run, permanent impact on the *level* of productivity: it reduces it by about 0.8% for each year that the crisis lasts. In other words a crisis lasting five years would reduce the level of GDP per worker by (5 x 0.8% =) 4.0%, permanently. Of course, the estimated effects are for an "average" crisis as experienced by these 61 countries over the period 1955-2010. Both estimates of θ are significant at the 5% level.

The remaining columns of Table 6 report various sensitivity tests:

Column (2): exclude the Great Recession (2008-1010).
Column (3): exclude countries affected by the Asian financial crisis of 1997-98. (Korea, Malaysia , Sri Lanka, Taiwan, Thailand, Indonesia, India, Philippines, and China).
Column (4): exclude countries affected by the Latin American debt crisis of the 1980s (Argentina, Bolivia, Brazil, Chile, Columbia, Costa Rica, Ecuador, Mexico, Peru, Uruguay and Venezuela).
Column (5): developed countries only.
Column (6): developing countries only.
Column (7): early years only (all countries, 1950-1979).
Column (8): later years only (all countries, 1980-2010).

The size of θ varies in an interesting way across these sub-samples, though with one exception it is always large numerically. Excluding the Great Recession reduces θ numerically from minus 0.839 to minus 0.673, or by 20%, surprisingly little; this may be partly due to the fact that our time period ends in 2010. Excluding the Latin America countries roughly halves the size of θ numerically; θ now also fails to be significant.[7] This may be another way of saying that these countries managed their crises of the 1980s comparatively poorly. If the regression is run on developed countries only then the coefficients on *bank* and lagged *bank* are insignificant (column 5). An optimistic interpretation is that developed countries possess institutions able to deploy policies capable of neutralising the effect of banking crises. A more pessimistic interpretation is that these countries have up till now suffered only mild and isolated crises, e.g. the United Kingdom's secondary banking crisis of the 1970s. Or if the crisis was quite severe as Sweden's was in 1991-1994 it was against a benign international background. So for the developed countries past experience will not necessarily be a reliable guide to the effects of the present crisis and we should place more weight on the overall results.

Is there something special about banking crises as opposed to other types of crisis? To test this, we ran exactly the same model as in Table 6 but with each of the other crisis dummies (for currency, inflation, stock market, domestic debt and external debt crises) in turn replacing the banking crisis dummy. In each of these regressions we excluded crisis periods which also happened to be banking crises. This can be interpreted as testing for the effect of a non-banking crisis when the latter is not accompanied by a banking crisis. For none of these other crises was the long-run coefficient θ significant at the 5% level or better. So banking crises do indeed appear to have more severe effects.

Another sensitivity test we ran was to drop the third lag on productivity growth $(\Delta q_{i,t-3})$ since it is usually insignificant. With this simpler specification the test for the restriction on the coefficients on lagged productivity growth still fails. However, the estimates of θ were not very different.

[7] This is a Latin American effect since excluding each Latin American country in turn has little effect on the size and significance of θ.

Table 7 shows the same set of results but this time estimated by the Arellano-Bond (difference) method.[8] This method is potentially superior since it can deal with the fact that the lagged dependent variables are not exogenous so the OLS estimates are biased. However, given the number of time series observations available, the bias should be small (Nickell (1981)). The test for second-order serial correlation (which should be zero) is passed. As with OLS, the test for the restriction on the lagged coefficients is failed, though the resulting two estimates of θ are not very different. The coefficients have similar sizes and significance levels as when estimated by OLS. For the overall sample, the Arellano-Bond estimates say that the short-run effect of a banking crisis is to reduce productivity growth by 0.6% per year (slightly less than the OLS estimate) while the long-run reduction in the productivity level is somewhat higher than the OLS estimate: about 1.1%.[9]

What is the channel through which banking crises damage productivity? A partial answer to this question comes from looking at the effect of crises on capital per worker. We estimate aggregate capital stocks for each country by the perpetual inventory method (PIM), i.e. by cumulating aggregate investment, assuming an 8% depreciation rate.[10] We then fit exactly the same model of equation (7), except that the log of capital per worker replaces the log of GDP per worker on both the left and right-hand sides:

$$\Delta k_{it} = \phi_{i0} + \sum_{u=0}^{T-1} \phi_{1u} D_{t-u} + \phi_2 bank_{it} + \phi_3 bank_{it-1} + \phi_4 \Delta k_{it-1} + \phi_5 \Delta k_{it-2} + \phi_6 \Delta k_{it-3} + \eta_{it} \qquad (15)$$

where k_{it} is the log of capital per worker for the *i*-th country in year *t*. The results appear in Tables 8 and 9 and can be seen to be very similar to the results for GDP per worker, both overall for the whole sample and for the various sub-samples.[11] In the overall sample the OLS estimates of θ for capital per worker as the dependent variable are somewhat larger numerically (-1.1 versus -0.8%) and more significant than those for GDP per worker while for the Arellano-Bond estimates this difference is less pronounced. But on either method θ is still significant even when Latin America is excluded. So a reduction in the long-run level of the capital stock per worker seems to be a consequence of a banking crisis and helps to explain the earlier finding of a long-run reduction in labour productivity. But this does not necessarily rule out a channel running from TFP, since a long-run reduction in TFP would induce a long-run reduction in capital per worker.[12] And these estimates of the fall in capital per worker are too small by themselves to account for the fall in GDP per worker: if we weight the capital effect by capital's

[8] An alternative is to use the Arellano-Bond system estimator, but with over 53 time periods per country this results in an explosion in the number of instruments.

[9] We have also experimented with the Common Correlated Effects Mean Group Estimator of Pesaran (2006), using Markus Eberhardt's *xtmg* procedure within Stata. The estimated values of θ were similar to the OLS ones but a little larger and more significant.

[10] Aggregate investment in constant prices for each country is taken from the national accounts data underlying the Penn World Table, version 7 (the PWT variable IKON from the file na70_v2_wo_sources.xls, downloaded from http://pwt.econ.upenn.edu/). These series are in constant prices in national currency units, i.e. not adjusted to international dollars, which means that within each country they are comparable over time. To apply the PIM we need a starting value for the capital stock. This is first assumed to be zero and an initial series for the capital stock is estimated. The capital stock to real GDP ratio is then calculated for the *end* of the sample period in 2010. (Real GDP is estimated by adding the expenditure components in constant prices: GDP = CAKON + IKON + EXPK – IMPK). Since the starting date is 1950 for most countries the influence of the starting stock on the end-of-sample stock is negligible (it has decayed to 0.6% of its original value by 2010). A second-round estimate of the capital stock in each country is then constructed by assuming that the starting stock was in the same ratio to GDP as was the end-of-period stock.

[11] The reason for looking at the growth of capital per worker rather than the growth of investment per worker is that the latter variable has quite different time series properties: it is predominantly *negatively* serially correlated at one, two or three lags, while the growth of capital per worker, like the growth of GDP per worker, is *positively* serially correlated.

[12] Since we have calculated aggregate capital stocks we could in principle calculate TFP. But our stock estimates are fairly rough so not much confidence could be placed in any TFP estimates derived from them.

share (say one third), then the capital channel can explain less than half of the hit to GDP per worker. So the capital estimates imply an additional effect coming from TFP.

7.2 Regression results using the IMF definition of banking crises

We have also tested the robustness of our basic results by using the IMF definition of banking crises in place of the R-R one. Laeven and Valencia (2010) define a banking crisis to be systemic if two conditions are met: (1) significant signs of financial distress in the banking system (as indicated by significant bank runs, losses in the banking system, and bank liquidations); and (2) significant banking policy intervention measures in response to significant losses in the banking system. They deem the first year that both criteria are met to be the starting year of the banking crisis, and consider policy interventions in the banking sector to be significant if at least three out of the following six measures have been used:

1) extensive liquidity support (5% of deposits and liabilities to non-residents);
2) bank restructuring costs (at least 3% of GDP);
3) significant bank nationalizations;
4) significant guarantees put in place;
5) significant asset purchases (at least 5% of GDP);
6) deposit freezes and bank holidays.

They define the end of a crisis as occurring in the year before two conditions hold: real GDP growth and real credit growth are both positive for at least two consecutive years. But they also impose a maximum crisis length of 5 years. Their series cover the period 1976-2009.

53 countries in the IMF crisis database are also in the R-R one. For these 53, there were 85 R-R banking crises but only 55 IMF ones, so on the IMF definition crises are less frequent. IMF crises are also shorter on average: 3.3 years versus 3.7 years for R-R.

87 countries in the IMF database can be matched with productivity data from the TED. The results of running our basic regression, equation (7), but with a zero/one dummy for IMF banking crises in place of the R-R dummy, appear in Tables 10 (OLS) and 11 (Arellano-Bond). The results are similar qualitatively to the results of Tables 6 and 7 which use the R-R definition. The long-run impact of banking crises is of similar magnitude but somewhat lower significance using OLS; however, using the Arellano-Bond method θ is never significant.

7.3 Effects on GDP per capita via labour force participation

A possible criticism of our results is that the effects on labour productivity that we find may reflect differences across countries in labour market institutions.[13] In some countries the response of employment to a shock to output may be smaller than in others. Adjustment may be smaller *either* because of labour market rigidities which make it hard to fire people *or* because of real wage flexibility which reduces the incentive to do so. One way to look at this is to consider the effect of a financial crisis on GDP per capita rather than on GDP per worker. The relationship between the two is: GDP per capita = GDP per worker times the employment ratio, workers as a proportion of the population. So conceivably a hit to productivity might be

[13] We owe this point to Chris Pissarides.

compensated for by a rise in the employment ratio. Or the effect on GDP per capita might be larger than the effect on productivity, if the employment ratio falls. We can test for this by running our regression equation (7) with the dependent variable redefined as GDP per capita instead of GDP per worker. We find that the long-run effect of a banking crisis on GDP per capita is twice the size of the effect on GDP per worker and more significant: see Table 12. One year of a banking crisis reduces the long-run level of GDP per capita by 1.5-1.6%. The effect is highly significant even when Latin America is excluded. When only developed countries are included in the regression, the long-run effect is significant at the 10% level. In other words, part of the effect of a banking crisis comes in the form of a long-run fall in the employment ratio (whether due to higher unemployment or inactivity rates).[14]

8 Conclusions

The results suggest that banking crises as defined by Reinhart and Rogoff have on average a substantial and statistically significant effect on both the short-run growth rate and the long-run level of labour productivity. The short-run growth rate of labour productivity is typically reduced by 0.6 and 0.7% per year for each year that the crisis lasts and the long-run level by between 0.84 and 1.1% (the range is between the OLS and the Arellano-Bond estimates). No such significant long-run effects were found for the five other types of financial crisis distinguished by Reinhart and Rogoff, if these latter were not accompanied by a banking crisis.

One channel through which banking crises do their damage is through their effect on the long-run level of capital per worker. We find that this level is on average reduced by about 1% for each year of crisis. We also find that banking crises have a long-run effect on the employment ratio: the effect on GDP per capita is double the effect on GDP per worker.

Three qualifications should be noted. First, these results are for all countries combined — advanced, emerging and developing. If only advanced countries are considered then banking crises in the period studied (1955-2010) do not have a significant effect on the long-run productivity level. The same is true if Latin America is excluded, though in this case we still find a significant effect on capital per worker and also on GDP per capita, i.e. a significant effect on the employment ratio. Second, the banking crisis variable is a zero/one dummy and we have no measure of the severity of any crisis, other than the circular one of looking at its consequences. Because of this second qualification, it would be unwise to take too much comfort from the first one. It may be that the insignificant results found for the advanced countries just reflect the fact that advanced countries have since the 1950s and up to now (and our data stop in 2010) not experienced crises severe enough to generate a statistically significant effect on productivity levels.[15] And third, these are only average effects. No banking crisis is alike. In any particular country or particular period, the impacts may differ substantially from the mean.

[14] IMF (2009) also finds long-lasting effects on the employment ratio following a financial crisis.

[15] Compare again the findings of Jorda *et al.* (2012) for the advanced countries which relate to a longer time span, 1870-2008.

Finally, even if the findings on the damage hypothesis are accepted, this does not force automatic rejection of the rival labour hoarding hypothesis. The latter must be assessed on its own merits. However our finding of a *permanent* effect of banking crises on the labour productivity level cannot be attributed to labour hoarding.

TABLES

Table 1
Sectoral breakdown of the UK economy in 2007

	SECTOR	*Share of GDP, %*	*Share of total hours, %*	*Relative product-ivity, ratio*
A	***Agriculture, forestry & fishing***	0.6	1.6	0.39
B	***Mining & quarrying inc. oil & gas***	2.5	0.3	10.65
C	Manufacturing	11.1	10.9	1.01
D	Electricity, gas, steam, etc	1.3	0.4	2.93
E	Water supply, sewerage, etc	1.1	0.5	2.19
F	Construction	7.7	8.4	0.91
G	Wholesale & retail trade	11.5	15.0	0.76
H	Transport & storage	4.8	5.3	0.91
I	Accommodation & food services	2.9	5.4	0.54
J	Information & communication	6.0	4.3	1.34
K	***Financial & insurance activities***	8.3	4.1	2.07
L	***Real estate***	8.7	1.4	6.37
M	Professional, scientific & tech. activities	7.3	7.5	0.96
N	Administrative & support activities	4.5	7.5	0.59
O,P,Q	***Government services***	18.4	22.7	0.81
R	Arts, entertainment & recreation	1.5	2.2	0.67
S-U	Other services & household activities	1.8	2.4	0.72
	TOTAL	100.0	100.0	1.00

Source Office for National Statistics. Classification is in accordance with SIC 2007. Relative productivity is GDP share divided by hours share. Sectors in ***Bold Italic*** are those described in the text as "problematic" for various reasons.

Table 2
Official estimates of labour productivity compared to alternative measures: ratio of GDP per hour in (a) the trough (2009Q2) and (b) the latest period (2012Q1) to GDP per hour in the previous peak (2007Q4=100.0)

	Official	*With 2007 labour shares*	*Excluding questionable sectors*	*Chained volume measure*	*"Nonfarm business", 2007 labour shares*
	(1)	(2)	(3)	(4)	(5)
Trough (2009Q2) to peak (2007Q4)	96.7	97.0	95.2	96.6	95.5
Latest period (2012Q1) to peak (2007Q4)	98.4	98.1	99.0	98.1	95.9

Source Official measure is from the Office for National Statistics' *Productivity Bulletin,* July 2012. Other measures are our own calculations, using data underlying the *Productivity Bulletin,* namely real value added and "productivity hours". See text for further explanation.

Table 3
Proportion of country-years spent in financial crisis (61 countries), %

Crisis	*1950-2010*	*1950-1979*	*1980-2010*
Currency	17.4	12.6	22.1
Inflation	14.1	10.3	17.8
Stock market	20.3	19.2	21.4
Domestic debt	2.1	1.0	3.1
External debt	12.0	8.4	15.4
Banking	10.5	0.9	19.8

Source Reinhart-Rogoff spreadsheets (available at http://terpconnect.umd.edu/~creinhar).

Table 4
Number of crisis years, by country (61 countries, 1950-2010)
(countries ordered by frequency of crises, least crisis-prone first)

Country	*Currency*	*Inflation*	*Stock market*	*Domestic debt*	*External debt*	*Banking*	*Total*
Canada	1	0	5	0	0	3	9
Guatemala	3	4	0	0	2	3	12
Taiwan	7	1	0	0	0	4	12
Morocco	4	1	0	0	6	2	13
Singapore	2	2	11	0	0	2	17
Netherlands	1	0	14	0	0	3	18
Ireland	6	2	6	0	0	4	18
Tunisia	6	0	0	0	7	5	18
Sri Lanka	6	3	0	1	4	5	19
Algeria	7	5	0	0	6	3	21
Malaysia	1	1	10	0	0	9	21
Belgium	2	0	16	0	0	3	21
China	5	1	8	0	0	8	22
Sweden	6	0	12	0	0	4	22
Switzerland	2	0	18	0	0	2	22
Egypt	7	6	0	0	1	9	23
Australia	7	3	10	0	0	4	24
United Kingdom	8	1	8	0	0	9	26
New Zealand	6	0	17	0	0	4	27
Finland	4	0	19	0	0	4	27
Italy	3	2	19	0	0	6	30
Thailand	5	1	10	0	0	14	30
Costa Rica	5	8	0	0	13	4	30
Denmark	2	0	20	0	0	9	31
Norway	4	0	22	0	0	7	33
South Africa	10	0	15	0	5	3	33
Portugal	7	4	19	0	0	3	33
Japan	3	1	16	0	3	10	33
Germany	5	0	18	0	4	6	33
Austria	2	1	25	0	3	3	34
France	4	0	25	0	0	5	34
United States	5	0	18	0	0	12	35
Cote d'Ivoire	1	4	0	0	27	4	36
India	7	2	17	0	7	6	39
Spain	8	1	19	0	0	12	40
Iceland	19	18	0	0	0	7	44
Kenya	9	4	13	0	10	9	45
Hungary	10	8	4	0	18	8	48
Korea	14	9	16	0	0	11	50
Nigeria	11	12	8	0	14	5	50
Zambia	18	20	4	0	12	1	55
Dominican Rep.	6	9	0	27	14	2	58
Poland	19	14	5	0	17	5	60
Bolivia	13	21	0	3	17	7	61
Ghana	21	24	0	2	5	9	61
Philippines	7	4	28	0	12	12	63
Romania	17	13	4	9	13	10	66
Greece	10	3	28	2	15	8	66
Ecuador	18	20	0	1	22	6	67
Mexico	13	17	23	1	9	9	72
Indonesia	18	19	17	3	9	8	74
Venezuela	14	20	22	4	12	11	83
Turkey	29	29	11	1	6	7	83

Table 4, continued

Colombia	25	22	32	0	0	8	87
Russia	23	8	3	3	47	4	88
Zimbabwe	20	19	21	1	20	14	95
Chile	30	29	24	0	14	5	102
Peru	21	20	31	3	20	9	104
Brazil	36	38	8	4	15	7	108
Uruguay	34	35	30	0	8	6	113
Argentina	30	35	27	12	28	10	142
TOTAL	647	524	756	77	445	392	2841

Source Reinhart-Rogoff spreadsheets (available at http://terpconnect.umd.edu/~creinhar) and own calculations.

Table 5
Persistence of crises

Number of crises lasting:	*Currency*	*Inflation*	*Stock market*	*Domestic debt*	*External debt*	*Banking*
One year	236	65	98	11	44	32
Two years	40	27	96	4	7	15
Three years	22	9	65	3	10	20
Four years	11	8	19	2	2	16
Five years	2	6	9	1	6	9
Six years	6	1	7	0	2	8
Seven years	3	2	3	0	0	3
Eight years	1	1	4	0	2	5
Nine years	4	4	0	1	2	2
Ten years	2	1	0	0	5	2
More than ten years	4	9	1	0	11	1
Memo items:						
Total number of crises	331	133	302	22	91	113
Total number of crisis years	647	524	756	77	445	392
Mean years per crisis	1.95	3.94	2.50	3.50	4.89	3.47

Source Reinhart-Rogoff spreadsheets (available at http://terpconnect.umd.edu/~creinhar) and own calculations. Total number of observations is 3721. Total number of crisis years is $\sum_{i=1}^{N} in_i$ where n_i is the number of crises lasting i years and N is the maximum length in years of any crisis; e.g. for banking crises N =14 (Zimbabwe).

Table 6
Panel regression (least squares) estimates of equation (7): dependent variable is growth of labour productivity (Δq_{it})

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Independent variables	All countries and years	Exc. Great Recession	Exc. Asia	Exc. Latin America	Developed countries only	Developing countries only	1950-79	1980-2010
Δq_{it-1}	0.189***	0.186***	0.177***	0.179***	0.240***	0.170***	0.0444	0.208***
	(0.0380)	(0.0391)	(0.0413)	(0.0458)	(0.0445)	(0.0421)	(0.0583)	(0.0538)
Δq_{it-2}	0.0632**	0.0666**	0.0465	0.102***	0.0531	0.0548*	-0.00798	0.0382
	(0.0292)	(0.0298)	(0.0322)	(0.0334)	(0.0618)	(0.0309)	(0.0384)	(0.0349)
Δq_{it-3}	-0.00671	-0.0124	-0.0145	0.00410	0.0512*	-0.0191	-0.0997***	-0.0166
	(0.0179)	(0.0183)	(0.0204)	(0.0167)	(0.0282)	(0.0197)	(0.0340)	(0.0289)
$bank_{it}$	-0.0144***	-0.0136***	-0.0151***	-0.0102***	-0.00192	-0.0183***	-0.0120***	-0.0150***
	(0.00340)	(0.00349)	(0.00386)	(0.00263)	(0.00291)	(0.00481)	(0.00418)	(0.00364)
$bank_{it-1}$	0.00728***	0.00790***	0.00791***	0.00619***	0.00487	0.00808**	0.00755	0.00693**
	(0.00252)	(0.00271)	(0.00295)	(0.00220)	(0.00291)	(0.00332)	(0.0107)	(0.00263)
Observations	3,063	2,880	2,632	2,446	1,150	1,913	1,185	1,878
R^2 (within)	0.177	0.165	0.195	0.178	0.405	0.162	0.100	0.147
Number of countries	61	61	52	50	23	38	60	61
Coefficients on lagged Δq_{it}	0.0009	0.0000	0.0005	0.0000	0.0000	0.0041	0.0132	0.0021
100 x θ_1	-0.839***	-0.673**	-0.832**	-0.468	0.359	-1.171**	-0.453	-0.952***
	(0.341)	(0.354)	(0.415)	(0.347)	(0.289)	(0.475)	(1.280)	(0.365)
100 x θ_2	-0.793**	-0.638*	-0.797**	-0.434	0.326	-1.124**	-0.475	-0.911**
	(0.328)	(0.340)	(0.404)	(0.324)	(0.266)	(0.464)	(1.343)	(0.357)

Note *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses. Fixed effects, year dummies and constant included but not reported.
Coefficients on lagged Δq_{it}: p-value for $H_0: \phi_4 + 2\phi_5 + 3\phi_6 = 0$.

Table 7
Arellano-Bond (difference) estimates of equation (7):
dependent variable is growth of labour productivity (Δq_{it})

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Independent variables	All countries and years	Exc. Great Recession	Exc. Asia	Exc. Latin America	Developed countries only	Developing countries only	1950-79	1980-2010
Δq_{it-1}	0.177***	0.173***	0.165***	0.169***	0.244***	0.156***	0.0468	0.196***
	(0.0371)	(0.0382)	(0.0416)	(0.0464)	(0.0425)	(0.0405)	(0.0590)	(0.0514)
Δq_{it-2}	0.0539**	0.0583**	0.0416	0.0932***	0.0557	0.0425	-0.00867	0.0397
	(0.0274)	(0.0280)	(0.0312)	(0.0330)	(0.0588)	(0.0290)	(0.0391)	(0.0326)
Δq_{it-3}	-0.0143	-0.0194	-0.0159	-0.00160	0.0550**	-0.0309*	-0.0954***	-0.0109
	(0.0175)	(0.0185)	(0.0206)	(0.0168)	(0.0273)	(0.0181)	(0.0370)	(0.0283)
$bank_{it}$	-0.0150***	-0.0144***	-0.0164***	-0.00990***	-0.00190	-0.0186***	-0.00442	-0.0156***
	(0.00349)	(0.00356)	(0.00386)	(0.00285)	(0.00285)	(0.00481)	(0.00717)	(0.00374)
$bank_{it-1}$	0.00550**	0.00569**	0.00595*	0.00518**	0.00486*	0.00751**	0.0125	0.00506*
	(0.00256)	(0.00278)	(0.00306)	(0.00212)	(0.00271)	(0.00320)	(0.0137)	(0.00264)
Observations	3,002	2,819	2,534	2,396	1,127	1,875	1,125	1,877
Number of countries	61	61	51	50	23	38	60	61
2nd order autocorrelation	-0.918	-1.302	-0.866	0.356	-0.526	-0.603	-1.069	0.863
Coefficients on lagged Δq_{it}	0.00194	0.00429	0.0235	0.000150	0.00376	0.0723	0.110	0.0312
100 x θ_1	-1.096***	-1.005***	-1.112***	-0.550	0.362	-1.258***	0.831	-1.231***
	(0.356)	(0.380)	(0.417)	(0.382)	(0.278)	(0.467)	(1.954)	(0.382)
100 x θ_2	-1.048***	-0.962***	-1.068***	-0.515	0.327	-1.224***	0.869	-1.175***
	(0.347)	(0.369)	(0.409)	(0.361)	(0.254)	(0.463)	(2.044)	(0.374)

Note *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses. Fixed effects, year dummies and constant included but not reported. Coefficients on lagged Δq_{it}: p-value for $H_0: \phi_4 + 2\phi_5 + 3\phi_6 = 0$. 2nd order autocorrelation: Arellano-Bond test for 2nd order serial correlation in residuals.

Table 8
Panel regression (least squares) estimates of equation (15): dependent variable is growth of capital per worker (Δk_{it})

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Independent variables	All countries and years	Exc. Great Recession	Exc. Asia	Exc. Latin America	Developed countries only	Developing countries only	1950-79	1980-2010
Δk_{it-1}	0.475***	0.466***	0.510***	0.531***	0.486***	0.459***	0.403***	0.464***
	(0.0499)	(0.0518)	(0.0527)	(0.0642)	(0.0558)	(0.0579)	(0.0769)	(0.0555)
Δk_{it-2}	0.175***	0.187***	0.134***	0.200***	0.116***	0.189***	0.137***	0.172***
	(0.0276)	(0.0311)	(0.0310)	(0.0377)	(0.0387)	(0.0295)	(0.0491)	(0.0337)
Δk_{it-3}	0.0121	0.00714	0.0123	-0.0235	0.0181	0.0132	0.0181	-0.0113
	(0.0279)	(0.0305)	(0.0264)	(0.0341)	(0.0218)	(0.0339)	(0.0543)	(0.0338)
$bank_{it}$	-0.00479**	-0.00532**	-0.00379*	-0.00324	0.00297	-0.00786***	-0.00630	-0.00488**
	(0.00199)	(0.00216)	(0.00218)	(0.00224)	(0.00317)	(0.00225)	(0.00750)	(0.00213)
$bank_{it-1}$	-0.00220	-0.00268	-0.00200	-0.00129	-0.00331	-0.00248	-0.00168	-0.00262
	(0.00204)	(0.00219)	(0.00215)	(0.00204)	(0.00278)	(0.00268)	(0.00342)	(0.00212)
Observations	2,803	2,687	2,427	2,254	1,056	1,747	1,077	1,726
R^2 (within)	0.487	0.481	0.513	0.548	0.559	0.500	0.296	0.420
Number of countries	58	58	50	48	22	36	57	58
Coefficients on lagged Δq_{it}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
100 x θ_1	-1.118***	-1.276***	-0.941***	-0.781**	-0.0528	-1.640***	-1.164	-1.184***
	(0.331)	(0.363)	(0.357)	(0.342)	(0.399)	(0.415)	(0.885)	(0.346)
100 x θ_2	-0.909***	-1.038***	-0.771***	-0.627**	-0.0439	-1.331***	-0.988	-0.984***
	(0.269)	(0.294)	(0.292)	(0.274)	(0.331)	(0.339)	(0.748)	(0.289)

Note *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses. Fixed effects, year dummies and constant included but not reported.
Coefficients on lagged Δq_{it}: p-value for $H_0: \phi_4 + 2\phi_5 + 3\phi_6 = 0$.

Table 9
Arellano-Bond (difference) estimates of equation (15):
dependent variable is growth of capital per worker (Δk_{it})

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Independent variables	All countries and years	Exc. Great Recession	Exc. Asia	Exc. Latin America	Developed countries only	Developing countries only	1950-79	1980-2010
Δk_{it-1}	0.477***	0.467***	0.509***	0.531***	0.488***	0.459***	0.395***	0.468***
	(0.0494)	(0.0514)	(0.0522)	(0.0637)	(0.0527)	(0.0562)	(0.0721)	(0.0549)
Δk_{it-2}	0.177***	0.190***	0.134***	0.201***	0.118***	0.190***	0.140***	0.176***
	(0.0274)	(0.0309)	(0.0304)	(0.0365)	(0.0367)	(0.0288)	(0.0511)	(0.0345)
Δk_{it-3}	0.0163	0.0126	0.0127	-0.0193	0.0217	0.0130	0.0293	-0.000694
	(0.0267)	(0.0290)	(0.0257)	(0.0326)	(0.0202)	(0.0328)	(0.0519)	(0.0314)
$bank_{it}$	-0.00505**	-0.00604**	-0.00410*	-0.00249	0.00303	-0.00815***	-0.00360	-0.00513**
	(0.00224)	(0.00246)	(0.00233)	(0.00239)	(0.00303)	(0.00218)	(0.00809)	(0.00236)
$bank_{it-1}$	-0.00203	-0.00283	-0.00204	-0.00188	-0.00329	-0.00242	-0.00214	-0.00261
	(0.00208)	(0.00225)	(0.00198)	(0.00203)	(0.00268)	(0.00251)	(0.00368)	(0.00219)
Observations	2,745	2,629	2,377	2,206	1,034	1,711	1,020	1,725
Number of countries	58	58	50	48	22	36	57	58
2nd order autocorrelation	1.335	0.740	0.875	1.950	1.637	1.262	1.118	0.668
Coefficients on lagged Δq_{it}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
100 x θ_1	-1.137***	-1.419***	-0.997**	-0.755*	-0.0423	-1.677***	-0.832	-1.229***
	(0.411)	(0.462)	(0.405)	(0.392)	(0.379)	(0.397)	(1.122)	(0.418)
100 x θ_2	-0.920***	-1.148***	-0.817**	-0.603*	-0.0350	-1.361***	-0.703	-1.010***
	(0.333)	(0.373)	(0.333)	(0.312)	(0.314)	(0.323)	(0.947)	(0.347)

Note *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses. Fixed effects, year dummies and constant included but not reported. Coefficients on lagged Δq_{it} : p-value for $H_0: \phi_4 + 2\phi_5 + 3\phi_6 = 0$. 2nd order autocorrelation: Arellano-Bond test for 2nd order serial correlation in residuals.

Table 10
Panel regression (least squares) estimates of equation (7):
dependent variable is growth of labour productivity (Δq_{it}); IMF banking crises

	(1)	(2)	(3)	(4)	(5)	(6)
Independent variables	All countries and years	Exc. Great Recession	Exc. Asia	Exc. Latin America	Developed countries only	Developing countries only
Δq_{it-1}	0.283***	0.284***	0.285***	0.279***	0.299***	0.273***
	(0.0464)	(0.0500)	(0.0487)	(0.0502)	(0.0600)	(0.0490)
Δq_{it-2}	0.0520	0.0594*	0.0511	0.0791**	0.00342	0.0496
	(0.0330)	(0.0337)	(0.0351)	(0.0354)	(0.124)	(0.0346)
Δq_{it-3}	-0.0169	-0.0168	-0.0164	-0.0190	0.0313	-0.0236
	(0.0316)	(0.0338)	(0.0333)	(0.0342)	(0.0563)	(0.0331)
$bank_{it}$	-0.0178***	-0.0172***	-0.0173***	-0.0159***	-0.0195	-0.0165***
	(0.00430)	(0.00481)	(0.00473)	(0.00467)	(0.0126)	(0.00482)
$bank_{it-1}$	0.0102**	0.00982**	0.0116**	0.0126***	0.0238**	0.00722
	(0.00455)	(0.00489)	(0.00499)	(0.00455)	(0.0106)	(0.00508)
Observations	2,479	2,218	2,262	2,138	638	1,841
R^2 (within)	0.198	0.188	0.203	0.209	0.314	0.203
Number of countries	87	87	80	76	21	66
Coefficients on lagged Δq_{it}	0.0625	0.0000	0.0000	0.0000	0.0000	0.0000
100 x θ_1	-0.959**	-0.932	-0.716	-0.412	0.537	-1.157*
	(0.483)	(0.569)	(0.512)	(0.561)	(0.497)	(0.619)
100 x θ_2	-0.896**	-0.868	-0.668	-0.381	0.496	-1.089*
	(0.457)	(0.535)	(0.482)	(0.521)	(0.450)	(0.589)

Note *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses. Fixed effects, year dummies and constant included but not reported.
Coefficients on lagged Δq_{it}: p-value for $H_0: \phi_4 + 2\phi_5 + 3\phi_6 = 0$.

Table 11
Arellano-Bond (difference) estimates of equation (7):
dependent variable is growth of labour productivity (Δq_{it}); IMF banking crises

	(1)	(2)	(3)	(4)	(5)	(6)
Independent variables	All countries and years	Exc. Great Recession	Exc. Asia	Exc. Latin America	Developed countries only	Developing countries only
Δq_{it-1}	0.299***	0.303***	0.301***	0.292***	0.300***	0.287***
	(0.0451)	(0.0485)	(0.0460)	(0.0487)	(0.0579)	(0.0472)
Δq_{it-2}	0.0641*	0.0777**	0.0631*	0.0888**	0.00449	0.0625*
	(0.0337)	(0.0352)	(0.0354)	(0.0357)	(0.119)	(0.0351)
Δq_{it-3}	-0.00124	0.0115	-0.000485	-0.00892	0.0333	-0.00854
	(0.0318)	(0.0358)	(0.0331)	(0.0342)	(0.0520)	(0.0326)
$bank_{it}$	-0.0161***	-0.0142***	-0.0166***	-0.0135***	-0.0194*	-0.0138***
	(0.00454)	(0.00508)	(0.00506)	(0.00481)	(0.0114)	(0.00493)
$bank_{it-1}$	0.00810	0.00877	0.00935*	0.00781*	0.0228**	0.00446
	(0.00507)	(0.00580)	(0.00555)	(0.00444)	(0.0105)	(0.00576)
Observations	2,392	2,131	2,182	2,062	617	1,775
Number of countries	87	87	80	76	21	66
2nd order autocorrelation	0.126	0.198	-0.122	0.293	0.459	0.00256
Coefficients on lagged Δq_{it}	0.000679	0.000573	0.000672	0.000777	0.0714	0.00316
100 x θ_1	-1.028	-0.705	-0.926	-0.733	0.429	-1.188
	(0.626)	(0.774)	(0.681)	(0.639)	(0.408)	(0.792)
100 x θ_2	-0.943	-0.637	-0.849	-0.669	0.396	-1.098
	(0.580)	(0.706)	(0.629)	(0.585)	(0.366)	(0.739)

Note *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses. Fixed effects, year dummies and constant included but not reported. Coefficients on lagged Δq_{it}: p-value for $H_0: \phi_4 + 2\phi_5 + 3\phi_6 = 0$. 2nd order autocorrelation: Arellano-Bond test for 2nd order serial correlation in residuals.

Table 12
Panel regression (least squares) estimates of equation (7): dependent variable is growth of GDP per capita (Δy_{it})

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Independent variables	All countries and years	Exc. Great Recession	Exc. Asia	Exc. Latin America	Developed countries only	Developing countries only	1950-79	1980-2010
Δy_{it-1}	0.141*	0.131*	0.103	0.216***	0.300***	0.0961	0.0637	0.134
	(0.0718)	(0.0723)	(0.0788)	(0.0483)	(0.0559)	(0.0794)	(0.0524)	(0.128)
Δy_{it-2}	0.0492	0.0440	0.0421	0.0571	0.0513	0.0331	-0.0324	0.0562
	(0.0298)	(0.0294)	(0.0314)	(0.0350)	(0.0650)	(0.0285)	(0.0341)	(0.0409)
Δy_{it-3}	0.0322	0.0275	0.0270	0.0370	0.0524	0.0207	-0.0392	0.0204
	(0.0207)	(0.0209)	(0.0240)	(0.0250)	(0.0442)	(0.0226)	(0.0381)	(0.0230)
$bank_{it}$	-0.0185***	-0.0176***	-0.0207***	-0.0141***	-0.00737**	-0.0207***	-0.0202***	-0.0188***
	(0.00356)	(0.00363)	(0.00398)	(0.00282)	(0.00309)	(0.00500)	(0.00608)	(0.00392)
$bank_{it-1}$	0.00441	0.00511	0.00464	0.00367	0.00142	0.00603	0.00165	0.00381
	(0.00294)	(0.00309)	(0.00351)	(0.00225)	(0.00420)	(0.00372)	(0.0124)	(0.00321)
Observations	3,338	3,216	2,834	2,722	1,210	2,128	1,534	1,804
Number of countries	0.158	0.136	0.172	0.193	0.455	0.134	0.087	0.177
2nd order autocorrelation	61	61	52	50	23	38	59	61
Coefficients on lagged Δy_{it}	0.00135	0.00468	0.0322	8.55e-05	0.0257	0.0518	0.472	0.0272
100 x θ_1	-1.587***	-1.389***	-1.752***	-1.250***	-0.760*	-1.590***	-1.913	-1.679***
	(0.333)	(0.345)	(0.404)	(0.360)	(0.421)	(0.476)	(1.641)	(0.362)
100 x θ_2	-1.493***	-1.315***	-1.671***	-1.149***	-0.679*	-1.528***	-1.952	-1.588***
	(0.324)	(0.336)	(0.398)	(0.338)	(0.380)	(0.467)	(1.680)	(0.366)

Note *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses. Fixed effects, year dummies and constant included but not reported. Coefficients on lagged Δy_{it} : p-value for $H_0: \phi_4 + 2\phi_5 + 3\phi_6 = 0$.

CHARTS AND FIGURES

Figure 1
Hypothetical paths for GDP per hour during recession and recovery

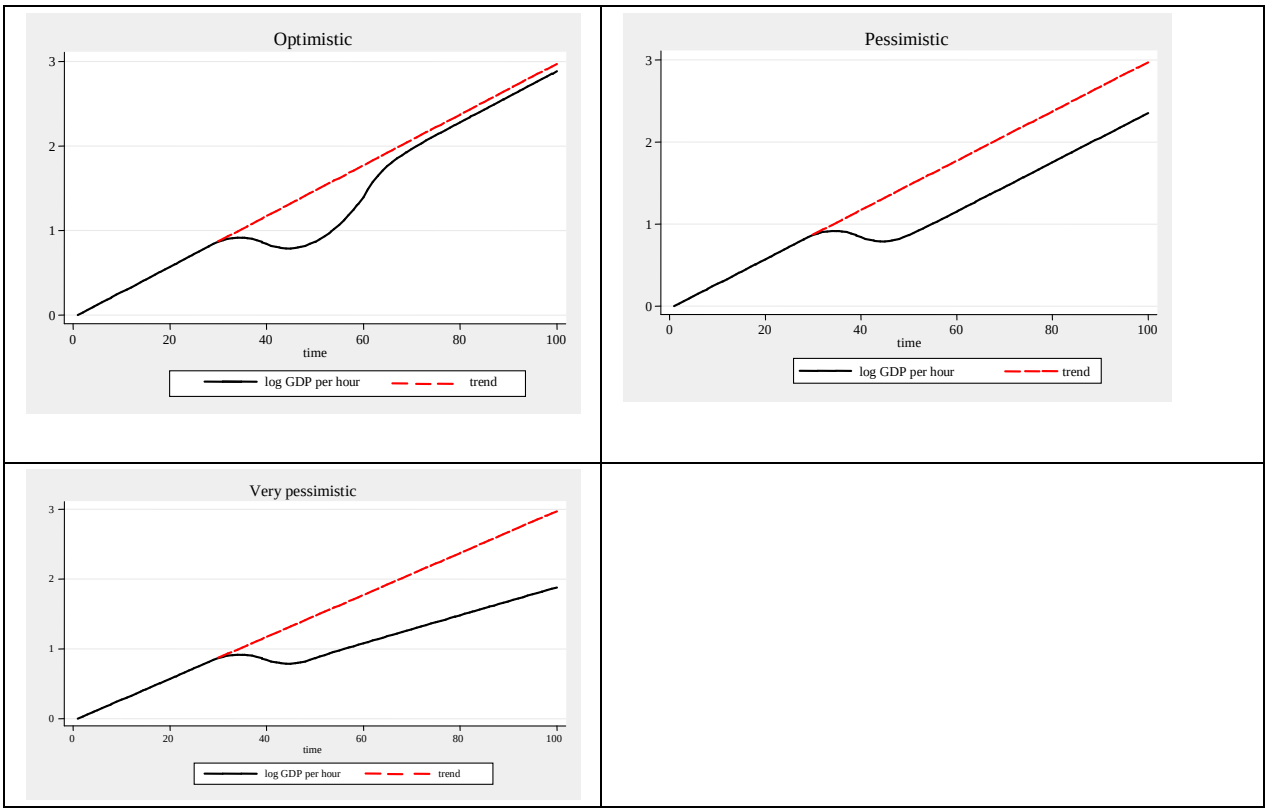
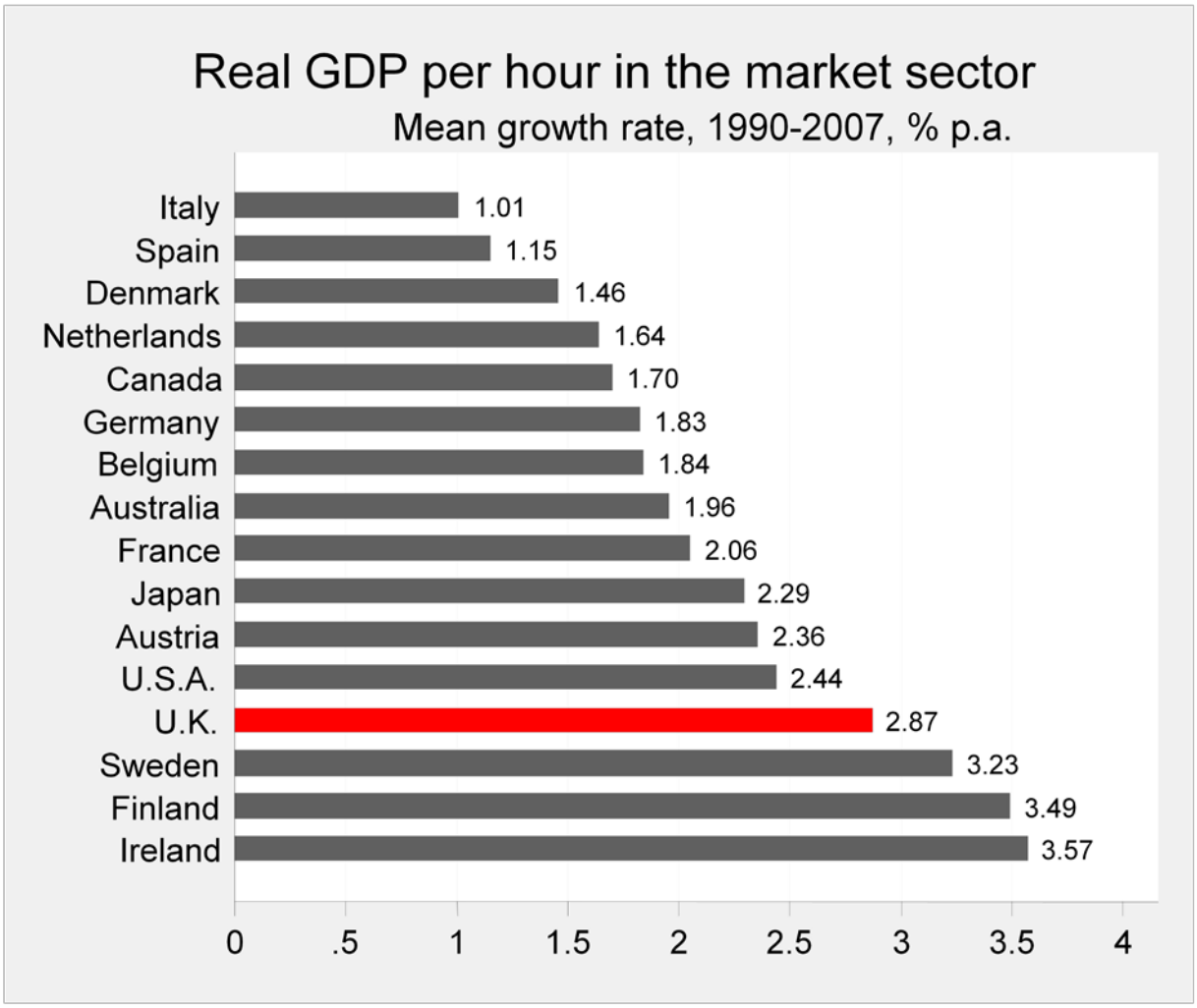
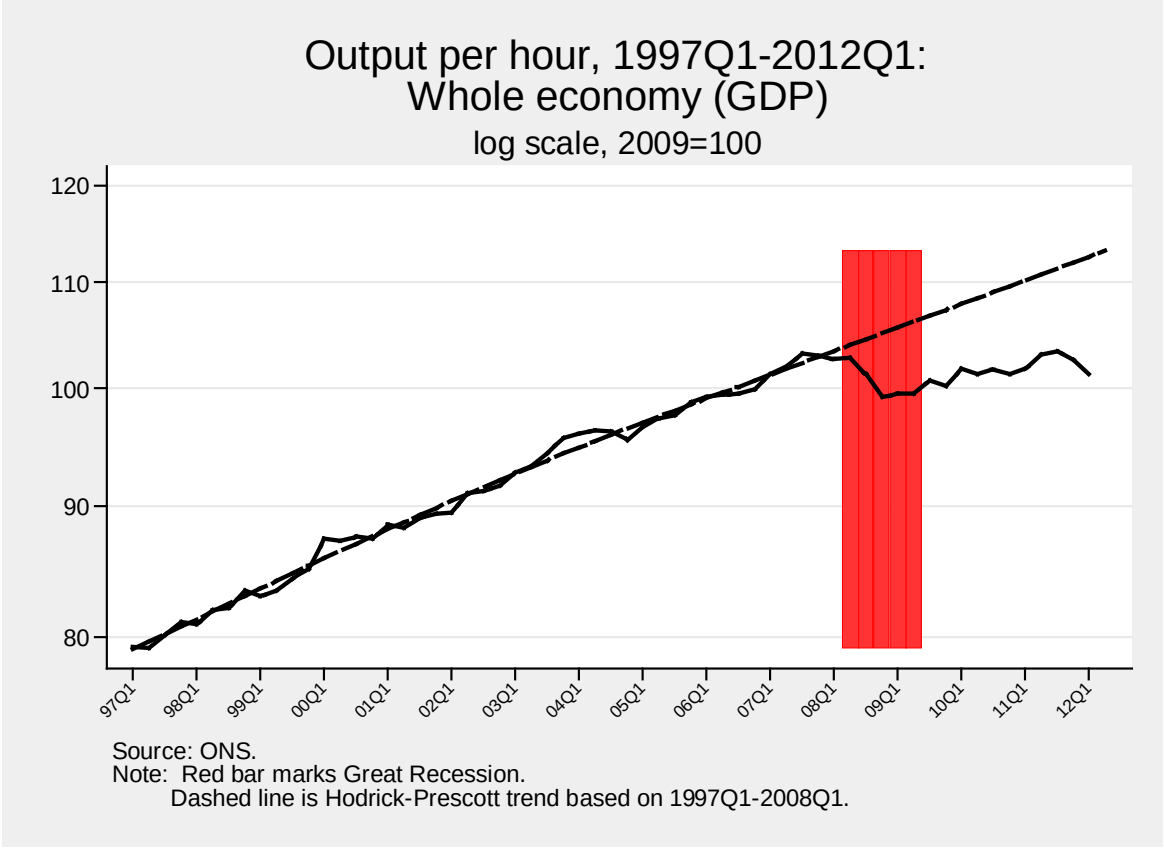


CHART 1



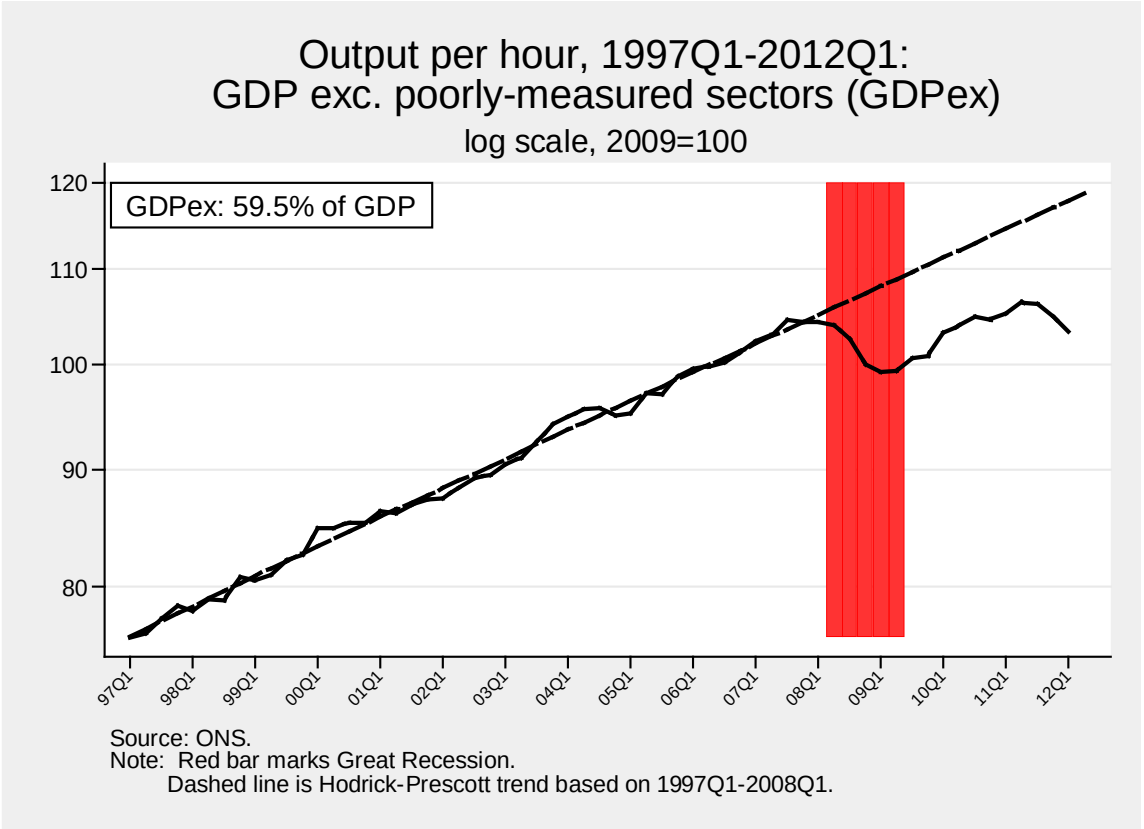
Source EU KLEMS, November 2009 release (www.euklems.net).

CHART 2



Source: ONS.
Note: Red bar marks Great Recession.
Dashed line is Hodrick-Prescott trend based on 1997Q1-2008Q1.

CHART 3



Source: ONS.
Note: Red bar marks Great Recession.
Dashed line is Hodrick-Prescott trend based on 1997Q1-2008Q1.

CHART 4

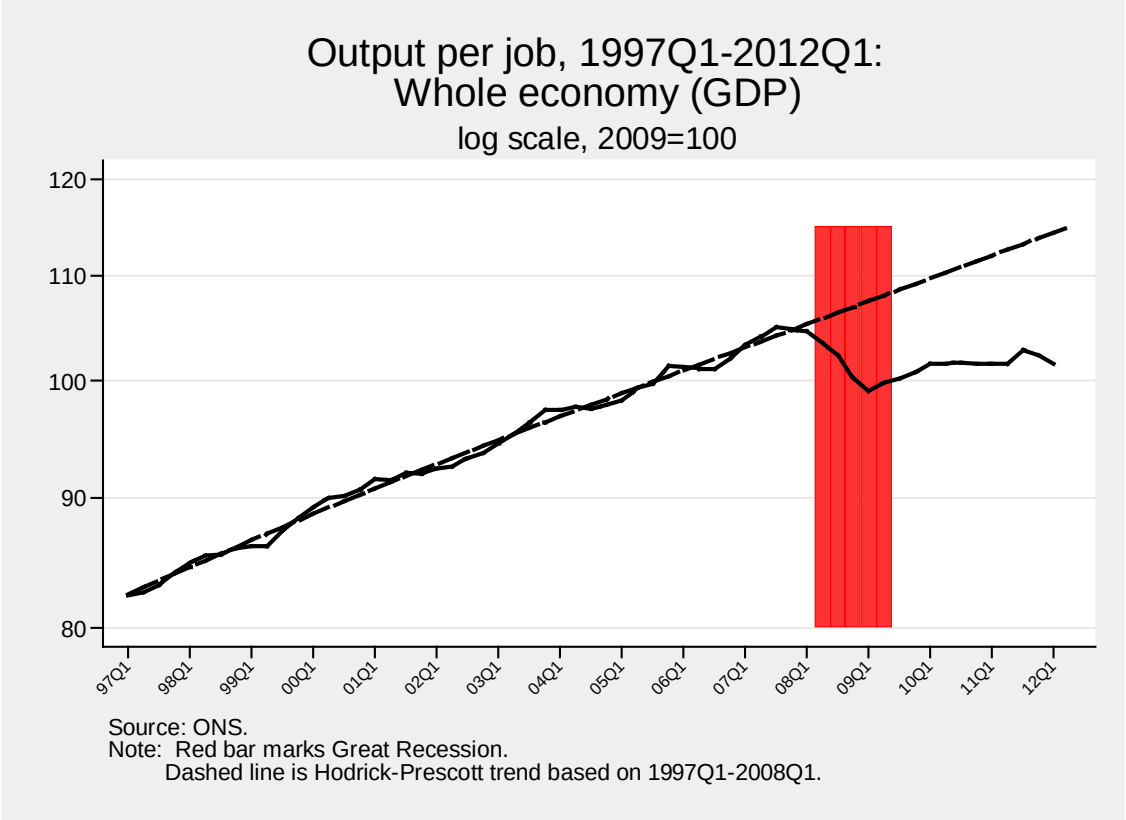


CHART 5

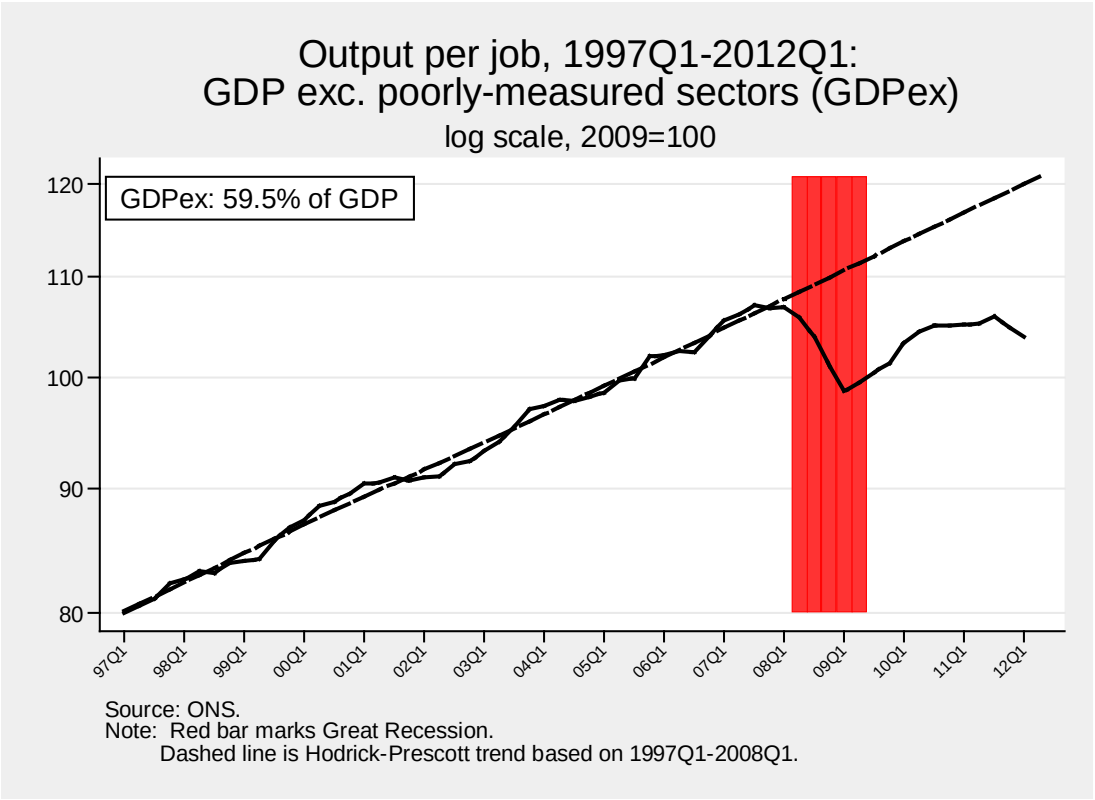
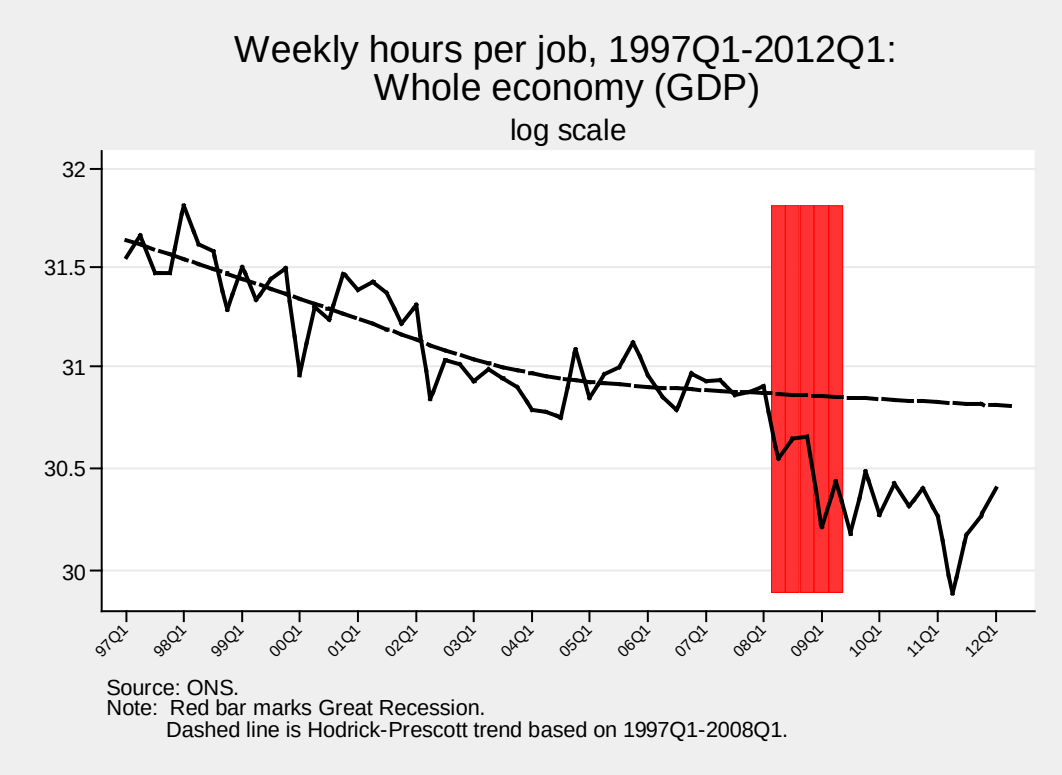
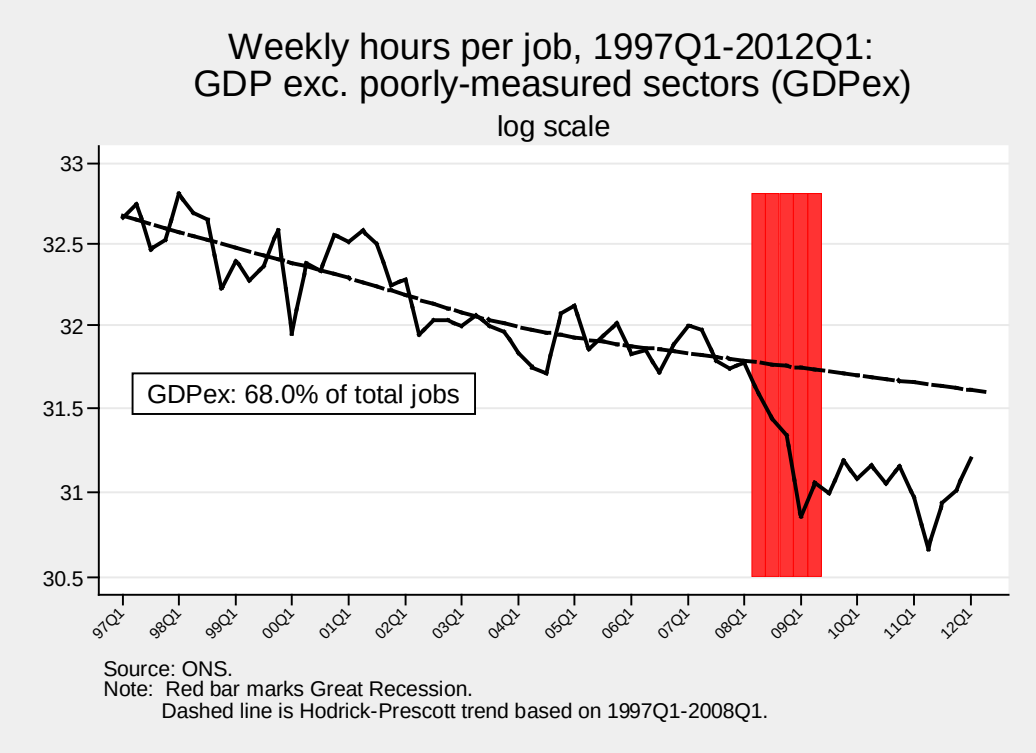


CHART 6



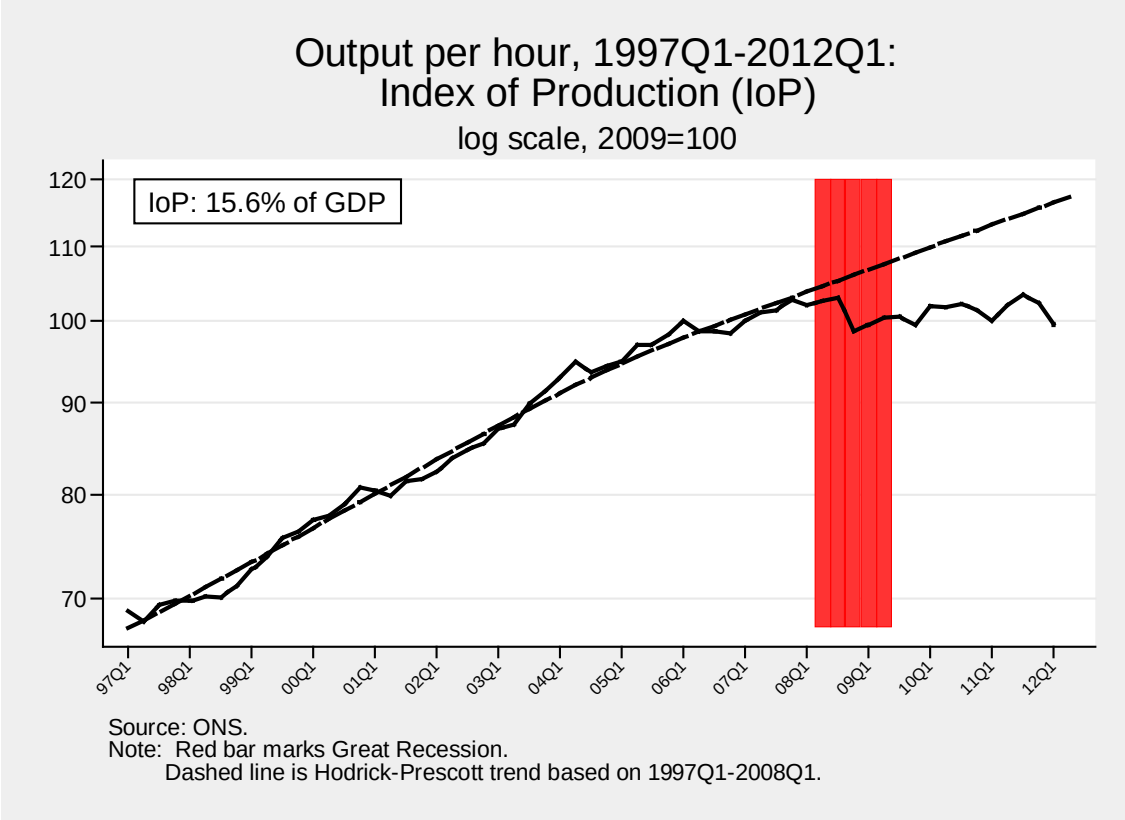
Source: ONS.
Note: Red bar marks Great Recession.
Dashed line is Hodrick-Prescott trend based on 1997Q1-2008Q1.

CHART 7



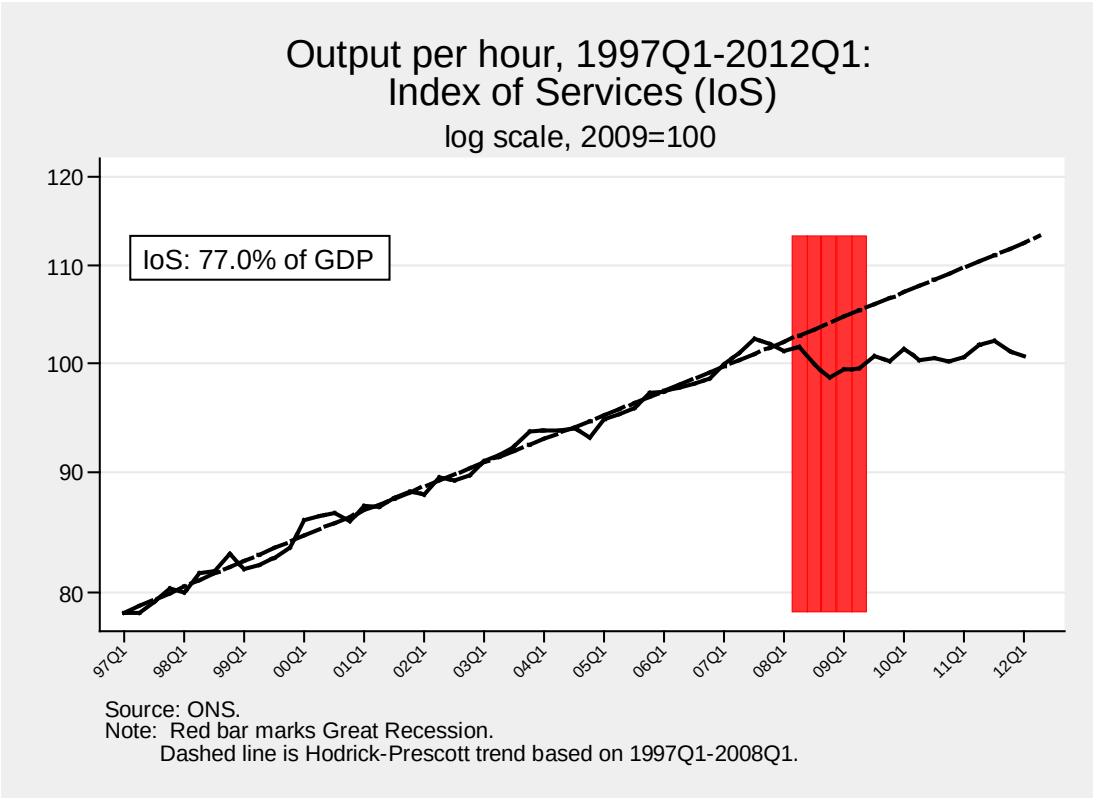
Source: ONS.
Note: Red bar marks Great Recession.
Dashed line is Hodrick-Prescott trend based on 1997Q1-2008Q1.

CHART 8



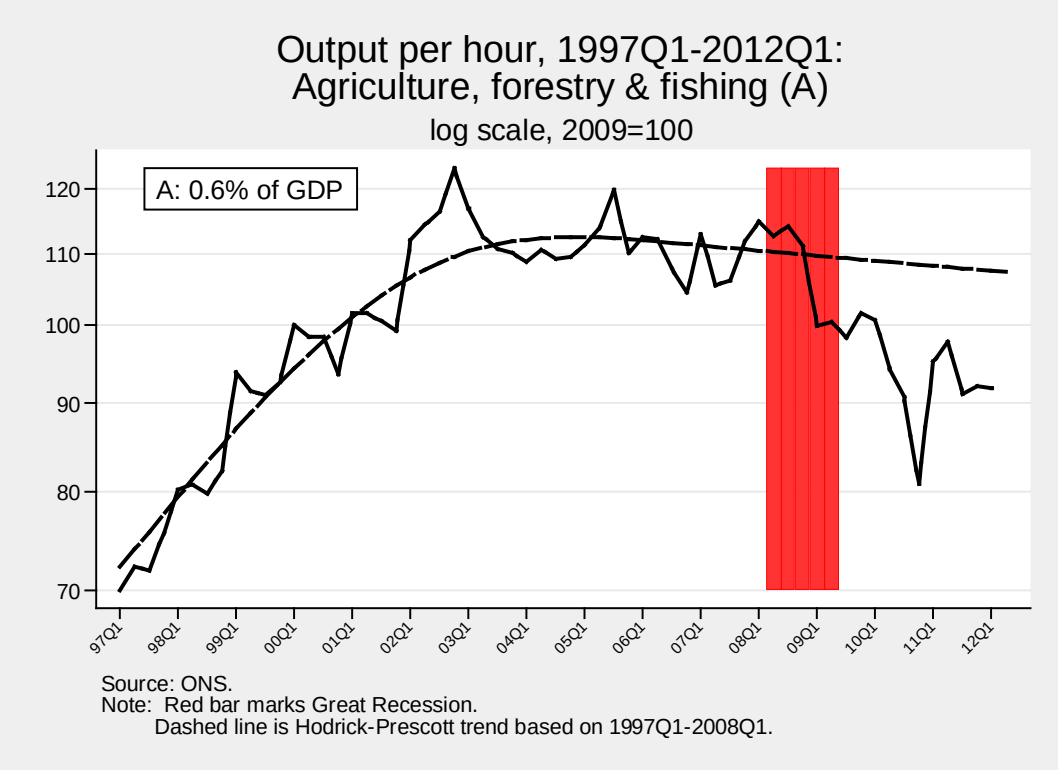
Source: ONS.
Note: Red bar marks Great Recession.
Dashed line is Hodrick-Prescott trend based on 1997Q1-2008Q1.

CHART 9



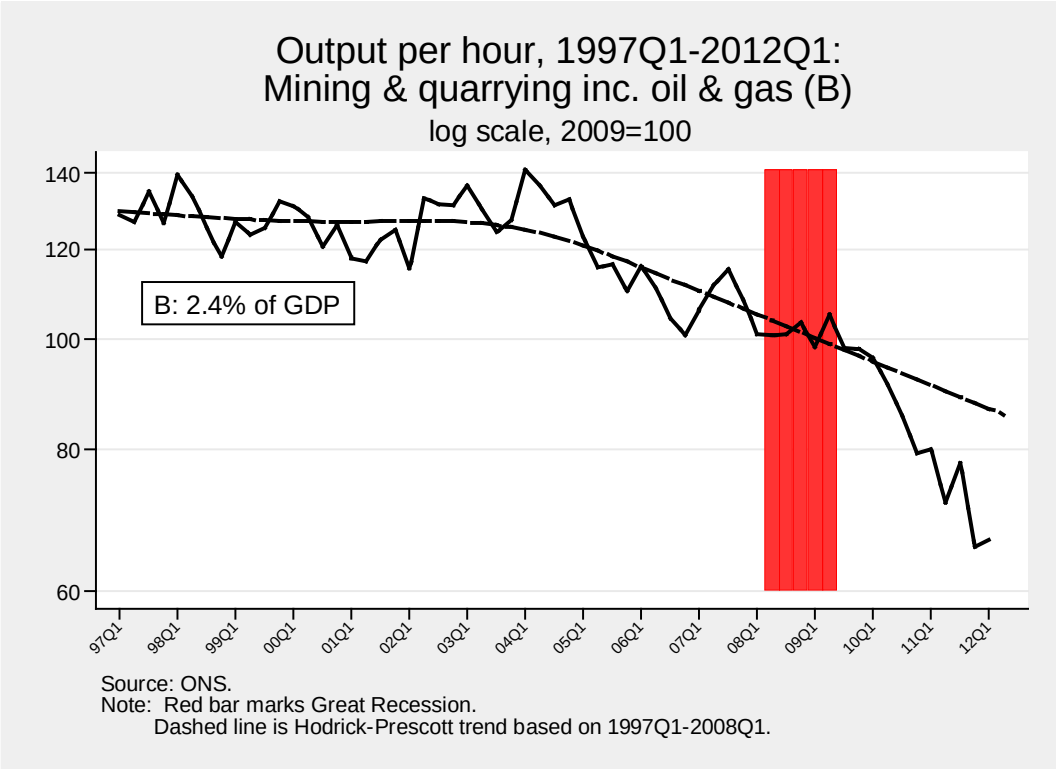
Source: ONS.
Note: Red bar marks Great Recession.
Dashed line is Hodrick-Prescott trend based on 1997Q1-2008Q1.

CHART 10



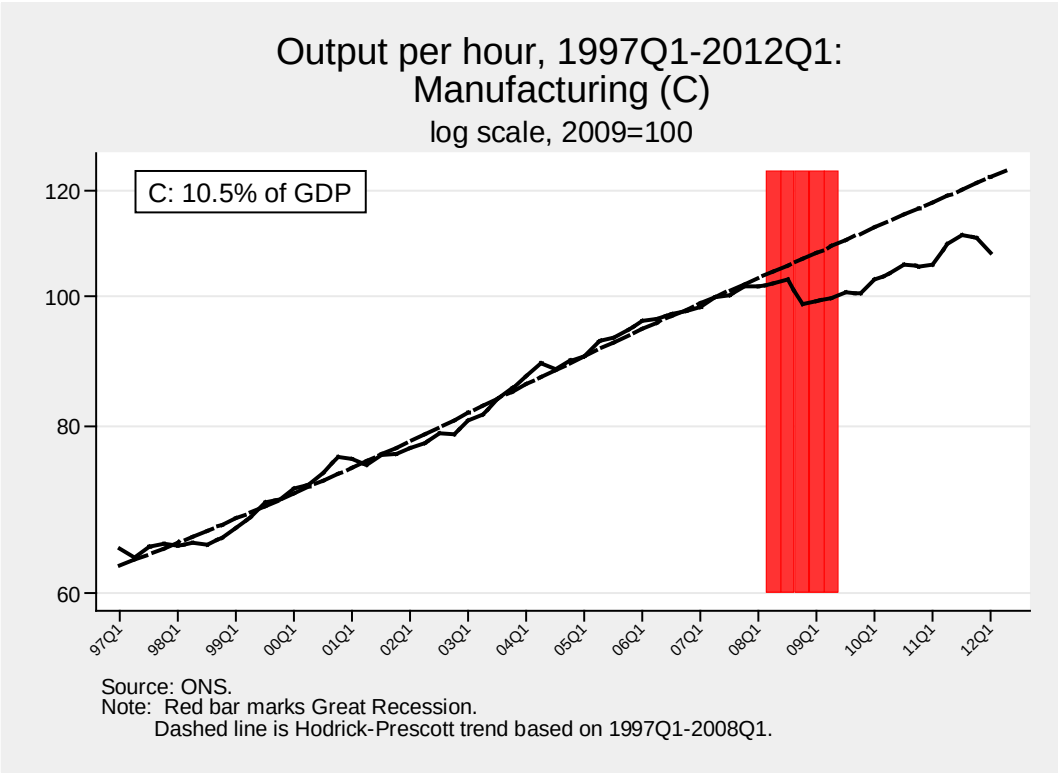
Source: ONS.
Note: Red bar marks Great Recession.
Dashed line is Hodrick-Prescott trend based on 1997Q1-2008Q1.

CHART 11



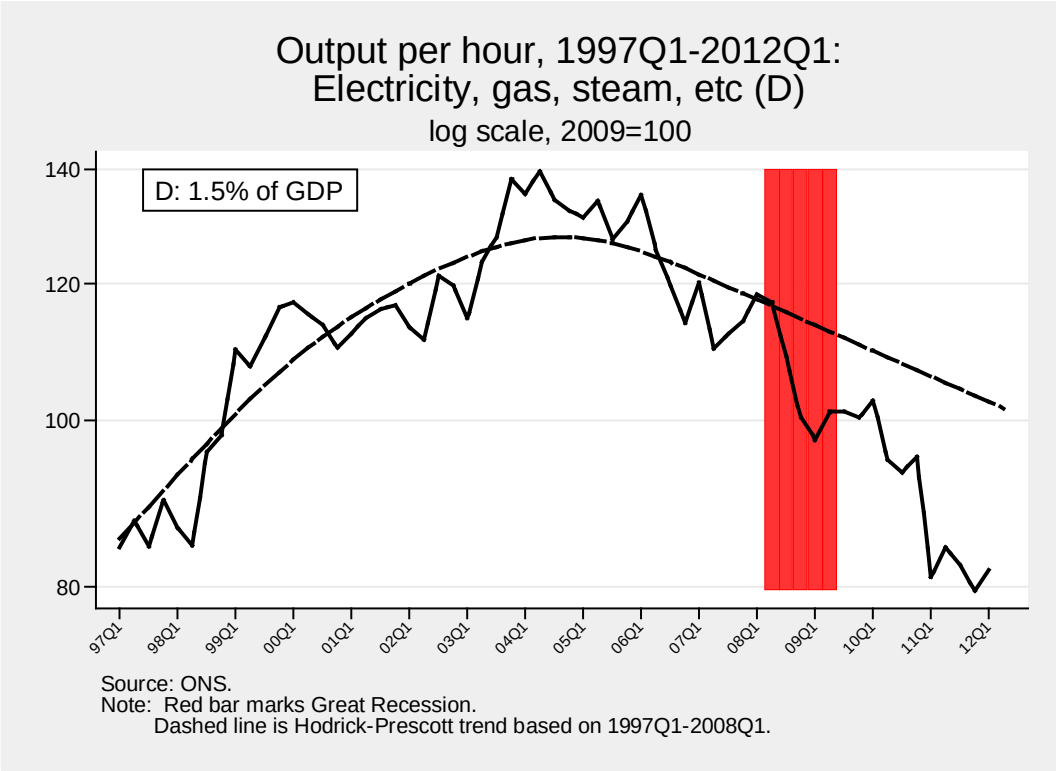
Source: ONS.
Note: Red bar marks Great Recession.
Dashed line is Hodrick-Prescott trend based on 1997Q1-2008Q1.

CHART 12



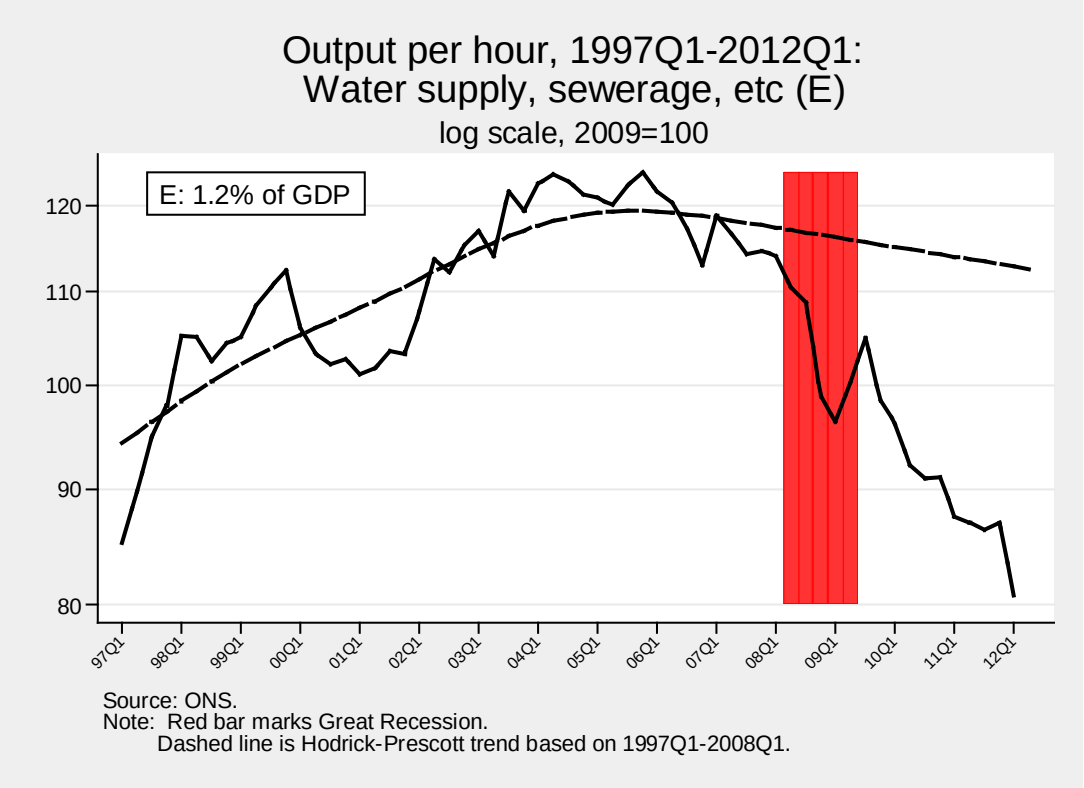
Source: ONS.
Note: Red bar marks Great Recession.
Dashed line is Hodrick-Prescott trend based on 1997Q1-2008Q1.

CHART 13



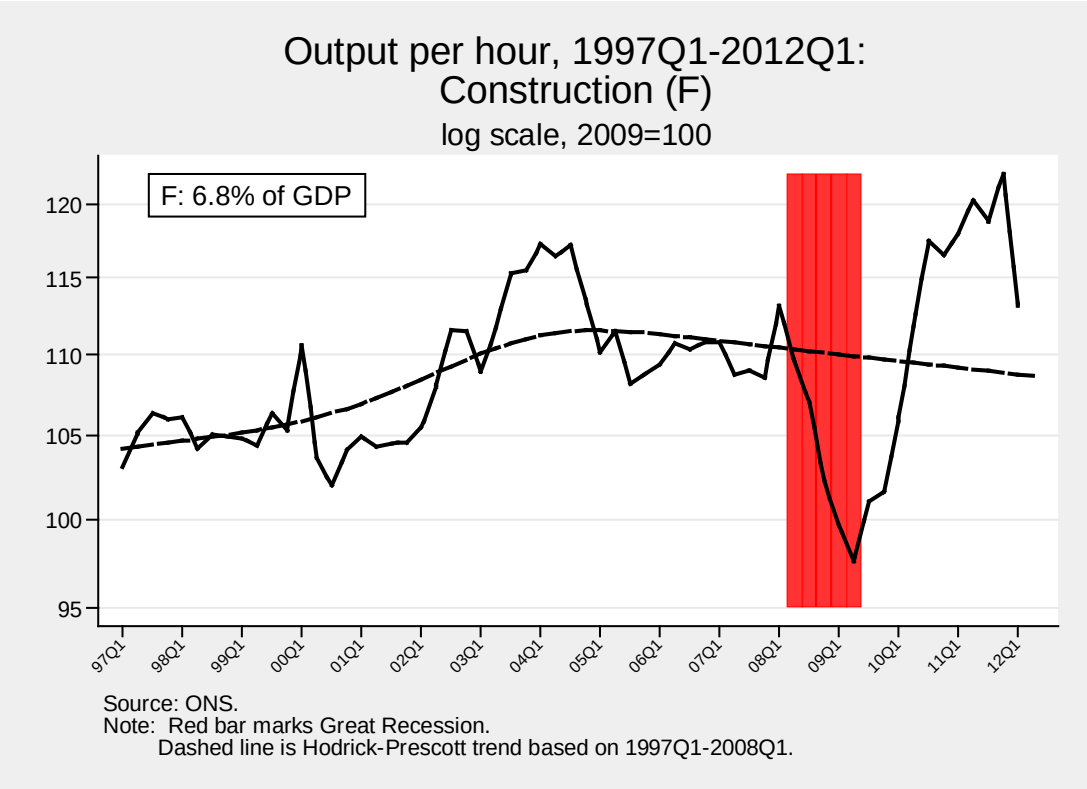
Source: ONS.
Note: Red bar marks Great Recession.
Dashed line is Hodrick-Prescott trend based on 1997Q1-2008Q1.

CHART 14



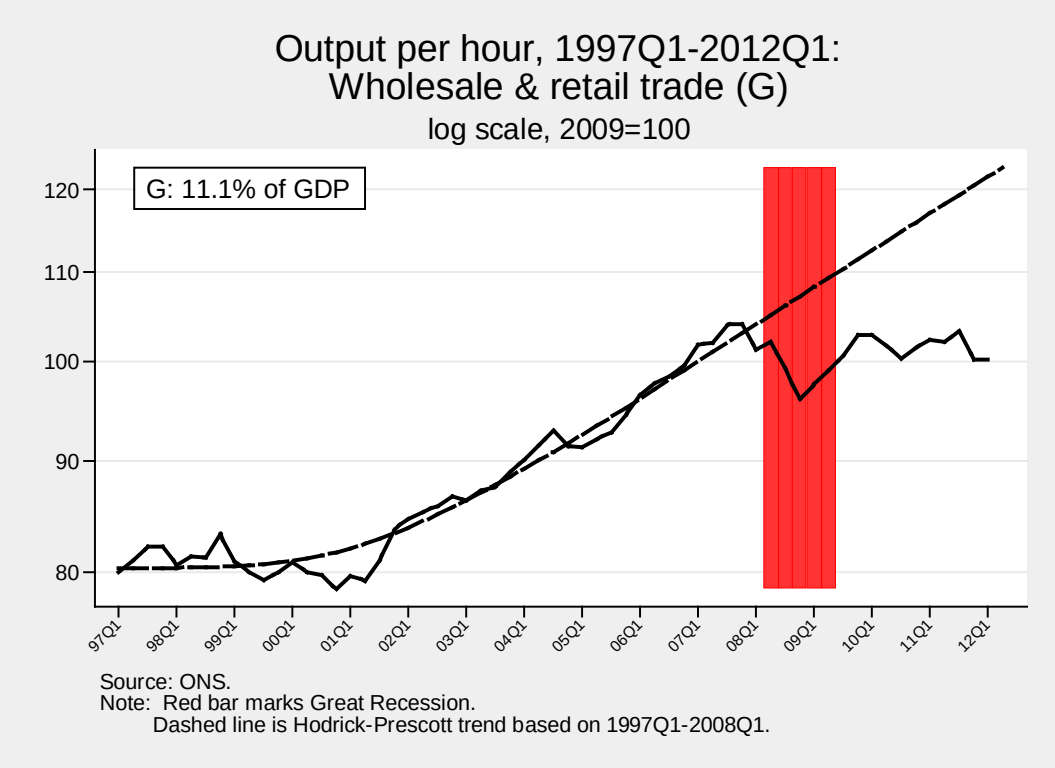
Source: ONS.
Note: Red bar marks Great Recession.
Dashed line is Hodrick-Prescott trend based on 1997Q1-2008Q1.

CHART 15



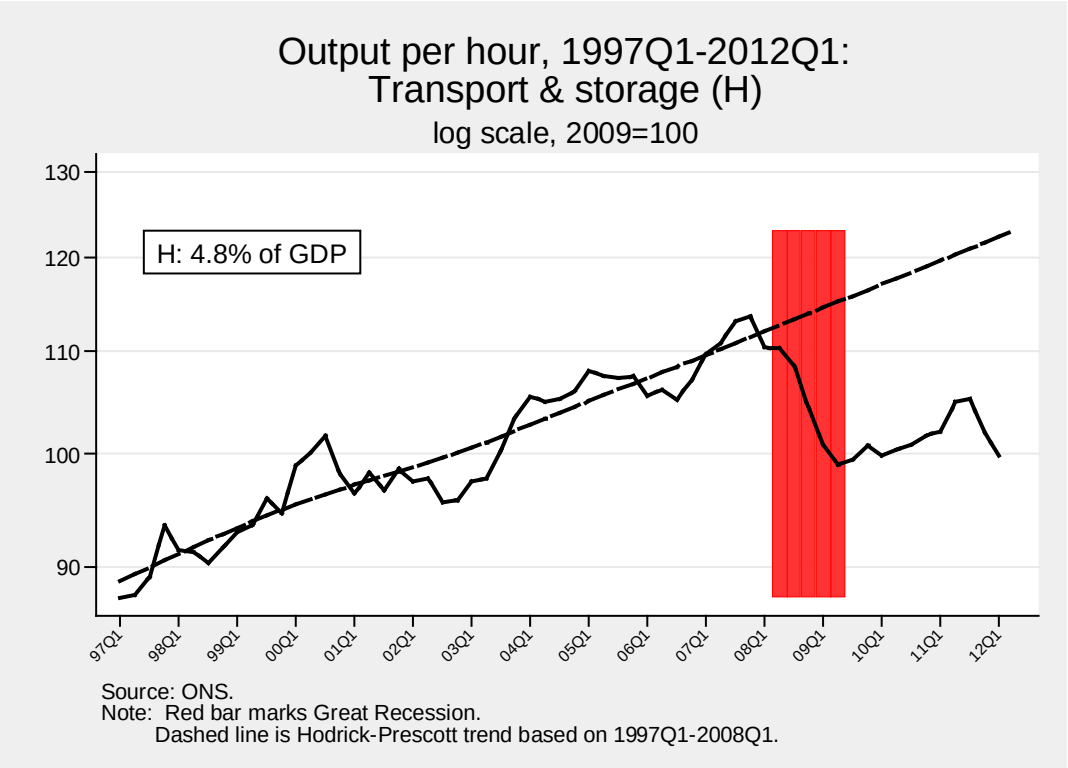
Source: ONS.
Note: Red bar marks Great Recession.
Dashed line is Hodrick-Prescott trend based on 1997Q1-2008Q1.

CHART 16



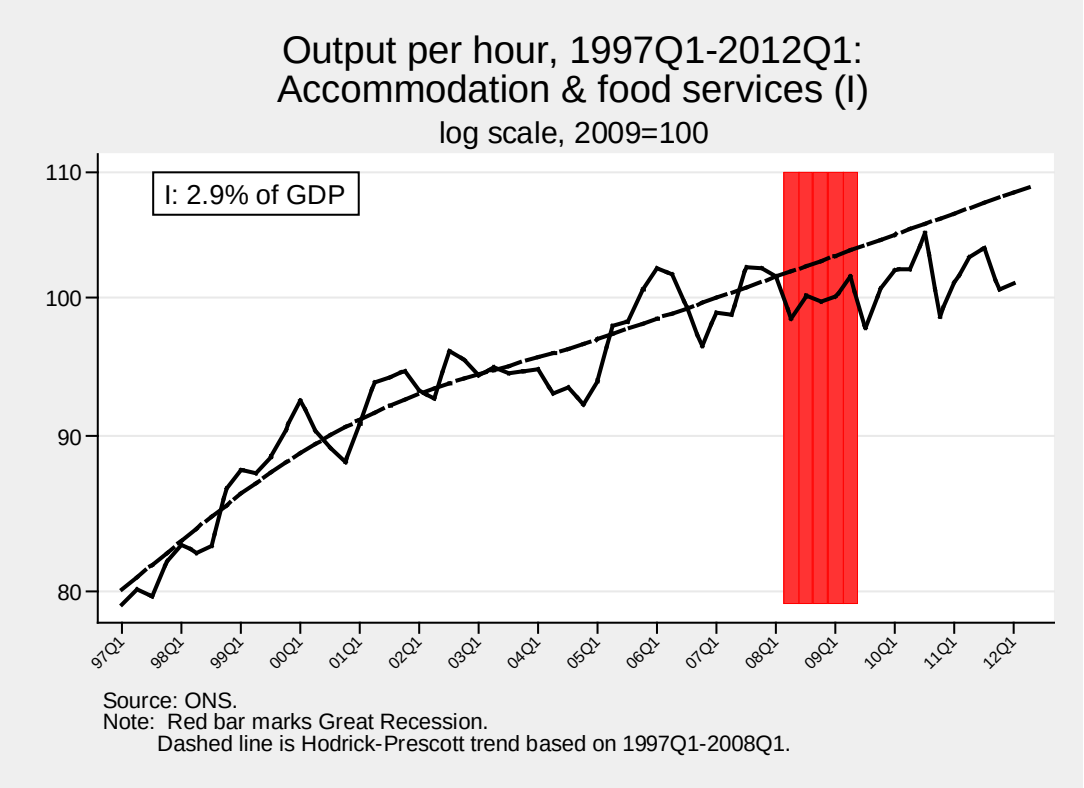
Source: ONS.
Note: Red bar marks Great Recession.
Dashed line is Hodrick-Prescott trend based on 1997Q1-2008Q1.

CHART 17



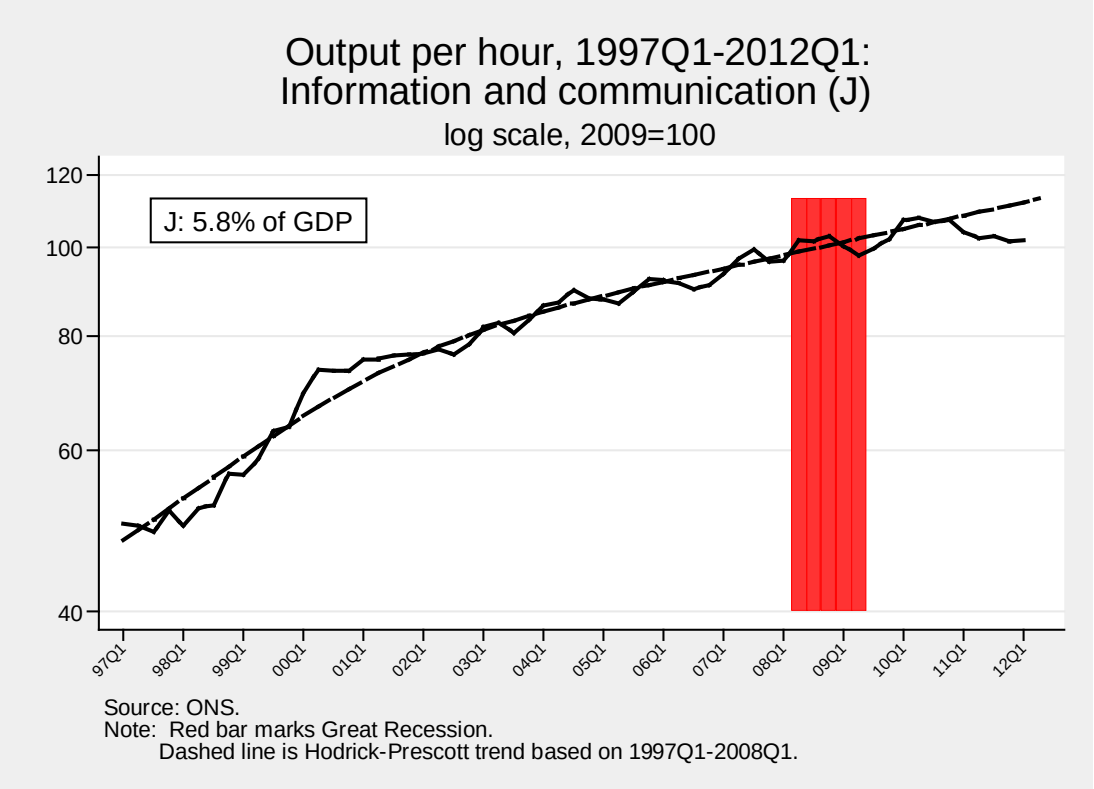
Source: ONS.
Note: Red bar marks Great Recession.
Dashed line is Hodrick-Prescott trend based on 1997Q1-2008Q1.

CHART 18



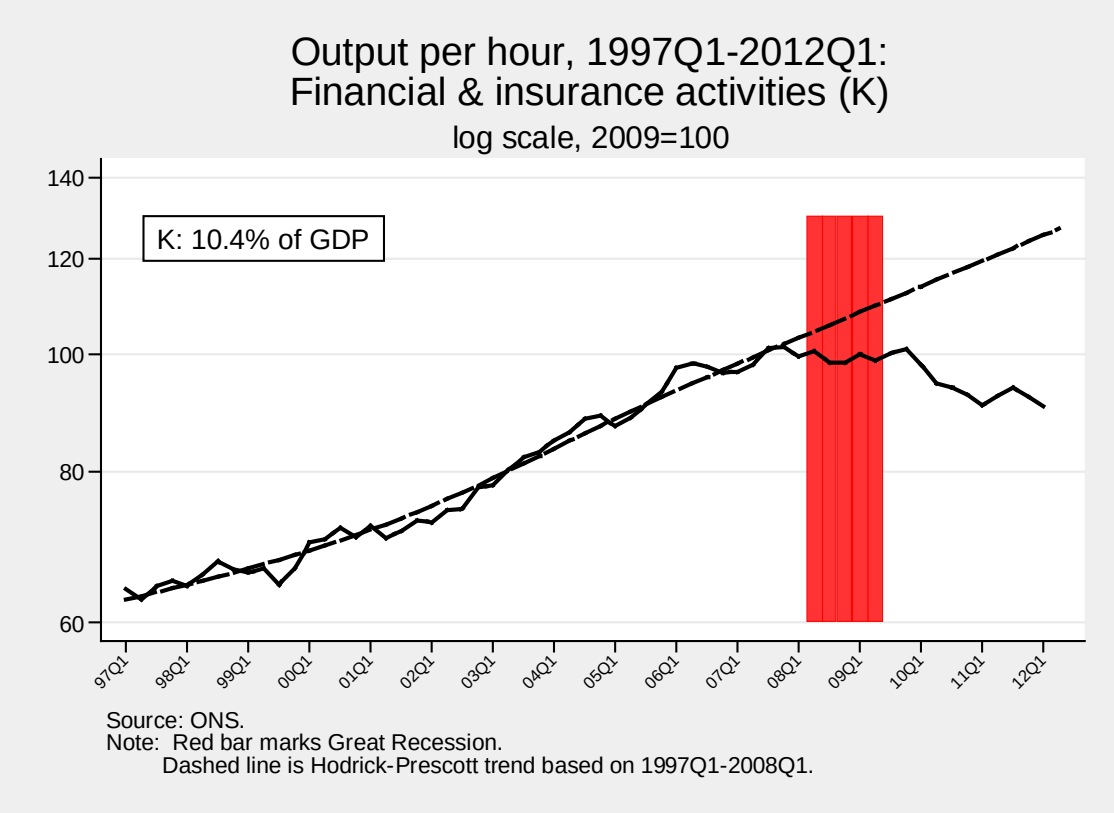
Source: ONS.
Note: Red bar marks Great Recession.
Dashed line is Hodrick-Prescott trend based on 1997Q1-2008Q1.

CHART 19



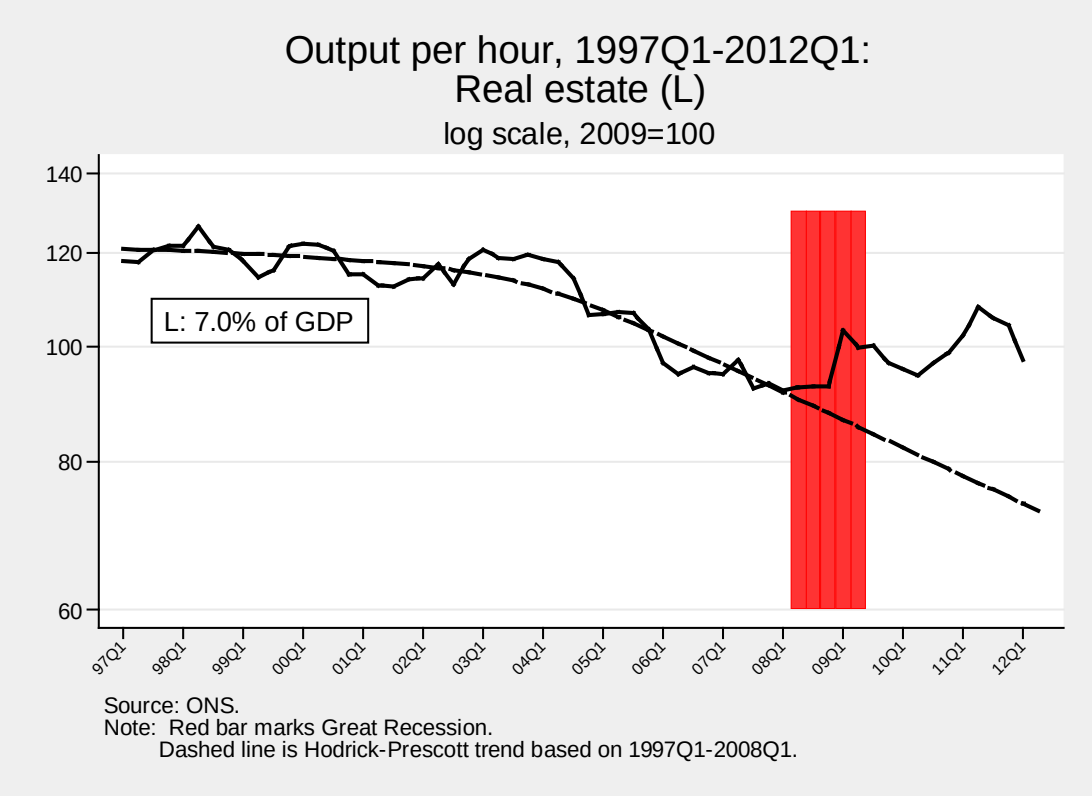
Source: ONS.
Note: Red bar marks Great Recession.
Dashed line is Hodrick-Prescott trend based on 1997Q1-2008Q1.

CHART 20



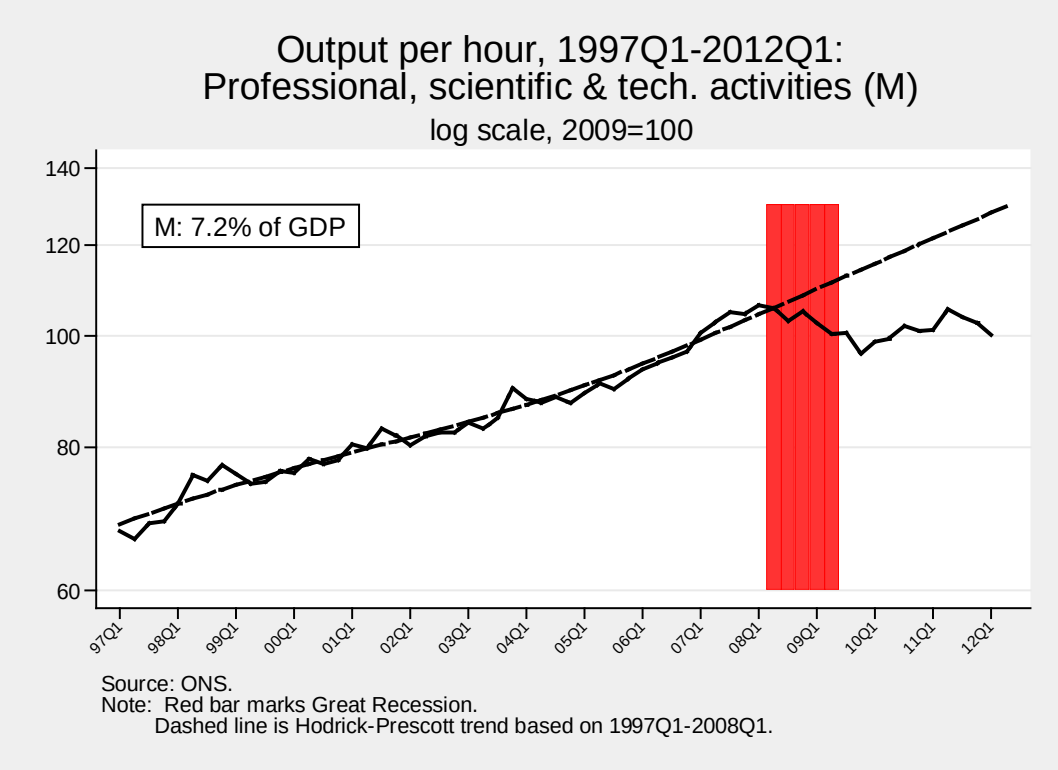
Source: ONS.
Note: Red bar marks Great Recession.
Dashed line is Hodrick-Prescott trend based on 1997Q1-2008Q1.

CHART 21



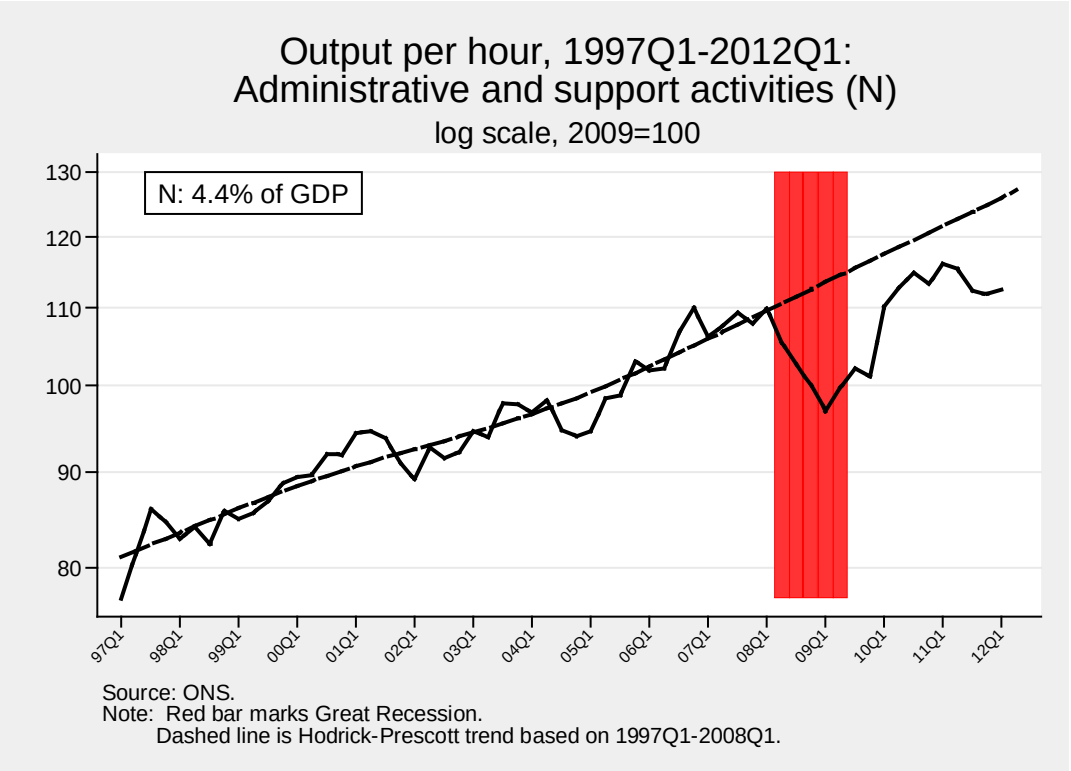
Source: ONS.
Note: Red bar marks Great Recession.
Dashed line is Hodrick-Prescott trend based on 1997Q1-2008Q1.

CHART 22



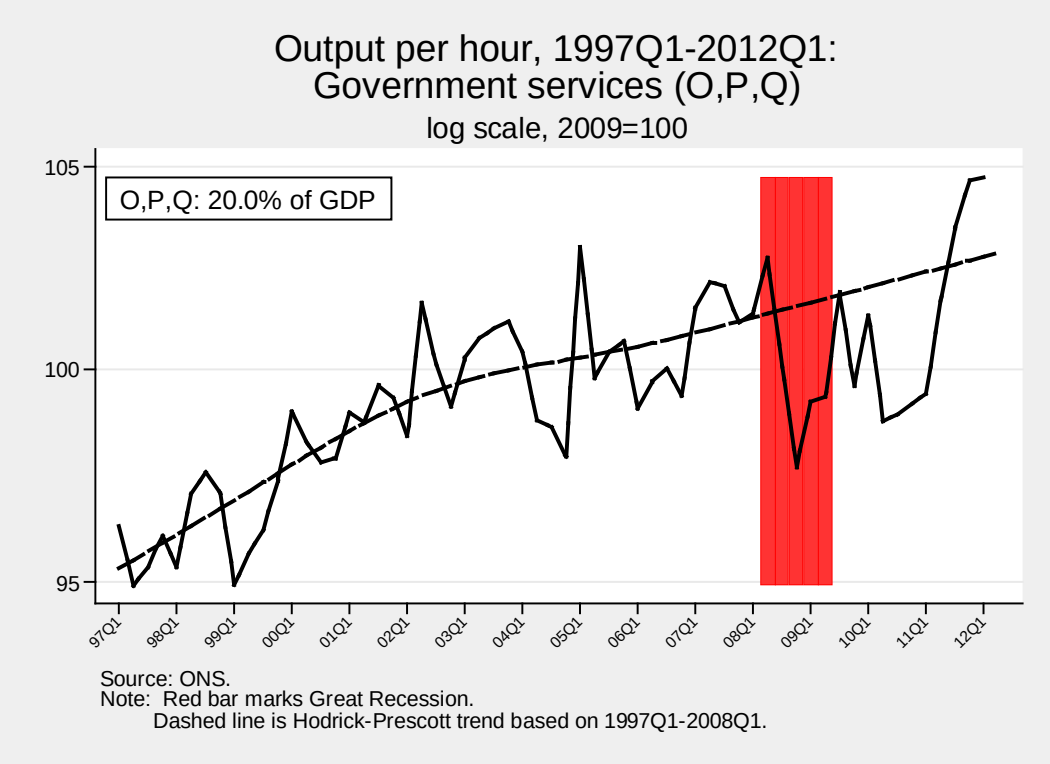
Source: ONS.
Note: Red bar marks Great Recession.
Dashed line is Hodrick-Prescott trend based on 1997Q1-2008Q1.

CHART 23



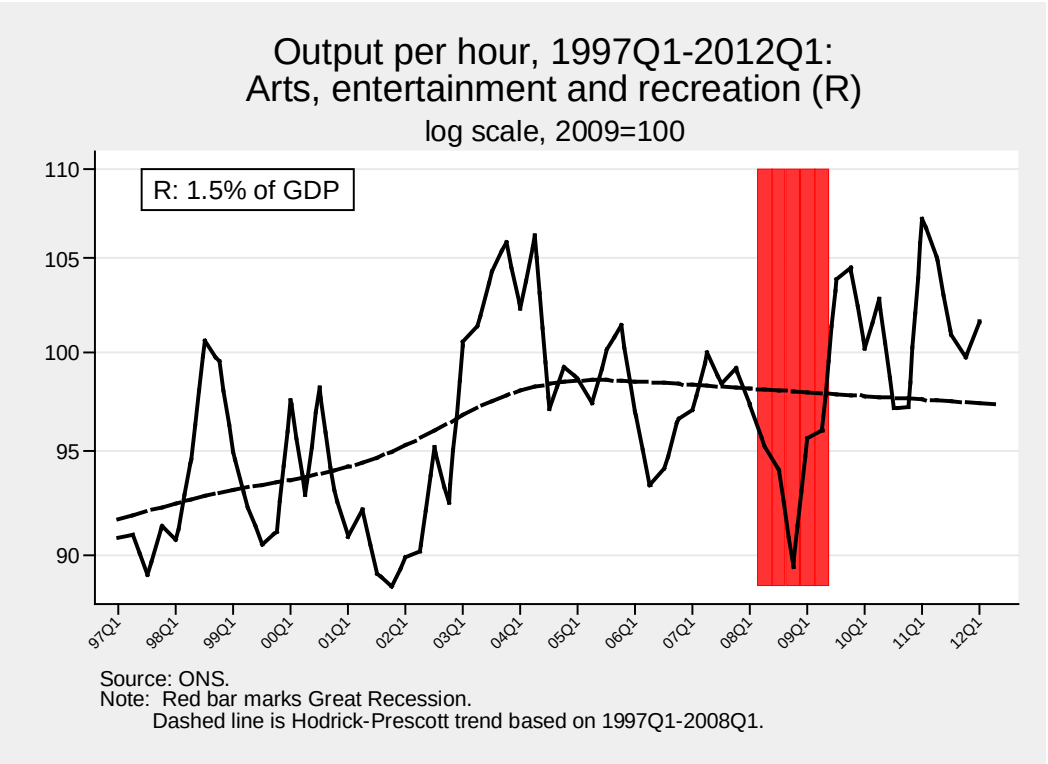
Source: ONS.
Note: Red bar marks Great Recession.
Dashed line is Hodrick-Prescott trend based on 1997Q1-2008Q1.

CHART 24



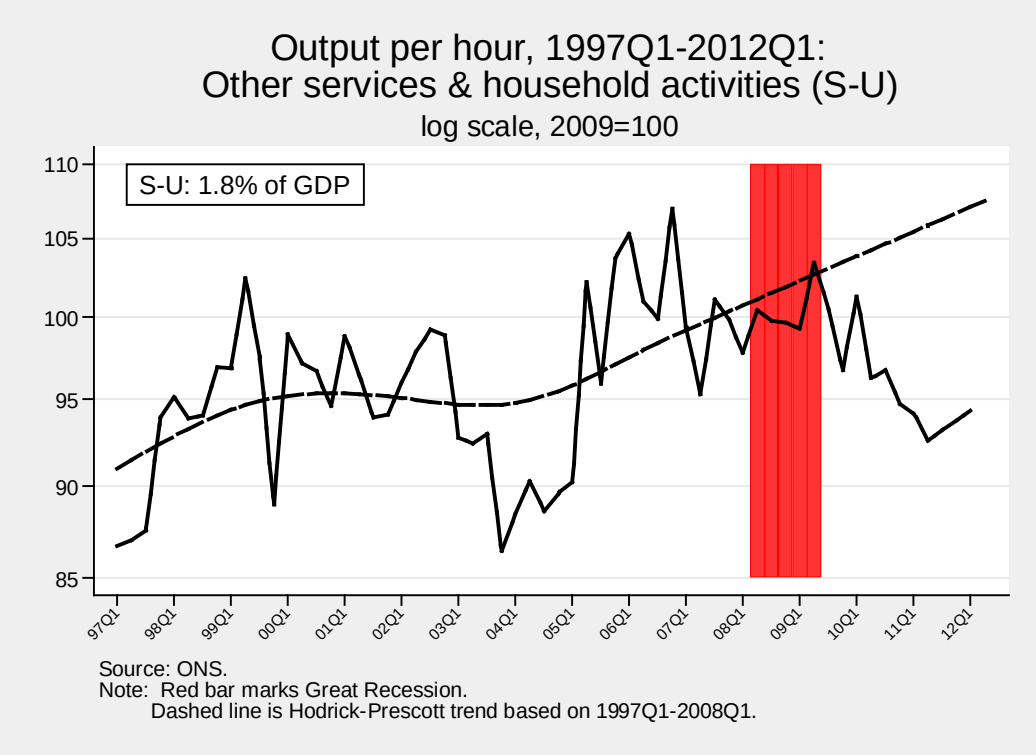
Source: ONS.
Note: Red bar marks Great Recession.
Dashed line is Hodrick-Prescott trend based on 1997Q1-2008Q1.

CHART 25



Source: ONS.
Note: Red bar marks Great Recession.
Dashed line is Hodrick-Prescott trend based on 1997Q1-2008Q1.

CHART 26



Source: ONS.
Note: Red bar marks Great Recession.
Dashed line is Hodrick-Prescott trend based on 1997Q1-2008Q1.

CHART 27

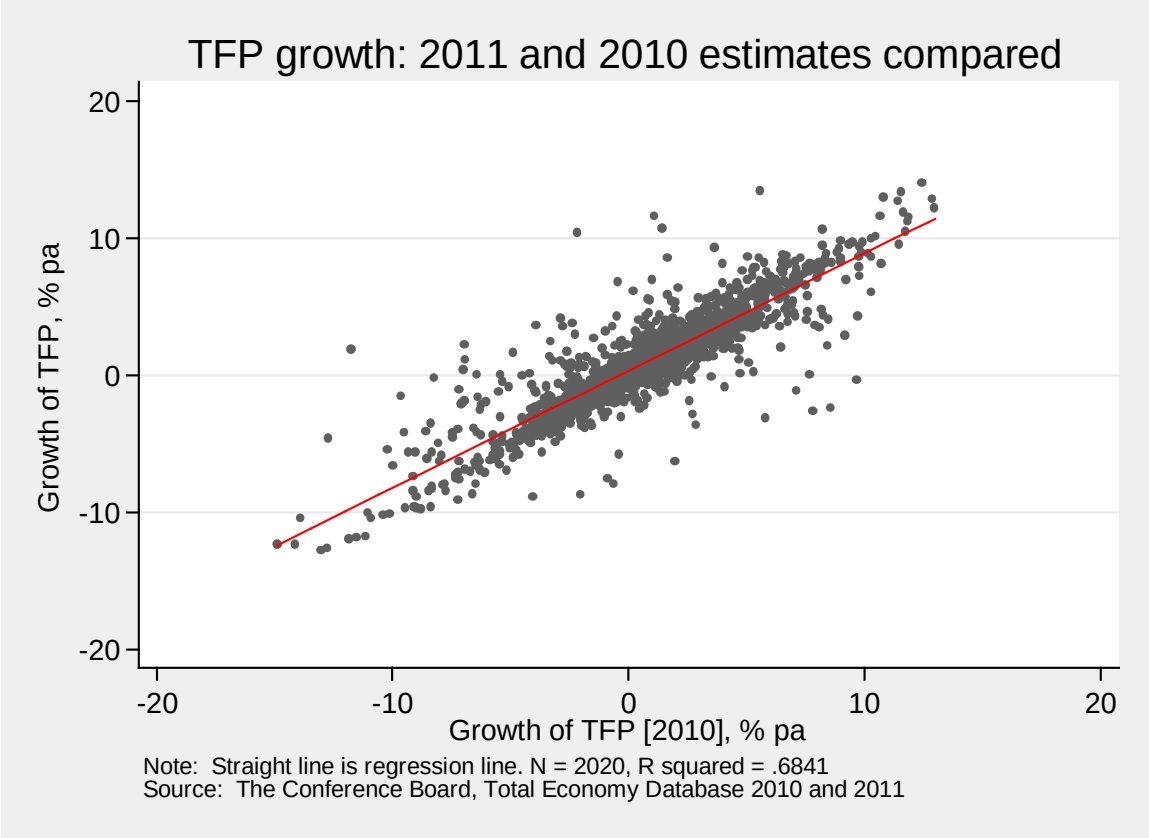
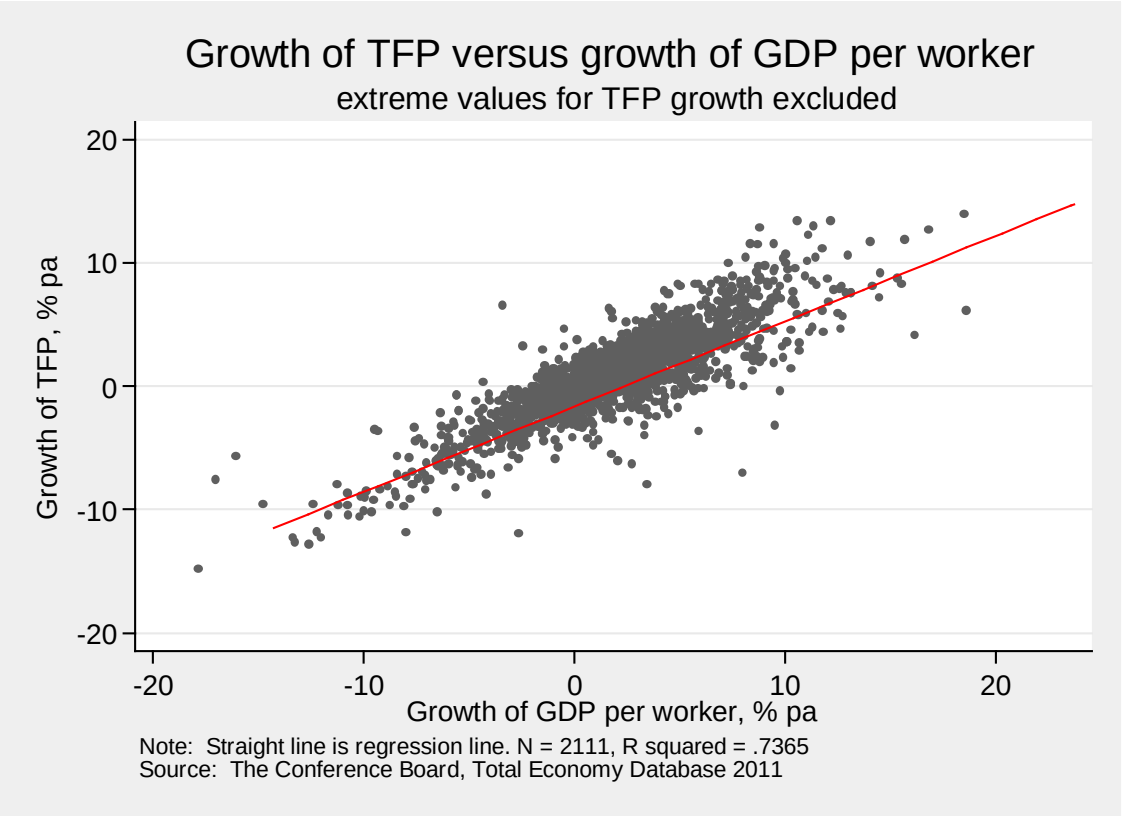


CHART 28



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