Effects of Financial Crises on Productivity, Capital and Employment

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ABSTRACT

We examine the hypothesis that capacity can be permanently damaged by financial, particularly banking, 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 61 countries over 1955-2010. A banking crisis as defined by Reinhart and Rogoff reduces the long-run level of GDP per worker, and also that of capital per worker, by on average 1.1%, for each year that the crisis lasts; it also reduces the TFP level by 0.8%. The long run, negative effect on the level of GDP per capita, 1.8%, is substantially larger. So there is also a hit to employment.

JEL codes: E23, E32, J24, G01, O47
Key words: productivity, financial, banking crisis, potential output, recession

1 Introduction[1]

The Great Recession which began at the end of 2007 or early in 2008 saw a sharp decline in the level of labour productivity (GDP per hour worked or per person employed) in most of the countries hitherto considered "advanced". This is not very surprising; the same pattern has been observed in earlier recessions. What is much more surprising is that, as the recovery in GDP began following the trough of the recession around a year later, labour productivity did not also recover the ground lost in many countries, though it did in the US and Spain (OECD (2012); Hughes and Saleheen (2012)). For example, in the UK in 2013Q1, five years after the onset of the recession, labour productivity was still 4% below its previous peak in 2007Q4 and well below the level expected on the basis of the pre-crisis trend (Chart 1).[2]

Two main hypotheses have been proposed to explain this puzzle. First, firms may be hoarding labour in anticipation of a recovery in demand (Martin and Rowthorn (2012)). This could be simply due to the cost of firing and then re-hiring (see e.g. Faccini and Hackworth (2010) for some UK evidence on this) or it could be because of the overhead character of some labour. 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

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[1] The views expressed in this paper are those of the authors and do not necessarily reflect those of the Bank of England or its Monetary or Financial Policy Committees. This is a shortened version of a longer paper (Oulton and Sebastiá-Barriel (2013)); the longer version also considers the UK experience more specifically. We are grateful to Jonathan Haskel, Martin Weale and an anonymous referee for useful comments on that version. We also thank our discussant, Davide Furceri, and other participants in the Institute for Macroeconomics/Bank of England Conference on "Unemployment, productivity and potential output: the aftermath of the crisis", 11-12 October 2012, particularly Chris Pissarides. The paper also benefited from the comments of participants at the annual conference of the Canadian Economic Association, Montreal, 30 May-2 June, 2013. Nicholas Oulton was a consultant to the Bank of England when this research was done. The Centre for Economic Performance is supported by the UK Economic and Social Research Council.

[2] For more detail on the UK experience see Oulton (2013).

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.

We do not address the labour hoarding hypothesis directly in this paper. Instead, Section 2 sets out some theoretical reasons why a financial crisis might damage an economy's capacity. Section 3 presents an empirical 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 4 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 gives data on 61 countries (rich, emerging and poor) over 61 years, 1950-2010. Section 5 reports the econometric results of fitting the model of Section 3 to these data. Finally, Section 6 concludes.

2 The main hypothesis: 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. The fall in output during the course of the Great Recession of 2008-2009 has of course been much smaller; for example in the United Kingdom GDP fell by about 5% peak to trough. So the Great Depression in the United States was a vastly larger shock than most countries are currently experiencing 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; also high debt interest payments may crowd out socially productive public expenditure (Barro

(1979)). Reinhart and Rogoff (2010) find that based on data for 44 countries spanning about 200 years, GDP growth rates fall as the gross central government debt-GDP ratio rises. The growth effects are similar in advanced and emerging economies.[3] Reinhart and Rogoff (2012) argue that the negative association between debt-GDP ratios and growth cannot be entirely due to cyclical effects (recessions causing high debt) since low growth is highly persistent in highly-indebted countries (so high debt is causing low growth). The very pessimistic case of Figure 1 finds some support in Broadberry and Crafts (1992) who argue that the Great Depression cast a long shadow over the British economy since it led to productivity-reducing policies such as protection and cartelisation of industries.

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, Jordà *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 a constant rate of inflation):

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

[3] This interpretation takes into account the critique of the published results by Herndon *et al*. (2013) and the subsequent response by Reinhart and Rogoff (2013).

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 in many countries. 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.

3 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:

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

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:

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

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 (since then $crisis_{it} = 0$).

In summary, in the specification suggested here, a financial crisis may have a temporary effect on the productivity growth rate (measured by γ in equation (1)) and hence a temporary effect on the productivity level. A financial crisis may also have a permanent effect on the productivity level (measured by θ in equation (3)). 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 growth 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 the coefficients have the following interpretation in terms of the theoretical model:

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

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

$$\theta_1 = \frac{3(\phi_2 + \phi_3)}{3 - 2\phi_4 - \phi_5}$$

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

The main interest attaches to the size of the long-run effect of financial crises, i.e. the absolute size of 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

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

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:

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

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

If financial crises affect labour productivity they presumably do so by affecting either capital per unit of labour or TFP or both (see the discussion in section 2). We can test for effects via these two channels by running exactly the same model as equation (7) but with either the growth of capital per unit of labour[4] or the growth of TFP replacing the growth of labour productivity. For example the model for capital per unit of labour is

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

where k_{it} is the log of capital per unit of labour for the *i*-th country in year *t*. An analogous equation can be used to test for effects on TFP.

4 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 were publicly available online at http://terpconnect.umd.edu/~creinhar.[5] 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.

4.1 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.

1. Currency crisis: defined as an annual rate of decline of the exchange rate of 15% or more.

[4] Apart from theoretical considerations, another reason for looking at the growth of capital per unit of labour rather than the growth of investment unit of labour 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 unit of labour, like the growth of GDP per unit of labour, is *positively* serially correlated.

[5] These data are now available at http://www.carmenreinhart.com/data/.

2. Inflation crisis: defined as an annual rate of inflation of 20% or more.
3. Stock market crisis: defined as a cumulative decline of 25% or more in real equity prices (R-R, chapter 16, page 150).
4. External debt crisis: 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: 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).
6. Banking crisis: 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 debt or banking 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.

Table 1 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 were 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 2 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.

4.2 Output and 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. 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 we do not want to confine the analysis to the richer countries with better statistics. So we have looked at GDP per person employed (per worker). 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. Population is also available in the TED.

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 planet, not just the OECD.[6]

4.3 Investment and capital

We also require data on capital stocks. 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. 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 in PWT terminology). Since the starting date is 1950 for most countries the influence of the starting stock on the end-of-sample

[6] The data used to generate the results reported below can be found in Stata and Excel format at http://www.bankofengland.co.uk/publications/Pages/workingpapers/2013/wp470.aspx.

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.

Given capital stocks we can now estimate TFP.[7] Let a_{it} be the log of the TFP level in the *i*-th country at time *t*. Then TFP growth is given by

$$\Delta a_{it} = \Delta q_{it} - s_K \Delta k_{it} \qquad (16)$$

where *k* is capital per worker and s_K is the capital share which we take to be 1/3.

5 The effect of crises: regression results

Section 3 set out a framework within which the 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. We report results 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)).

The detailed results from running the regression equation (7), with different dependent variables, for the whole sample and various sub-samples, are reported in Appendix Tables A1-A4. In each case time dummies and fixed effects are included. These regressions are estimated by the Arellano-Bond (difference) method.[8] This method is potentially superior to OLS as it can deal with the fact that the lagged dependent variables are not exogenous so the OLS estimates

[7] TFP is available in the TED but in the 2011 version only from 1992. In the 2010 version it is available from 1982 but where the two versions overlap the correlation between the two TFP series is not that high ($r = 0.83$): see Chart 27 in Oulton and Sebastiá-Barriel (2013).

[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. OLS results, which are similar, are reported in Oulton and Sebastiá-Barriel (2013).

are biased. However, given the number of time-series observations available, the bias should be small (Nickell (1981)). The results are first discussed from an econometric point of view before we turn to the topic of main interest, the long run effects of banking crises.

5.1 Regression results for labour productivity

Let us focus first on labour productivity. The first column of Appendix Table A1 reports the results for the whole sample. Just one financial crisis variable is included, a banking crisis (*bank*).[9] All the interesting coefficients are significant and have the expected signs. In particular the coefficient on current *bank* is negative and significant at the 1% level; the coefficient on lagged *bank* is positive and also significant at the 1% level. The test for second order autocorrelation (which should be zero) is passed. However the test for whether the two solutions for β and θ do not differ significantly from each other (see the row labelled "Coefficients on lagged Δq_{it}") is failed. 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.

Still focusing on column (1) of Appendix Table A1, the solution for γ (the negative of the coefficient on the lagged banking dummy, $bank_{it-1}$) says that a banking crisis reduces productivity *growth* in the short-run by about 0.55 percentage points 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.

Results estimated by OLS appear in Oulton and Sebastiá-Barriel (2013); the absolute size of γ is a bit higher and that of θ is a bit lower than as estimated by the Arellano-Bond method. We have also experimented with the Common Correlated Effects Mean Group Estimator of Pesaran (2006), using Markus Eberhardt's *xtmg* procedure within Stata (Eberhardt (2012)). The estimated values of γ and θ were similar to the Arellano-Bond ones.

The remaining columns of Table Appendix Table A1 report various sensitivity tests by excluding certain groups of countries or years:

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).

[9] $bank_{it}$ is a one/zero dummy variable for the presence or absence of a banking crisis in the *i*-th country in year *t*.

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).

For labour productivity the coefficient on current *bank* is negative and highly significant for all sub-samples except for developed countries and for the early years. The coefficient on lagged *bank* is positive and highly significant for all sub-samples except the early years (Appendix Table A1). The fact that neither the current nor the lagged banking crisis dummy is significant when only the early years are included is not too surprising when we recall that the incidence of banking crises was much lower in this period (Table 1).

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 Appendix Table A1 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 types of 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.

The econometric results when either capital per worker or TFP per worker is the dependent variable are broadly similar (Appendix Tables A2 and A3). The coefficient on current *bank* is significant overall but not significant for developed countries or when only 1950-79 is included. For capital per worker it is also not significant when Latin America is excluded. The coefficient on lagged *bank*, the negative of γ, is never significant for capital per worker, i.e. there is no short run effect of a banking crisis on the growth of capital per worker. On the other hand lagged *bank* is highly significant for TFP growth even for developed countries though not for 1950-79 only.

In other respects the equations for capital per worker and TFP are similar to the one for labour productivity. The test for second-order serial correlation (which should be zero) is passed. The test for the restriction on the lagged coefficients is mostly failed for capital but passed for TFP.

5.2 Estimates of the long run effects of banking crises (θ)

Long run effects on labour productivity

Table 3 shows estimates of the parameter θ for the whole sample and for the various sub-samples. Recall that θ measures the long run effect of a crisis on the level of the dependent variable. There are in fact two solutions for θ if we do not impose the theoretical restrictions on the coefficients on the lagged dependent variable (equation (11) but it turns out that these solutions are not very different from each other (Oulton and Sebastiá-Barriel (2013)).

Let us focus first on the top panel of Table 3, where the dependent variable is labour productivity (GDP per worker). In the whole sample, the solution for θ says that a banking crisis has a long-run, permanent impact on the *level* of productivity: it reduces it by 1.096% 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 1.096% =) about 5.5%, permanently. Of course, the estimated effects are for an "average" crisis as experienced by these 61 countries over the period 1955-2010.[10]

The size of θ varies in an interesting way across these sub-samples, though with two exceptions it is always large numerically and negative. Excluding the Great Recession reduces θ numerically from minus 1.096 to minus 1.005, or by 4%, surprisingly little; this may be partly due to the fact that our observation period ends in 2010. Excluding the Latin America countries roughly halves the size of θ numerically; θ now also fails to be significant.[11] This may be another way of saying that the Latin American countries managed their crises of the 1980s comparatively poorly. If the regression is run on developed countries only then θ is insignificant (column 5). An optimistic interpretation is that developed countries possess institutions able to deploy policies capable of neutralising the effect of banking crises (or at least managing things better than did the Latin American countries). 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

[10] The alternative estimate of θ based on the second relationship in equation (11) is -1.048, also significant at the 1% level (Oulton and Sebastiá-Barriel (2013), Table 7).

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

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. This is especially the case when we recall that Greece, Ireland Portugal and Spain are members of the developed countries group. Finally, θ is positive and insignificant when the regression is run just over the first half of the observation period, 1950-79 (column 7). As we have already seen, banking crises were much less frequent then (Table 1).

Long run effects on capital and TFP

The estimated long run effects on capital per worker and TFP of a banking crisis appear in the second and third panels of Table 3.They can be seen to be similar to the results for GDP per worker, both overall for the whole sample and for the various sub-samples. For the whole sample, for each year of a R-R crisis, capital per worker is reduced by 1.137% (significant at the1% level). The effect on capital is significant (at the 10% level) even when Latin America is excluded; however, θ is not significant when only developed countries are included. 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 have a direct effect on labour productivity as well as an indirect one through inducing a long-run reduction in capital per worker. 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 share (say one third), then the capital channel can explain only about a third of the hit to GDP per worker. So the capital estimates imply an additional effect coming from TFP. And we do indeed find this to be the case. In the whole sample TFP falls by 0.813% (significant at the 5% level) for each year of a banking crisis. But the TFP effect is not significant when Latin America is excluded or when only developed countries are included.

5.3 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 Appendix Table A5. The results are similar qualitatively to the results of Tables 3 which use the R-R definition. The long-run impact of banking crises is of similar magnitude. However, θ is never significant (though it is significant using OLS: see Oulton and Sebastiá-Barriel (2013).

5.4 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.[12] 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 in countries where employment is rapidly cut when output falls, thus keeping up labour productivity, there will be a fall in the employment ratio.

[12] We owe this point to Chris Pissarides.

There is another reason why the employment ratio may fall. If a banking crisis reduces TFP and/or capital per worker, then the demand for labour (the marginal productivity schedule) shifts to the left. Unless labour supply is completely inelastic there will be a fall in employment relative to population.

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 (Appendix Table A4). We find that the long-run effect of a banking crisis on GDP per capita is substantially larger than the effect on GDP per worker and more significant: see the lowest panel of Table 3. One year of a banking crisis reduces the long-run level of GDP per capita by 1.79%. The effect is highly significant, at the 1% level, even when Latin America is excluded. When only developed countries are included in the regression, the long-run effect is lower though still large, a reduction of 0.79%, and this is significant at the 5% 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 increased inactivity).[13]

6 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 growth rate of labour productivity is reduced by 0.55 percentage points per year for each year that the crisis lasts. More importantly, the long-run *level* is reduced by about 1.1% for each year that the crisis lasts. 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 1.1% for each year of crisis. A second channel is via TFP whose long run level is reduced by about 0.8% for each year of crisis.

These results are for all countries combined — advanced, emerging and developing. The Latin American countries have a considerable influence on the size and significance of the effects. If Latin America is excluded, the long run effect of banking crises on labour productivity and TFP is no longer significant and just barely significant (at the 10% level) for

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

capital per worker. If only developed countries are included in the sample, then there are no significant long run effects of banking crises on GDP per worker, capital per worker or TFP.

However, we also find a highly significant effect of banking crises on GDP per *capita* (rather than per worker), reducing it by about 1.8% for each year of crisis; this is substantially larger than the effect on GDP per *worker* (1.1%). That is, there is a significant effect on the employment ratio. This effect is significant for all groups of countries, not just the developing ones. For the developed countries alone, the effect of a banking crisis is to reduce the long run level of GDP per capita by about 0.8%, a smaller effect than in the sample as a whole but still significant at the 5% level.

A qualification is that the banking crisis variable is a one/zero 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, it would be unwise to take too much comfort from the fact that the effects on productivity and capital are not found to be significant for the developed countries. It may be that the weaker results found for the advanced countries just reflect the fact that these 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.[14] After all, the developed countries in our sample include Greece, Ireland, Portugal and Spain. It is hard to believe that long run productivity and employment levels in these countries will not be affected by the current crisis.

Finally, the reported effects are only average ones. No banking crisis is alike. In any particular country or particular period, the impacts may differ substantially from the mean, either on the upside or the downside. What sort of policies mitigate the long run effects of banking crises must remain a topic for future research.

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

Table 1
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 (downloaded from http://terpconnect.umd.edu/~creinhar).

Table 2
Persistence of crises (61 countries, 1950-2010)

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 (downloaded from 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).

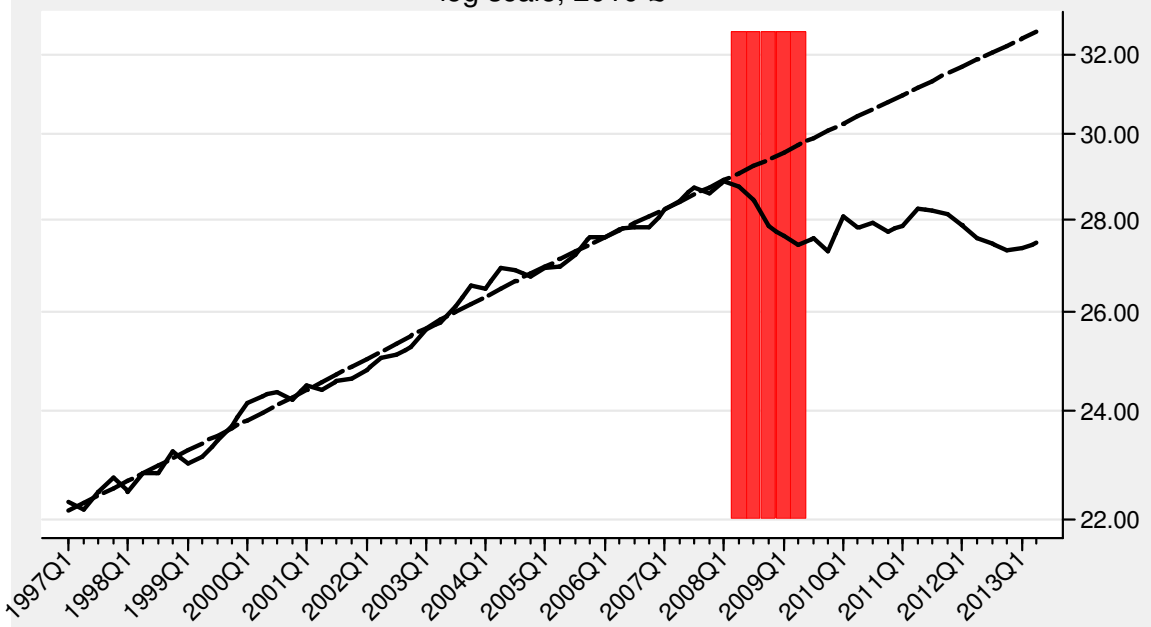
Table 3
Long run percentage effects on levels of GDP per worker, capital per worker, TFP, and GDP per capita of one year spent in a Reinhart-Rogoff banking crisis

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Variable affected by crisis	All countries and years	Exc. Great Recession	Exc. Asia	Exc. Latin America	Developed countries only	Developing countries only	1950-79	1980-2010
GDP per worker								
100 x $\hat{\theta}$	-1.096***	-1.005***	-1.112***	-0.550	0.362	-1.258***	0.831	-1.231***
(s.e.)	(0.356)	(0.380)	(0.417)	(0.382)	(0.278)	(0.467)	(1.954)	(0.382)
Capital per worker								
100 x $\hat{\theta}$	-1.137***	-1.419***	-0.997**	-0.755*	-0.0423	-1.677***	-0.832	-1.229***
(s.e.)	(0.411)	(0.462)	(0.405)	(0.392)	(0.379)	(0.397)	(1.122)	(0.418)
TFP								
100 x $\hat{\theta}$	-0.813**	-0.718**	-0.807**	-0.373	0.394	-0.864**	1.019	-0.854**
(s.e.)	(0.340)	(0.341)	(0.379)	(0.329)	(0.288)	(0.437)	(1.916)	(0.358)
GDP per capita								
100 x $\hat{\theta}$	-1.794***	-1.574***	-1.849***	-1.444***	-0.789**	-1.773***	0.390	-1.875***
(s.e.)	(0.372)	(0.386)	(0.406)	(0.396)	(0.386)	(0.495)	(2.170)	(0.410)

Note *** p<0.01, ** p<0.05, * p<0.1. Estimates of θ ($\hat{\theta}$) are derived by substituting the estimated regression coefficients from equation (7), shown in Appendix Tables A1-A4, into the first relationship in equation (11); results using the second relationship are similar. Standard error for $\hat{\theta}$ estimated by Stata's *nlcom* procedure. In the full sample ("All countries and years") the number of countries is 61, the period is 1950-2010 (61 years) and the total number of observations is 3277; 23 countries are classified as developed and 38 as developing.

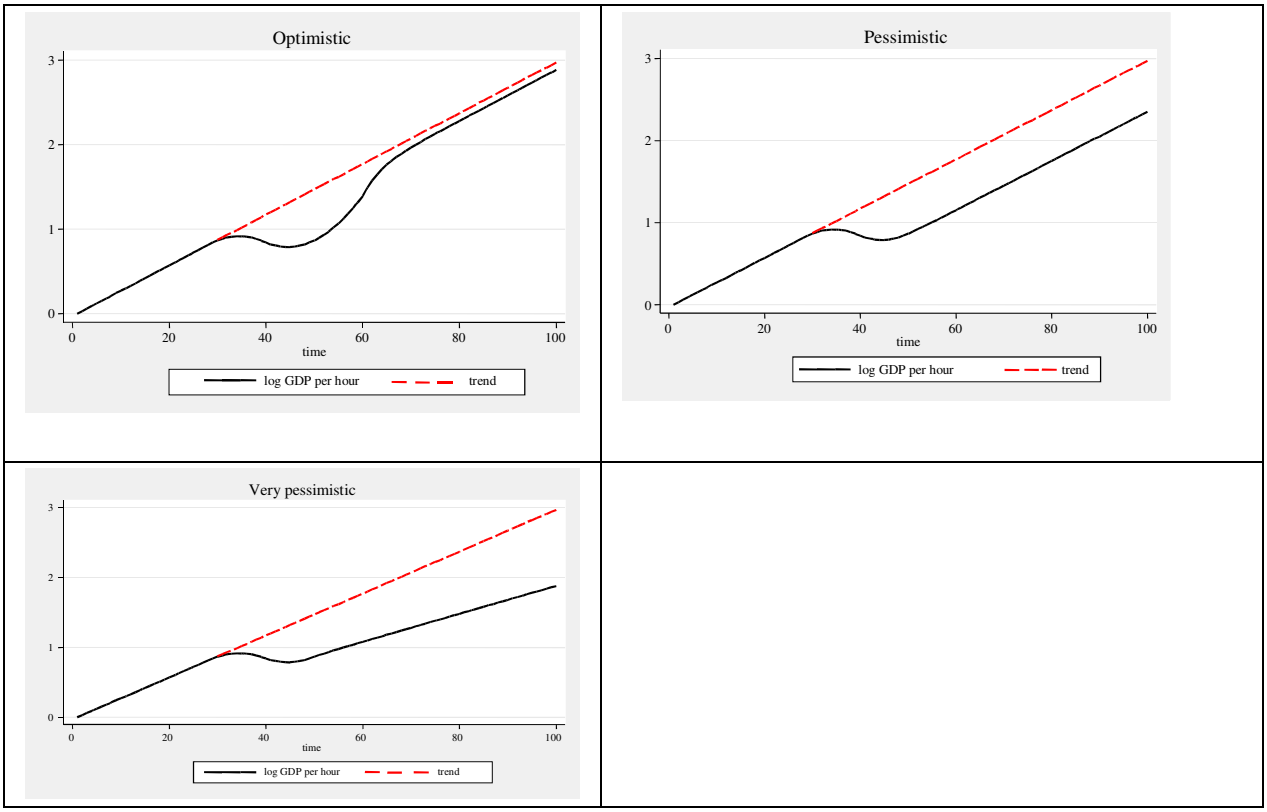
The data used to produce these results and those of Appendix Tables A1-A5 can be found at: http://www.bankofengland.co.uk/research/Documents/workingpapers/2013/wp470data.xlsx.

Chart 1



Source: Office for National Statistics, Labour Productivity Bulletin, September 2013.
Note: Seasonally adjusted. Red bar marks Great Recession (2008Q2-2009Q3).
Dashed line is Hodrick-Prescott trend estimated over 1997Q1-2008Q1.

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



APPENDIX TABLES

Table A1
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

Note *** p<0.01, ** p<0.05, * p<0.1. Robust standard (adjusted for clustering by country) 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 A2
Arellano-Bond (difference) estimates of equation (7):
dependent variable is growth of capital per worker (Δk_{it})

Independent variables	(1) All countries and years	(2) Exc. Great Recession	(3) Exc. Asia	(4) Exc. Latin America	(5) Developed countries only	(6) Developing countries only	(7) 1950-79	(8) 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}	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Note *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors (adjusted for clustering by country) 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 A3
Arellano-Bond (difference) estimates of equation (7):
dependent variable is growth of TFP (Δa_{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
Δa_{it-1}	0.172***	0.176***	0.162***	0.158***	0.228***	0.156***	0.0666	0.200***
	(0.0457)	(0.0464)	(0.0520)	(0.0561)	(0.0460)	(0.0505)	(0.0646)	(0.0599)
Δa_{it-2}	0.0130	0.0124	0.0126	0.0625*	0.0354	0.000925	-0.0486	0.0193
	(0.0315)	(0.0316)	(0.0360)	(0.0359)	(0.0711)	(0.0321)	(0.0382)	(0.0414)
Δa_{it-3}	-0.0380*	-0.0381*	-0.0364	-0.0292	0.0610*	-0.0561***	-0.115***	-0.0210
	(0.0204)	(0.0216)	(0.0230)	(0.0188)	(0.0354)	(0.0200)	(0.0385)	(0.0290)
$bank_{it}$	-0.0154***	-0.0149***	-0.0159***	-0.0107***	-0.00229	-0.0186***	-0.00318	-0.0157***
	(0.00326)	(0.00318)	(0.00356)	(0.00255)	(0.00269)	(0.00438)	(0.00779)	(0.00357)
$bank_{it-1}$	0.00826***	0.00863***	0.00870***	0.00740***	0.00559**	0.0109***	0.0131	0.00836***
	(0.00258)	(0.00276)	(0.00300)	(0.00205)	(0.00278)	(0.00312)	(0.0128)	(0.00262)
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	-1.125	-1.135	-0.983	-0.623	-0.972	-0.614	-0.632	-0.299
Coefficients on lagged Δq_{it}	0.339	0.354	0.447	0.0394	0.0313	0.903	0.0115	0.174

Note *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors (adjusted for clustering by country) in parentheses. Standard error for θ estimated by Stata's *nlcom* procedure. 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 A4
Arellano-Bond (difference) 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}	0.126*	0.115	0.0985	0.207***	0.301***	0.0748	0.0430	0.128
	(0.0717)	(0.0726)	(0.0787)	(0.0473)	(0.0531)	(0.0778)	(0.0569)	(0.124)
Δy_{it-2}	0.0370	0.0307	0.0389	0.0502	0.0516	0.0141	-0.0457	0.0559
	(0.0276)	(0.0272)	(0.0296)	(0.0338)	(0.0622)	(0.0250)	(0.0328)	(0.0382)
Δy_{it-3}	0.0207	0.0147	0.0242	0.0303	0.0528	0.00178	-0.0479	0.0256
	(0.0218)	(0.0222)	(0.0241)	(0.0253)	(0.0422)	(0.0220)	(0.0396)	(0.0233)
$bank_{it}$	-0.0184***	-0.0173***	-0.0209***	-0.0145***	-0.00748**	-0.0216***	-0.00578	-0.0188***
	(0.00340)	(0.00349)	(0.00378)	(0.00290)	(0.00295)	(0.00488)	(0.0115)	(0.00382)
$bank_{it-1}$	0.00219	0.00288	0.00390	0.00232	0.00131	0.00484	0.00963	0.00205
	(0.00295)	(0.00310)	(0.00346)	(0.00228)	(0.00396)	(0.00348)	(0.0129)	(0.00328)
Observations	3,277	3,155	2,782	2,672	1,187	2,090	1,475	1,802
Number of countries	61	61	52	50	23	38	59	61
2nd order autocorrelation	0.0896	-0.0971	0.416	0.0659	-1.944	0.836	-0.564	-0.111
Coefficients on lagged Δq_{it}	0.0146	0.0485	0.0463	0.000136	0.0120	0.315	0.275	0.0259

Note *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors (adjusted for clustering by country) 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 A5
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 (adjusted for clustering by country) 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. $\hat{\theta}_1$ ($\hat{\theta}_2$): estimate of θ using the first (second) relationship of equation (11). Standard errors for $\hat{\theta}_1$ and $\hat{\theta}_2$ estimated by Stata's *nlcom* procedure.

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