Effects of financial crises on labour productivity, capital and employment

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May 2013

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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. The long run, negative effect on the level of GDP per capita, 1.7-1.8%, is substantially higher.

JEL codes: E23, E32, J24, O47
Key words: productivity, financial, banking crisis, 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 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 (Chart 1).

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 line. In the *very* pessimistic picture, the growth rate too is permanently lowered by a financial

[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. 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. 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.

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 (they assign the debt/GDP ratios to four buckets: below 30%, 30-60%, 60-90% and above 90%). The growth effects are similar in advanced and emerging economies.[2] 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, 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 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

[2] My 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 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

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

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).

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 are publicly available at http://terpconnect.umd.edu/~creinhar. 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 (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 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 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 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. 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 in Oulton and Sebastiá-Barriel (2013). 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 of Oulton and Sebastiá-Barriel (2013). 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.[3]

5 The effect of crises: regression results

5.1 Regression results using the R-R definitions of crises

Section 3 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. 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

[3] 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.

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 3 reports the results of running least squares regressions based on equation (7) with time dummies and fixed effects included. These regressions are estimated by the Arellano-Bond (difference) method.[4] 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 are biased. However, given the number of time-series observations available, the bias should be small (Nickell (1981)).[5] 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 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 3, 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% 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 1.1% 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 1.1% =) 5.5%, permanently. Of course,

[4] 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.

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 1% level.

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 3 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 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.[6] 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* is insignificant; also θ is positive and 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

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

weight on the overall results. 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).

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 3 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.

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.[7] 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 Table 4 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.[8] But now θ is significant (at the 10% level) even

[7] 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.

[8] 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

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 induce a long-run reduction in capital per worker.[9] 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.

5.2 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.

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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.

[9] 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.

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 Table 5. 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).

5.3 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.[10] 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 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 6. One year of a banking crisis reduces the long-run level of GDP per capita by 1.7-1.8%. 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 still large though lower, a reduction of 1.3-1.4%, 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 inactivity rates).[11]

[10] We owe this point to Chris Pissarides.
[11] IMF (2009) also finds long-lasting effects on the employment ratio following a financial crisis.

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 short-run growth rate of labour productivity is reduced by about 0.6% per year for each year that the crisis lasts and the long-run level by about 1.1%. 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 between 0.9 and 1.1% for each year of crisis. We also find that banking crises have a long-run effect on the employment ratio: the level of GDP *per capita* is reduced by 1.7-1.8%. This is substantially larger than the effect on GDP per *worker* (1.1%).

Three qualifications should be noted. First, 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 productivity is no longer significant. But we still find a highly significant effect of banking crises on capital per worker and also on GDP per capita, i.e. a significant effect on the employment ratio. If only the 23 advanced countries are included then banking crises in the period studied (1955-2010) do not have a significant effect on the long-run productivity level. However, crises continue to have a significant (at the 5% level) though smaller effect on the level of GDP per capita, reducing it by 0.7-0.8% for each year of crisis. 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.[12] 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 damage hypothesis are accepted, this does not force automatic rejection of the rival labour hoarding hypothesis (which we have not tested directly in

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

this paper). The latter must be assessed on its own merits. However our finding of a *permanent* effect of banking crises on GDP per worker and per capita cannot be attributed to labour hoarding.

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
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 (adjusted for clustering by country) errors 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 4
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 (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 5
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)

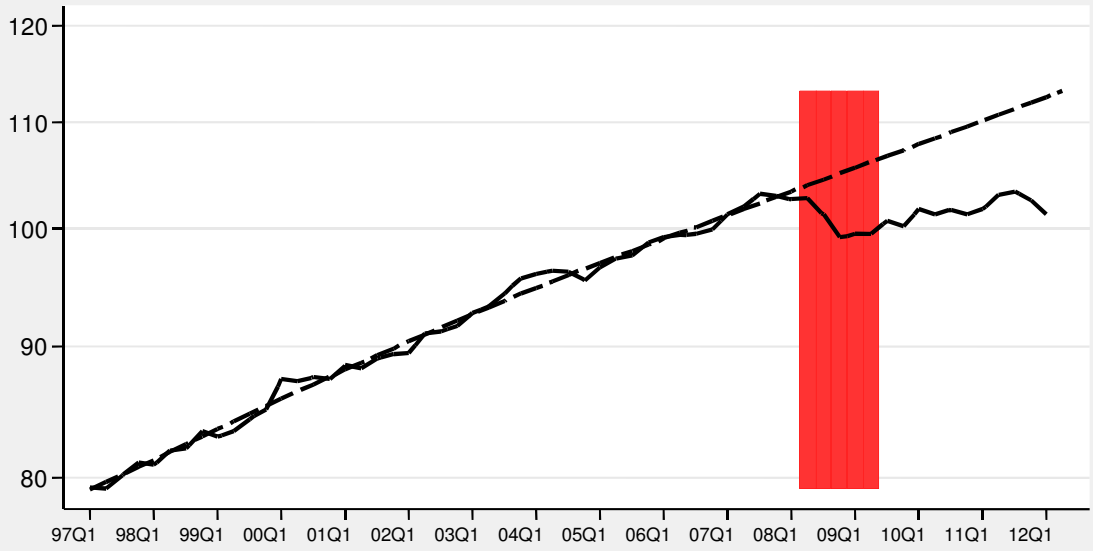
Note *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors (adjusted for clustering by country) in parentheses. Standard error for θ estimated by Stata's *nlcom* procedure. Fixed effects, year dummies and constant included but not reported. Coefficients on lagged Δq_{it}: p-value for $H_0: \phi_4 + 2\phi_5 + 3\phi_6 = 0$. 2nd order autocorrelation: Arellano-Bond test for 2nd order serial correlation in residuals.

Table 6
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
100 x θ_1	-1.794***	-1.574***	-1.849***	-1.444***	-0.789**	-1.773***	0.390	-1.875***
	(0.372)	(0.386)	(0.406)	(0.396)	(0.386)	(0.495)	(2.170)	(0.410)
100 x θ_2	-1.711***	-1.513***	-1.769***	-1.339***	-0.705**	-1.739***	0.403	-1.770***
	(0.369)	(0.384)	(0.404)	(0.377)	(0.350)	(0.496)	(2.242)	(0.415)

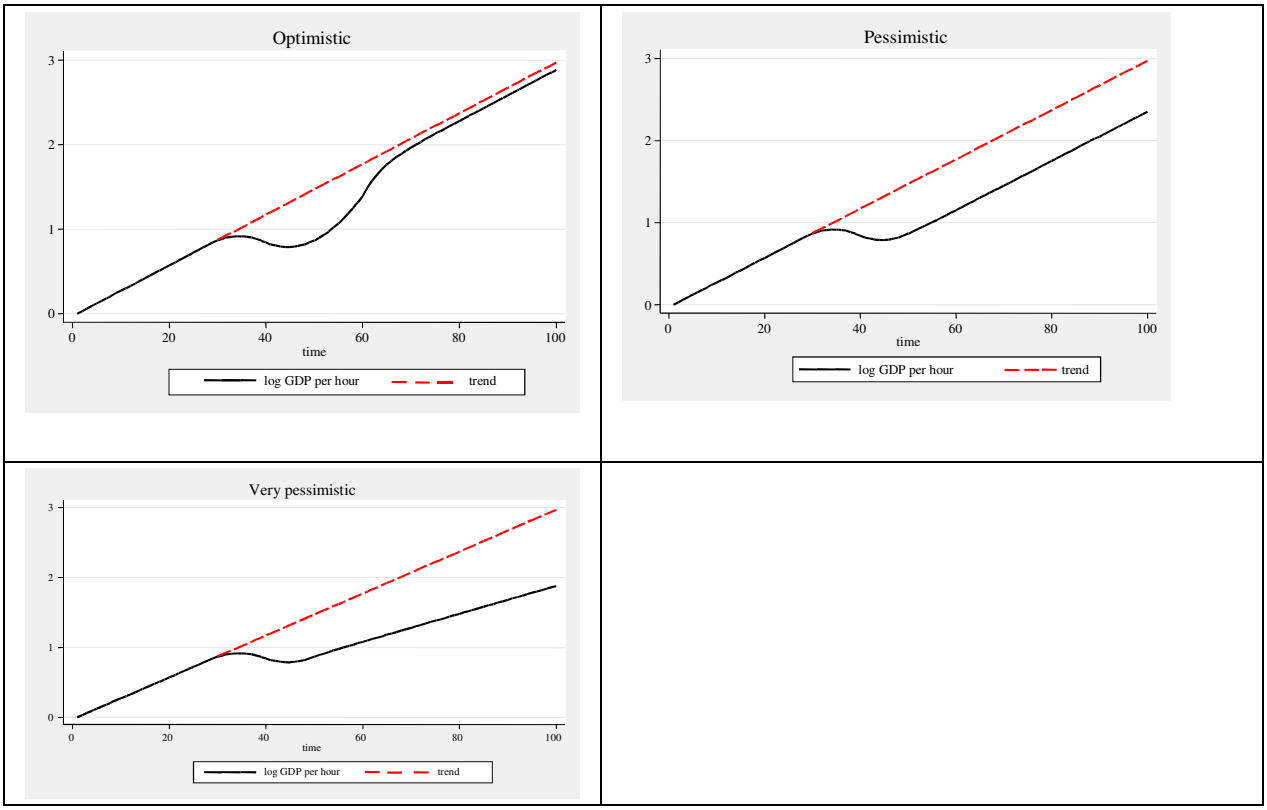
Note *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors (adjusted for clustering by country) in parentheses. Standard error for θ estimated by Stata's *nlcom* procedure. Fixed effects, year dummies and constant included but not reported. Coefficients on lagged Δq_{it}: p-value for $H_0: \phi_4 + 2\phi_5 + 3\phi_6 = 0$. 2nd order autocorrelation: Arellano-Bond test for 2nd order serial correlation in residuals.

Chart 1



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

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



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