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THE EFFECTS OF BANKING CRISES ON POTENTIAL OUTPUT IN OECD COUNTRIES[1]

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Abstract Simple time series models looking for the effect of banking crises on output generally find that they reduce the sustainable level of output permanently. However, not all crises are the same, with some being caused by recessions and others causing or preceding recessions. Using a common definition of crises in 13 OECD countries, we look at the determinants of productivity per person hour, and include the possibility of a step down in the level of trend productivity around the time of crises. Although on average crises reduce output permanently by almost 3 per cent, it is not possible to impose a common effect across all crises. Only 4 of the 10crises studied here have a significant permanent negative effect on output. We show, however that crisis-related recessions are generally longer and deeper than non-crisis recessions.

Keywords: Banking crises, costs of crises, potential output
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Introduction

Whereas there are many studies which assess the ex ante causal or predictive factors underlying financial instability (see the reviews in Bell and Pain (2000) and Demirguc Kunt and Detragiache (2005) as well as Davis and Karim (2008)), those which estimate the ex post costs are rather less common. On the other hand, the costs of crisis are key to the motivation for financial regulation. Saving of such costs represents the benefit arising from tighter regulation, to offset against the impact of regulation on bank spreads (Barrell et al 2009).

Costs of crisis can be distinguished in terms of their components (fiscal and stakeholder costs versus output losses), and whether they impinge in the short run (mainly via demand reductions) or also in the long run (reduction in supply capacity). Most empirical work to date has focused on the short run output costs of crisis. In this paper, we provide a comprehensive survey of the recent literature on costs of crises, and then undertake our own empirical work which focuses on the long run impact of crises on output via their "scarring" effect on the supply side of the economy. We contend that our work fills an important gap in the literature, and the results help to justify stringent banking regulation.

1 Literature survey

We summarise the literature on output costs of banking crises in general terms, highlighting key methodological issues, as well as providing in an appendix detailed summaries of three relevant recent papers, namely Cecchetti et al (2009), Cerra and Saxena (2008) and Furceri and Mourougane (2009). We emphasise the difference between losses as compared to trend output, a cyclical component, and losses in the level of trend output, a structural component.

1.1 Components of losses

Cecchetti et al (2009) highlight a number of complementary linkages from the financial to the real economy that may cause output losses following banking crises. Investment may be affected by increases in funding costs, decreased credit availability; higher risk aversion driving up risk premia and leading to flights to quality; worsening of firms' net worth and impairment of their borrowing capacity from lower equity and property prices. Consumption may be impacted via loss of household net worth from lower equity and property prices as well as credit rationing. Net trade may affect output through the reduction in exports as a result of flight to "safe haven" currencies and/or reversals of capital flows,

These aspects are generally related to short term output losses. On the other hand, Furceri and Mourougane (2009) note there may also be long-run effects on potential GDP, which in a standard production function framework is determined by inputs of capital and labour as well as technical progress. Financial crises lower incentives to invest in capital by decreasing demand for products and raising uncertainty on investment returns and risk premia. In addition, as noted, firms may have to cope with less advantageous investment-financing conditions due to tighter lending standards in the form of an increasing real cost of borrowing and/or limited credit supply.

Furthermore, by reducing labour demand, financial crises can lead to an increase in the structural unemployment rate, through hysteresis effects. In terms of labour force participation rates, second-income earners can be encouraged to look for a job and to enter the labour force (additional worker effect) thus buoying labour supply. But at the same time, the high unemployment rate may discourage workers from searching for a new position (discouraged worker effect) offsetting the gain. Workers exiting the labour force will add to human capital decumulation, hence reducing potential output in the short if not in the longer run.

Finally, the effect of a banking crisis on total factor productivity is a priori uncertain. On the one hand, spending on innovation is procyclical and is likely to be massively reduced at times of crisis. Higher risk premia are also likely to affect R&D spending. On the other hand, firms may have stronger incentives to restructure and/or improve their x-efficiency in periods of crisis to limit their losses.

As an example of supply-side effects of crises, Barrell et al (2009) showed that beyond the scale of the recession in the short run due largely to lower aggregate demand, the UK economy may be "scarred" permanently on the supply side in the wake of a banking crisis. This arises mainly from loss of capital from higher risk premia, but also links to loss of skilled labour from net outwards migration.

1.2 Timing of banking crises

In estimating the magnitude of costs, a first issue is to assess the timing of a banking crisis. There is no unique indicator of a banking crisis. The problem lies in the fact that a banking crisis is a complicated event, so proxies for banking crises would not necessarily be perfectly correlated with banking crises themselves. For instance, if aggregate banking capital is used as a measure for banking insolvency, then a lower bound threshold for a crisis event need to be defined. However, government intervention or deposit insurance could prevent a crisis, while the threshold could still be violated. Although crises often show up in liabilities, they do not often stem from the liabilities side (Kaminsky and Reinhart, 1999); and problems in asset quality commonly erode banking capital so that a single proxy variable would not pick up all crisis events. Furthermore, there may be underreporting of data indicating risks in financial accounts of banks in advance of crises. As a result the estimated start date of the crisis is typically constructed on the basis of several criteria which vary according to the study, and often using accurate, post crisis data.

Caprio and Klingebiel (1996) focus on the solvency side of crises and define a systemic crisis as an event when "all or most of banking capital is exhausted". Insolvency was judged on the basis of official data and published reports by financial market experts; if official data recorded positive banking system capital but experts judged it to be negative, they recorded a systemic crisis In an updated database (1980-2002), Caprio and Klingebiel (2003) identified 93 countries as having experienced systemic crises; and the final version is published in World Bank (2003).

Demirguc-Kunt and Detragiache (1998) used a more specific set of four criteria: first that the ratio of nonperforming assets to total assets in the banking system exceeded 10 per cent; second, the cost of the rescue operation was at least 2 per cent of GDP; third, banking sector problems had led to a large scale nationalisation of banks; and fourth that extensive bank runs took place or emergency measures (such as deposit freezes, prolonged bank holidays, or generalised deposit guarantees) were enacted by the Government in response to the crisis. Achievement of at least one of the conditions was a requirement for systemic crisis, otherwise bank failure was non-systemic. A follow up study conducted by Demirguc-Kunt and Detragiache (2005) with an extended sample of 1980-2002, identified 77 systemic crises over 94 countries.

According to Laeven and Valencia (2008) which is used by some of the most recent studies, in a systemic banking crisis, a country's corporate and financial sectors experience a large number of defaults and financial institutions and corporations face great difficulties repaying contracts on time. As a result, non-performing loans increase sharply and all or most of the aggregate banking system capital is exhausted. In some cases, the crisis is triggered by depositor runs on banks, though in most cases it is a general realization that systemically important financial institutions are in distress. This definition combines quantitative data with some subjective assessment of the situation. It excludes single bank failures that do not link to systemic distress[3]. As a cross-check on the timing of each crisis, they examine whether the crisis year coincides with deposit runs, the introduction of a deposit freeze or blanket guarantee, or extensive liquidity support or bank interventions. Or alternatively they require that it becomes apparent that the banking system has a large proportion of nonperforming loans and that most of its capital has been exhausted. By these means they identify 124 systemic banking crises over the period 1970 to 2007.

Even if systemic crises unambiguously occur, identifying their starting and ending dates is hazardous. Banking system data can be either unavailable or unreliable or crises can be a result of culmination of a prolonged period of systemic insolvency. Kaminsky and Reinhart (1999) note that crises can also be dated too early, since the worst of the crisis could unfold after the subjective start date. Dating is also problematic when there are successions of crisis episodes; with Japan being a good example.

Despite these problems, the usual approach in both the literature on early warning systems and costs of crisis is to adopt one of these established crisis databases, which ensures inter alia comparability with the existing literature (see for example Barrell et al (2010) who largely adopt World Bank (2003) Table 1 lists the complete set of OECD crises we identify for this paper. We exclude crises in Spain, Germany and the UK in the 1970s because of constraints form the other data we use. We do not include the sub-prime crises in the UK, the US, France, Germany, the Netherlands and Belgium in our sample as it is too early to investigate their long run effects.

Table 1: Crisis dates

Country	Crisis date/s
Canada	1983
Denmark	1987
Finland	1991
France	1994,
Italy	1990
Japan	1991,1997
Sweden	1991
UK	1991,
US	1988

See Appendix 3 Table A3.3 for sources.

1.3 Methodology for measuring output losses

Having adopted a crisis definition, most studies of output losses due to banking crises have sought to measure them as differences from trend in terms of output growth. In IMF (1998) and Aziz et al (2000) costs were measured relative to the three years preceding the crisis, for Bordo et al (2001) it was relative to the previous five years. The end of the crisis is then defined as being

[3] We exclude single bank crises in the UK in 1984 (Johnson Mathey) and 1995 (Barings) from our sample as these are unlikely to have systemic effects

when output growth returns to trend. Demirguc-Kunt et al (2006) similarly measure output losses in terms of growth in the three years after the crisis relative to average growth three years before the crisis.

Hoggarth, Reis and Sapporta (2002) note that this method may be less accurate than an approach which sums the levels of output losses relative to trend, where in their case trend is measured as average growth over ten years prior to the crisis. Levels allow more sensitively for output losses than do growth rates for crises that last more than one year. This is because the growth rate criterion would say the crisis is over as soon as the growth rate gets back to trend, while actually there is an “integral” of output losses that continues to build up until the level of output gets back to its trend path. Meanwhile a longer period to judge the trend helps to adjust for the fact that there may have been growth in excess of trend prior to the crisis.

Several other studies have used estimates of trend growth to evaluate the impact of a banking crisis. Angkinand (2007) adopts a simple approach where to calculate the potential output levels, the quarterly real GDP data from 1970 up to each crisis period are smoothed by Hodrick–Prescott (HP) filter. The potential level trend is assumed to grow constantly at the rate of the averaged 3-year pre-crisis growth rates of the HP filter estimates. Boyd et al (2005) assess the estimated trend growth rate for country i in year t as a variance-weighted average of its own historical growth rate up to year t and the world growth rate at t, and then measure output losses relative to that. Davis and Stone (2004) sought to deal with the recession problem by taking the trend over 5 years in the past and the future, i.e. allowing ex post for the crisis-induced recession in the average, which may be balanced by growth well in excess of trend in the preceding boom.

Cecchetti et al (2009) measure output costs by comparison of current levels of GDP with the level of GDP at the onset of the crisis. This gives measures of the length of recession in quarters, before GDP returns to its previous peak, depth of recession (percent fall in GDP at the trough relative to peak) and a ratio of cumulative GDP loss to pre crisis GDP. This measure, of course, fails to allow for growth that would have been expected to occur in the meantime, unlike the Hoggarth, Reis and Sapporta (2002) approach.

Most of these studies look at the scale of the recession following a banking crisis, or longer term output losses relative to an unchanged trend, and hence do not measure any potential permanent effects. However, some techniques do address this issue. Cerra and Saxena (2008) use the Nelson and Plosser (1982) autoregressive univariate model of GDP growth, which accounts for nonstationarity and serial correlation, to measure the counterfactual. This baseline model in then extended to include the current and lagged impact of the shock, and impulse response functions with one standard deviation error bands from 1000 Monte Carlo Simulations to quantify the response of growth to each crisis type. Furceri and Mourougane (2009) estimate changes to potential output growth, thus in effect calculating whether the trend itself has changed, independently of the demand-induced shortfall during the recession following the crisis. For their work, they use OECD potential growth estimates based on a production function, cross-checked with a Hodrick-Prescott filter. This is also a way to avoid the problems of using average growth around the time of the crisis. Following Cerra and Saxena (2008) they then assess the impact of the crisis on potential output via a univariate autoregressive growth model and derivation of impulse response functions to the shock of banking crisis.

1.4 Results for output losses

Concerning results, IMF (1998) found that average cumulative output losses following banking crises in OECD countries were 10.2% of GDP, with the average length of banking crises being 4.1 years. Hoggarth, Reis and Sapporta (2002) found that crises lasted a similar time in OECD countries (4.6 years) but less in emerging market economies (3.3 years). Emerging markets may be more flexible in terms of labour and product market adjustment following a shock than OECD countries. A similar aspect may underlie their finding that cumulative output losses (i.e. the integral of output below trend) were much greater in OECD countries (23.8% of GDP) than in emerging market economies (13.9%). Banking crises alone cost 5.6% and twin crises 29.9%.

Bordo et al (2001) did not distinguish between developed countries and emerging market economies, but estimated losses of 6.2% of GDP from banking crises and 18.6% for twin (banking and currency) crises. Aziz et al (2000) found losses of 9% for twin crises. Meanwhile, Bordo et al (2001) showed that output losses are greater where there are liquidity support operations (possibly supporting insolvent banks, thus generating moral hazard) and an exchange rate was previously pegged (possibly as it exposes institutions to greater market risk). Cecchetti, Kohler and Upper (2009), looking at 40 systemic crises in OECD and middle-income countries, found that the mean crisis length is 11.4 quarters and the mean cumulative loss (relative to peak GDP) is 18.4 %.

Cerra and Saxena (2008) with a much wider range of countries (190) and broad definition of crises (see Appendix 2) found banking crises generate a maximum loss of 7.5% relative to the projections of an autoregressive growth model, reaching a trough in 5 years and showing remarkable persistence of losses, averaging 6% of GDP at 10 years. The result suggests a major ongoing cost of crises extending into decades, with integrals well in excess of Hoggarth, Reis and Sapporta (2002) and Ceccheti et al (2009). Similar results were found for industrial countries separately. Long lasting persistence was also found by Boyd et al (2005), in that after a banking crisis is "over" the process of recouping lost output occurs very slowly, and possibly may never be complete. For their average sample country, the estimated present discounted value of crisis-related output losses is bounded between 63% and 302% of real, per capita GDP in the last year before the crisis onset. Such high estimates are obviously partly driven by the methods for obtaining trend growth estimates.

The above all focus on current real GDP losses, relative to previous peak or some measure of trend. As noted, Furceri and Mourougane (2009) assess losses in potential output. They find that the fall in potential GDP following a banking crisis is 1.5% or 2.1% per annum depending on the methodology, a level reached in 5 years and maintained for at least another 5 years. This is in line with results for actual losses by Cerra and Saxena (2008) and Boyd et al (2005). Results are robust to allowance that financial crises may be endogenous to potential output developments, and to inclusion of other recognized shocks such as oil crises. Losses in potential output are greater for the so-called "big five" OECD crises, namely Spain (1977), Norway (1987), Finland (1991), Sweden (1991) and Japan (1992) where the loss in potential output is 4% per annum. Complementing these results, Cecchetti et al (2009) provide tentative that trend GDP is changed by banking crises, by showing that crises are associated with breaks in the statistical series for the level or growth of GDP. They find that nine of the 40 countries they study have significantly lower levels of GDP and lower growth in the wake of the crises, while others have lower levels and higher growth post crisis, but take a long time to recover previous levels. They also find that five of their forty countries have significantly higher output after the crisis. This is not to suggest that crises may be good for some economies, but rather reflects the use of univariate explanations that do not take account of other developments.

Measures of output losses based on a measurement of output growth or level relative to that in the past could exaggerate costs if recessions would have occurred anyway, thus coinciding with or even causing the banking crisis. Bordo et al (2001) sought to overcome this by comparing recessions with banking or twin crises with those without, in the same country's experience. They found banking crises worsened the downturn in recessions by 5% of GDP and twin crises by 15%.

Hoggarth, Reis and Sapporta (2002) undertook a similar exercise using different countries' recessions at the same time. They accordingly sought to estimate the banking crisis component of a recession by comparing the depth of recessions in countries that suffered banking crises with comparable countries that did not suffer banking crises at the same time. For developed countries they found that output losses in recessions with banking crises were equivalent to 32% of GDP compared to 6% without a crisis. In emerging market economies the comparative figures are 16% compared to 6%. Complementary regressions showed that banking crises explain most of the output loss difference in high income countries and currency crises in low to middle income countries.

Dell'Ariccia et al (2008) sought to address the difficulty of distinguishing the effects of a crisis from a recession that would have occurred anyway by showing that crises affect financially dependent industries more than others, where dependence is measured by the share of investment not financed from current cash flow.[4] Davis and Stone (2004) and Barrell, Davis and Pomerantz (2007) looking at effects on consumption and investment respectively, introduce dummy variables into structural equations for the relevant variables, thus seeking to capture effects of the banking or currency crisis (such as credit rationing) which go beyond the normal cyclical patterns that would be captured by the standard right hand side variables for the item in question. In each case such extra effects were found.

2 Empirical work

We now go on to estimate losses in potential output as a consequence of banking crises in 13 OECD countries over the period 1980-2008, using a production function based approach previously employed inter alia in estimating the impact of EMU on growth in Europe in Barrell et al (2008). Our choice of countries is related to Barrell et al (2010) as is our time period. That paper looks at the determinants of crises, and we wish to assess their consequences as an input into the evaluation of policy responses to the recent crisis[5].

2.1 Methodology

Our basic approach is to derive an equation for output per person hour at basic prices and estimate the effects of banking crises, while allowing for other conventional determinants of labour productivity. The crises in Table 1 are drawn from the standard datasets cited in Section 1, namely World Bank (2003), Caprio and Klingebiel (2003) and Laeven and Valencia (2008) while also being largely consistent with Demirguc-Kunt and Detragiache (2005) (see Appendix 3 Table A3.3 for the comparison of these datasets). We include 10 crises in our econometrics.

[4] So for example in the US tobacco, pottery and leather have low dependence and electrical machinery, plastic products and professional goods very high dependence.
[5] We omit Norway from our sample as the output series depends too heavily on oil production.

Economists generally agree that we may describe output as being produced by capital and labour inputs mediated by a production function that embeds the current state of technology and efficiency in factor use. Many things change the supply of factors and the efficiency with which they are used. Technology also changes over time. This approach assumes a general underlying production function that maps the factor inputs to final output, thereby representing the productive capacity of an economy. With two factors of production this can be expressed as:

$$Y = f\left(K_t, L_t, TFP_t\right) \tag{1}$$

where Y is the final output good, K is the capital stock, L is labour input and TFP indicates the state of technology and the efficiency of factor use. This may be summarized as

$$\text{TFP}_t = \text{g(technology, efficiency)} \tag{2}$$

Labour input may be multiplicatively decomposed into units of labour, E_t, and hours per unit, H_t

$$L_t = E_t H_t \tag{3}$$

Employment and hours data for the whole economy are relatively easily available from OECD labour force statistics. Capital will increase in line with output unless there are factors causing capital deepening (or shallowing).

If we start with equation (1) above we can then write (4) which is the relationship between labour productivity and the factors driving it through their impact on the level of capital, the efficiency of factor use and technology. Labour productivity per person hour can be expressed as:

$$Ln(Y/EH_t) = F(\textit{capital deepening, technology, efficiency}) \tag{4}$$

where Y/EH is an output per person hour. We use a number of different indicators and drivers of technology and efficiency. We avoid econometric estimation using the capital stock because of measurement problems, and instead look for effects arising from factors determining capital deepening as well as those that affect the cost of capital, such as risk premia driven by financial crises and the user cost of capital. The left hand side of this relationship is labour productivity per person hour. As the data on the user cost of capital is generated, and is strongly related to spikes induced by financial crises, we use indicators of these spikes directly[6]. A number of determinants of productivity have been identified in the literature, and we discuss them in turn.

The technical progress term in (3) may depend on a number of factors, including research and development (R&D) and openness and competition indicators. Endogenous growth models have been developed by Aghion and Howitt (1998) and others, where R&D expenditures or the number of researchers drive the growth process. Griffith et al. (2004) discuss the two faces of R&D. Not only does R&D increase the innovation rate in the technology frontier country, but it also raises the absorptive capacity of an economy to new ideas. Hence we use an estimate of the

[6] Our generated data is also I(0) and if included it does not form part of the cointegrating sets discussed below.

stock of R&D at time t as an indicator of usable knowledge, based on the accumulation of flows of R&D onto a depreciating stock[7].

Openness to trade is also thought to have important effects on productivity growth. The ability to trade enables a country to specialise in more efficient production processes, thus raising the aggregate growth rate temporarily. Endogenous growth models have also pointed to the possibility that contacts with the outside world may potentially raise the growth rate permanently (see, for instance, Coe and Helpman, 1995; and Proudman and Redding, 1998).

There is evidence that increases in competition brought about by the removal of trade barriers raise output, and we draw attention to the single market programme (ESM) as a factor affecting a number of our countries. Our variable for the single market mirrors the official timing of the programme and starts in 1986 at 0 and rises to 1.0 in 1993. EU dummies (eu95, eu86) are introduced as well (which increase from 0 to 1 over three year period) to capture the gradual process of integration of a country into a member of the European Union. We also use a direct indicator of openness (OPEN) as measured by the sum of the volumes of imports and exports of goods and services as a ratio of real output. This variable would capture both the increase in trade as a result of the changing nature of goods and also the conscious attempts to increase competition by removing barriers, as with the ESM.

Furthermore, Foreign Direct Investment (FDI) as a proportion of GDP can reflect the creation of knowledge or/and ease of absorption of technical progress via in effect direct import of frontier technology by foreign firms, that local firms can imitate. We can summarise the determinants of technical progress as

$$tech_t = c_1*(R\&D/Y)_t + c_2*ESM_t + c_3*\ln(OPEN)_t + c_4*\ln(FDI/Y)_t + c_5*eu86_t + c_6*eu95_t \quad (5)$$

In order to capture the general pattern of technical progress, we also include a trend (TIME) for each country, while various measures in equation (5) are additional determinants of the deviation from frontier productivity. We capture a long run impact of banking crises with dummies (which are 0 prior to crisis occurrence and 1 from the time of the crisis onwards) in this equation.

$$\ln(Y/EH_t) = d_1 + d_4*\ln(FDI/Y)_t + d_5*(R\&D/Y)_t + d_6*ESM_t + d_7*\ln(OPEN)_t + d_8*eu86_t + d_9*eu95_t + d_{10}*TIME_t + e_1*CRISLR_{t-1} + error_t \quad (6)$$

From this we can derive the following dynamic equation in error correction format

$$D\ln(Y/EH)_t = d_1 + d_2*((\ln(Y/EH)_{t-1} + d_4*\ln(FDI/Y)_{t-1} + d_5*(R\&D/Y)_{t-1} + d_6*ESM_{t-1} + d_7*\ln(OPEN)_{t-1} + d_8*eu86_t + d_9*eu95_t + d_{10}*TIME_{t-1} + e_1*CRISLR_{t-1}) + d_{11}*D\ln(Y/EH_{t-1}) + error_t \quad (7)$$

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[7] We use OECD data on gross expenditures on R&D for the whole economy. We benchmark the stock before the beginning of our data period as the flow divided by the average growth rate and the depreciation rate, and we cumulate flows onto this stock with a depreciation rate of 15 per cent.

2.2 Results

Our first task is to assess the stationarity of the variables. As shown in Table 2, we can conclude that the main variables are all I(1)[8] justifying an error correction framework for productivity. The error correction form is estimated using Common Correlated Effects (CCE) (Pesaran, 2006), where Ordinary Least Squares (OLS) is applied to the panel of variables given in equation (7), with cross section averages of the independent as well as dependent variables added as additional time series regressors. The CCE method deals with potential heterogeneity in our group of countries and absorbs the effects of common unobserved factors omitted from the panel that might otherwise cause biases in coefficients. The data period is 1980-2008. Our data sources are summarised in Appendix 3.

Table 2: ADF Tests of variable stationarity

	Ln(Y/EH)		(R&D)/Y		Ln(FDI/Y)		Ln(OPEN)	
	level	1st diff	level	1st diff	level	1st diff	level	1st diff
Belgium	-1.943*	-3.309	-2.947	-3.043	-2.515*	-4.680	-0.370*	-3.72
Canada	-1.036*	-3.355	-2.169*	-3.355	-0.443*	-3.881	-1.491*	-3.725
Denmark	-1.903*	-2.697	-0.612*	-2.916	0.038*	-3.924	1.738*	-3.185
Finland	-1.937*	-4.246	-0.759*	-3.816	-0.310*	-4.316	0.788*	-3.064
France	-3.354	-3.626	-2.663	-2.590*	-0.300*	-3.589	-0.106*	-3.189
Germany	-1.655*	-3.879	-2.464*	-3.353	-0.604*	-4.076	1.029*	-3.498
Italy	-2.257*	-2.573*	-1.637*	-2.097*	-1.773*	-3.888	-1.063*	-5.122
Japan	-2.024*	-2.427*	-1.995*	-2.795	1.401*	-4.288	1.121*	-4.148
Neths	-2.123*	-3.157	-2.643*	-3.431	-1.005*	-3.018	0.400*	-3.989
Spain	-2.341*	-2.204*	0.922*	-1.332*	-2.403*	-2.109*	-1.306*	-1.860*
Sweden	-0.330*	-1.599*	-2.758	-2.525*	-1.342*	-4.071	0.026*	-3.237
UK	-1.228*	-4.142	-1.678*	-2.805	-0.960*	-3.556	-0.248*	-3.256
US	-0.072*	-5.049	-2.920	-3.654	-0.760*	-3.375	-0.723*	-3.702

*Note: * indicates less than 90% significance level*

Before proceeding to the estimation of the panel, it is necessary first to find a cointegrating set of variables for each country and then use them to undertake dynamic panel analysis on the dependent variable, output per person hour. We first test the unrestricted long run variables (i.e. including productivity, R&D, FDI, openness and the time trend for each country as well as the crisis dummies), with appropriate additional dummies imposed[9]. We then search for a minimum cointegrating set, because if a variable is included in a cointegrating set when it is not needed, then that set is not irreducible in the terms of Davidson (1998) and hence we may gain spurious information about the determinants of long run behaviour. Residuals from the long run estimated equations are tested for the existence of a unit root, using t-statistics of Augmented Dickey-Fuller tests by including intercept and 1 lag. Our tests show that all equations for all countries cointegrate, implying we have an acceptable specification, as shown in Table 3[10].

Table 3: Cointegration of the long run (unrestricted)

Belgium	Canada	Denmark	Finland	France	Germany	Italy	Japan	Neths	Sweden	Spain	UK	US
-4.171*	-4.292**	-5.119***	-4.738***	-4.391*	-4.189**	-4.552**	-5.176***	-4.785**	-4.088**	-4.05*	-3.957*	-3.852*

Data period 1980-2008.

[8] As several variables exhibit partial or pure structural breaks, their stationarity tests can be affected. We assume that all our variables are difference stationary, as an overwhelming majority of variables in our analysis are.

[9] Following Juselius (2006), dummies are imposed to allow for "blips and transitory shocks".

[10] Albeit only at the 10% level for Belgium, Germany, Italy, Japan and the US

We use our minimum cointegrating set in our error correction framework above and include the averages of the dependent and the independent variables in a general-to-specific approach to eliminate insignificant variables starting from the most insignificant ones first. The results from general-to-specific estimation for the variables to be included in the long run and short run are in Table 4. In all cases we maintained the crisis indicator whether or not it was significant.

The Common Correlated Effects (CCE), which are the averages of a change in productivity, levels of openness and ratio of foreign direct investment to GDP are highly significant, with a common coefficient across countries. The significance of common parameters for the averages of openness and foreign direct investment to GDP ratio suggests that globalisation had a positive effect on output per person hour in all countries in our sample[11]. It should be noted that while the average of a change in output per person hour is a stationary stochastic variable, the average value of openness and FDI to GDP ratio are trending. We can consider these trend variables to be determinants of a common technical progress for countries in the panel, and other country specific variables to be indicative of the factors driving deviations from the common level of technical progress (i.e. whether countries approach the frontier level faster or slower).

In addition to a common level of technical progress, a country-specific trend variable was found significant and positive in six countries, with an average impact on productivity growth of 1% per annum for Germany, Netherlands, UK and the US and more than 1.5% for Belgium and Japan[12]. This factor might be seen as the unexplained component of technical progress in these countries. At the same time, there is evidence that Italy and Spain lag behind the common trend, as their country specific trend parameters are negative.

In the long run, R&D is significant in Denmark, Finland, France, Italy and the Netherlands, and marginally significant in Germany. In all cases it has a positive sign, indicating that higher R&D enables these countries to create or absorb technical progress more readily. The effect of a one unit of GDP increase in R&D varies, with Italy showing the highest significant effect from a low level of R&D and Germany the lowest from a high level of R&D. For the countries with no reported coefficient, it was insignificantly different from zero and hence excluded. The impact of these parameters should be evaluated in conjunction with information on other trend variables. In Germany, autonomous technical progress (supplementary to its common level) is positive and significant whilst in Italy as it negative, at lest over the data period we are studying.

Openness as an additional factor is significant and positive in Canada and France where there may be a trade effect from adjacent countries. The contribution of openness is negative in Belgium, perhaps in part because much of its recorded trade is 'through-trade with Germany and France, and hence it may have little effect on technical progress. FDI is found significant only in the US, implying that embodiment of best practice in new plant from abroad has helped to boost labour productivity growth. In the long run, there are also European Single Market dummies in Belgium, Denmark, Finland, Germany, Italy and Spain. In addition, for Spain and Sweden variables proxying the process of European integration are found to be highly significant and having a positive impact on productivity.

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[11] Although the short run effects are the same, long run cumulative impacts differ among countries.
[12] An additional trend variable (increasing up to 1990 and then remaining flat) is included in the long run for Japan, to capture different paces of development in technical progress before and after 90's.

Table 4: Basic results (dependent variable is D ln (Y/EH)

	Error correction	R&D/Y	Ln(FDI/Y)	Ln(Open)	European single market	EU membership 1995	EU membership 1986	Long run crisis effect	Crisis date	Trend	DLn(Y/EH(-1))	AvDLn(Y/EH)	AvLn(Open)	AvLn(FDI/Y)
Belgium	-0.513 (0.000)	-	-	-0.538 (0.009)	0.125 (0.000)	-	-	-		0.017 (0.000)	-	0.562 (0.000)	0.061 (0.004)	0.021 (0.002)
Canada	-0.389 (0.000)	-	-	0.119 (0.037)	-	-	-			-	-	0.562 (0.000)	0.061 (0.004)	0.021 (0.002)
Denmark	-0.958 (0.000)	0.014 (0.000)	-	-	0.132 (0.000)	-	-			-	-	0.562 (0.000)	0.061 (0.004)	0.021 (0.002)
Finland	-0.674 (0.000)	0.029 (0.000)	-	-	0.168 (0.001)	-	-	-0.104 (0.013)	1991	-	-	0.562 (0.000)	0.061 (0.004)	0.021 (0.002)
France	-0.636 (0.000)	0.013 (0.000)	-	0.361 (0.000)	-	-	-			-	-	0.562 (0.000)	0.061 (0.004)	0.021 (0.002)
Germany	-0.687 (0.002)	0.005 (0.049)	-	-	0.076 (0.000)	-	-	-		0.011 (0.000)	0.422 (0.055)	0.562 (0.000)	0.061 (0.004)	0.021 (0.002)
Italy	-0.305 (0.001)	0.052 (0.000)	-	-	0.152 (0.012)	-	-	-0.083 (0.064)	1990	-0.012 (0.039)	-	0.562 (0.000)	0.061 (0.004)	0.021 (0.002)
Japan	-0.825 (0.000)	-	-	-	-	-	-	-0.041 (0.000)	1997	0.016 (0.000)	0.422 (0.002)	0.562 (0.000)	0.061 (0.004)	0.021 (0.002)
Neths	-0.657 (0.000)	0.008 (0.000)	-	-	-	-	-	-		0.009 (0.000)	0.306 (0.048)	0.562 (0.000)	0.061 (0.004)	0.021 (0.002)
Sweden	-0.305 (0.000)	-	-	-	-	0.13 (0.000)	-			-	-	0.562 (0.000)	0.061 (0.004)	0.021 (0.002)
Spain	-0.28 (0.005)	-	-	-	0.096 (0.03)	-	0.126 (0.000)	-		-0.013 (0.032)	-	0.562 (0.000)	0.061 (0.004)	0.021 (0.002)
UK	-0.456 (0.003)	-	-	-	-	-	-			0.012 (0.002)	0.369 (0.036)	0.562 (0.000)	0.061 (0.004)	0.021 (0.002)
US	-0.845 (0.000)	-	0.074 (0.004)	-	-	-	-	-0.044 (0.000)	1988	0.009 (0.000)	-	0.562 (0.000)	0.061 (0.004)	0.021 (0.002)

Note: Probabilities are given in parenthesis; variables significant at least at 90% level are reported (with the exception of crises variables); avdln(y/eh), avln(open) and avln(fdi/y) represent unweighted cross section averages of the corresponding variables.

Our major focus is on the impact of banking crises, and out of 13 crises in the sample, there are three with a highly significant long run negative impact (Finland in 1991, Japan in 1997 and the US in 1988), plus Italy with a long term effect of the crisis of 1990 being significant at 90 per cent level. There are four systemic crises in our set, and three of them (the US, Japan and Finland) have significant negative effects. The fourth in Sweden has an insignificant negative effect, and it may be masked by the major restructuring of the polity induced by the crisis. As we can see from Table 5 when we include the insignificant crises in the regression (we exclude these from Table 4 for reasons of clarity but they were included in the regression) there are also negative but not significant effects in Canada, France, Sweden and the UK, with only one country in a sample, Denmark in 1987, having an insignificant positive long run effect. It was not possible to impose a common coefficient on the crisis dummies[13].

Table 5: Impacts of crises on output

	Long run crisis effect	Crisis date
Belgium	-	
Canada	-0.022 (0.274)	1983
Denmark	0.014 (0.124)	1987
Finland	**-0.104 (0.013)**	**1991**
France	-0.011 (0.408)	1994
Germany	-	
Italy	**-0.083 (0.064)**	**1990**
Japan	**-0.041 (0.000)**	**1997**
Neths	-	
Sweden	-0.005 (0.879)	1991
Spain	-	
UK	-0.003 (0.847)	1991
US	**-0.044 (0.000)**	**1988**
Average	-0.024	

Note: significant crises are in bold

The significant long run effects from crisis are between 4%-10% per annum, with Finland affected the most and the US and Japan comparatively less. The average effect of a systemic crisis (including Sweden) is to reduce sustainable output by 4.9 percent permanently. The average impact on output over all the crises we include is around -0.024 (excluding Denmark it would be -0.026) Overall, we suggest our results are strongly consistent with the effects of scarring in a subset of crises. There remain crises where such scarring is not significant. Note that these effects

[13] Null hypothesis of a common coefficient is rejected based on a p-value being equal to 0.00

on productivity are themselves distinct from the short run impact of demand on output. We note also that it can be argued that the dummies might underestimate the impact of a banking crisis since it may affect R&D, FDI and openness. Accordingly, our estimates are a lower bound of the impact of banking problems on potential output.

2.3 Assessing potential output losses

In order to assess output losses, we compare potential output as generated by the restricted long run of the above equations with actual output. We take the implied long run labour productivity from the cointegrating part of our regression, and multiply it by an estimate of trend labour input made up of trend employment multiplied by trend hours calculated with a simple Baxter-King two-part filter. This gives us an estimate of trend output in basic prices (or at factor cost), which can be used to create an estimate of the cyclical component of output. In order to do this, trend output at basic prices is compared to actual output at basic prices, and the output gap is calculated as difference between the logs of these two series.

These series together allow us to see not only all the completed recessions over the 1980-2008 period, but also the "steps down" in long run potential output when there is a significant banking crisis effect. We are then able to compare the cumulative loss of GDP and recession length for non-crisis recessions with cumulative losses from crisis recessions, as well as seeing how much (permanent) output loss was generated by the "scarring" of the economy as shown by the long run dummy variable.

A set of charts for each country are shown in Figures 1-13, with the top panel coming from our production function approach and the bottom from a standard Baxter-King filter approach to trend and cycle estimation based on data starting in 1970 or before and ending in 2008. The line denoted "implied" is the level of potential output as derived from the long run of the equation, whilst that denoted TR (trend) is from the Baxter-King Filter. The dashed line is "actual" output developments. The shaded blocks denoted "cycle" are the deviations of the actual from the long run level of potential output. Note that for each country the trend is adjusted so that over the estimation period, the average deviation of actual output is zero. For each country, trend output rises over time, as would be expected. In most countries there are recessions in the early 1980s and 1990s.

Figures based on the production function approach depict only crises that were found necessary to be included in the long run specification, while charts from Baxter-King filter methodology illustrate all the crises initially included in the analysis Visual inspection of the charts shows that out of 10 crises incorporated in the estimation, 6 are identified with falls in output. At the same time, it can be seen that, out of four significant banking crises 2 were results of already ongoing problems in the economies (Italy and the US), while the remaining two crises initiated recessions (Japan and Finland).

The timing and depth of recessions is detailed in Tables 6 for our productivity based approach, and the Appendix table details the same features for the Baxter-King filter. The production function approach identifies 31 recessions defined as being a minimum of two periods of consecutive fall in output, but excluding the long 'recessions' in Belgium, Italy and Spain that start in 1982 as they are at the beginning of the data period. These long recessions may be inaccurate descriptions of trend in the first period. We also exclude long and shallow recessions in Canada, France and the US for the same reason, but this does not affect our conclusions. Only 6 of these are associated with banking crises (in italics) in Finland, Japan, UK and the US, three of which (Finland, Japan and the US) coincided with the occurrences of systemic banking crisis. At the same time, the Baxter-King filter gives us 49 observations of recessions[14], with 6 associated with banking crises in Canada, Finland, Japan, Sweden and the UK, and 3 with systemic banking crisis (Finland, Japan and Sweden).

Table 6: Recessions with and without banking crises

Country	Start	Cumulative Depth	Duration in years	Banking crisis
Belgium	1992	-0.107	4	
Canada				1983
Denmark	1981	-0.048	4	1987
	1991	-0.064	4	
	2004	-0.007	*2*	
Finland	1982	-0.036	5	**1991**
	1990	*-0.172*	5	
	2002	-0.033	3	
France	1981	-0.072	6	1994
	2001	-0.014	3	
Germany	1982	-0.028	4	
	1987	-0.007	3	
	1993	-0.065	3	
	1998	-0.002	2	
	2003	-0.031	4	
Italy	1991	-0.124	3	1990
Japan	1983	-0.010	2	**1991**, **1997**
	1986	-0.028	3	
	1993	*-0.029*	3	
	1998	*-0.045*	6	
Netherlands	1982	-0.044	3	
	1988	-0.021	2	
	1992	-0.038	4	
	2003	-0.039	4	
Spain	2002	-0.030	3	
Sweden	1981	-0.006	*2*	**1991**
	1996	-0.122	*5*	
	2003	-0.078	2	
UK	1981	*-0.078*	5	1991
	1989	*-0.087*	6	
	1999	-0.007	2	
USA	1982	-0.029	2	**1988**
	1987	*-0.024*	2	
average loss per recession year		-0.014	3.5	

Note: Based on econometric model; systemic crisis in bold
Recessions are defined as more than one year and less than seven years of negative output gaps

[14] Following the production function based approach three long and shallow recessions (two in Germany and one in Belgium) were excluded

The average length of recession, based on production function approach, is 3.5 years, as we can see from Table 7. This is shorter than the average of recessions associated with banking crisis which last on average 4.5 years (which is within the range of findings in previous studies). Recessions associated with systemic crises are marginally shorter than those associate with all crises but longer than the overall average. Recessions without banking crises are shorter than others at around 3 years. In the Baxter-King approach the average recession is inevitably shorter, at 3.2 years with banking crisis recessions averaging 2.8 years.

Table 7: Summary comparisons of the cyclical costs of crises

		Total	Crisis	Systemic Crisis
Length in years	**Production function**	3.5	4.5	4.3
	Baxter-King	3.2	2.8	3.0
Average annual loss of output	**Production function**	-0.014	-0.016	-0.019
	Baxter-King	-0.008	-0.013	-0.014

Note the average annual loss as compared to trend is the cumulated output gaps divided by the number of years the recession lasts

In order to calculate the depth of the recession, we take the cumulative loss in output during the recession period, which is the sum of deviations of the actual output from the long run level of potential output. The average depth[15] of all recessions in the production function approach is 1.3 per cent a year, whilst it increases to 1.6 per cent a year for banking crises. The Baxter-King filter inevitably gives shallow recession of less than a percent a year, and those associated with banking crises are predictably deeper at 1.3 per cent a year. Recessions accompanied by systemic banking crises are deeper (1.9 percent) as compared to other production-function based recessions. In the Baxter-King approach, the depth of the recession is the greatest, at 1.4 per cent a year when there is an associated systemic banking crisis, while the length of a period when output is below its trend is marginally higher at 3 years.

Cumulative output loss on average across countries per occurrence[16] of a recession in case of production function is 4.9 per cent when no distinction is made between banking and non-banking crises recessions. This increases to 7.2 percent if only output losses associated with banking crises are included, which again places our findings well in line with results from other results. The cumulated losses for systemic crises are much harder to calculate. They comprise large cyclical element of 8.2 percent cumulated losses before a return to trend, but that trend level of output is also reduced by the crisis. In some sense the loss is infinite as it is permanent.

[15] Calculated as a ratio of the sum of the depth of all recessions over the sum of the duration of all recessions.

[16] Given as a ratio of sum of all cumulated losses across counties over number of recessions

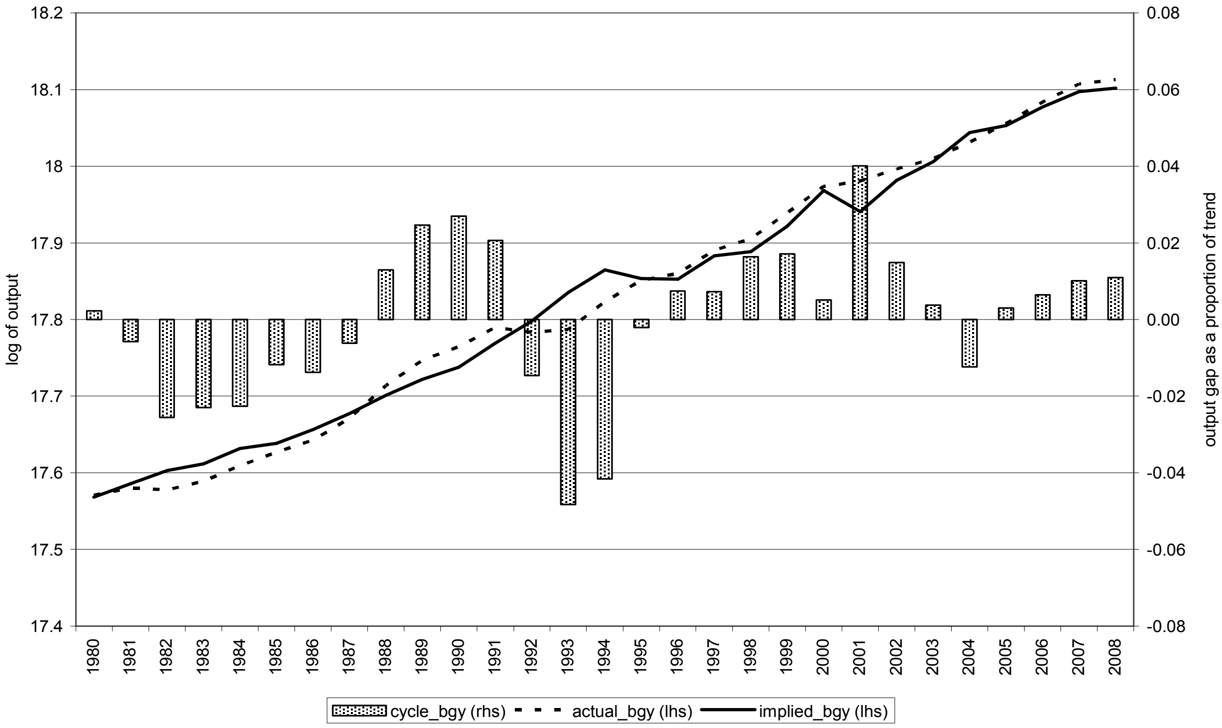
Although in case of analysis based on the Baxter-King filter methodology we observe the same types of dynamics, i.e. banking crises associated losses are higher as compared to all recessions considered together, in general cumulative losses are lower (2.7 % and 3.6% correspondingly).

Conclusions

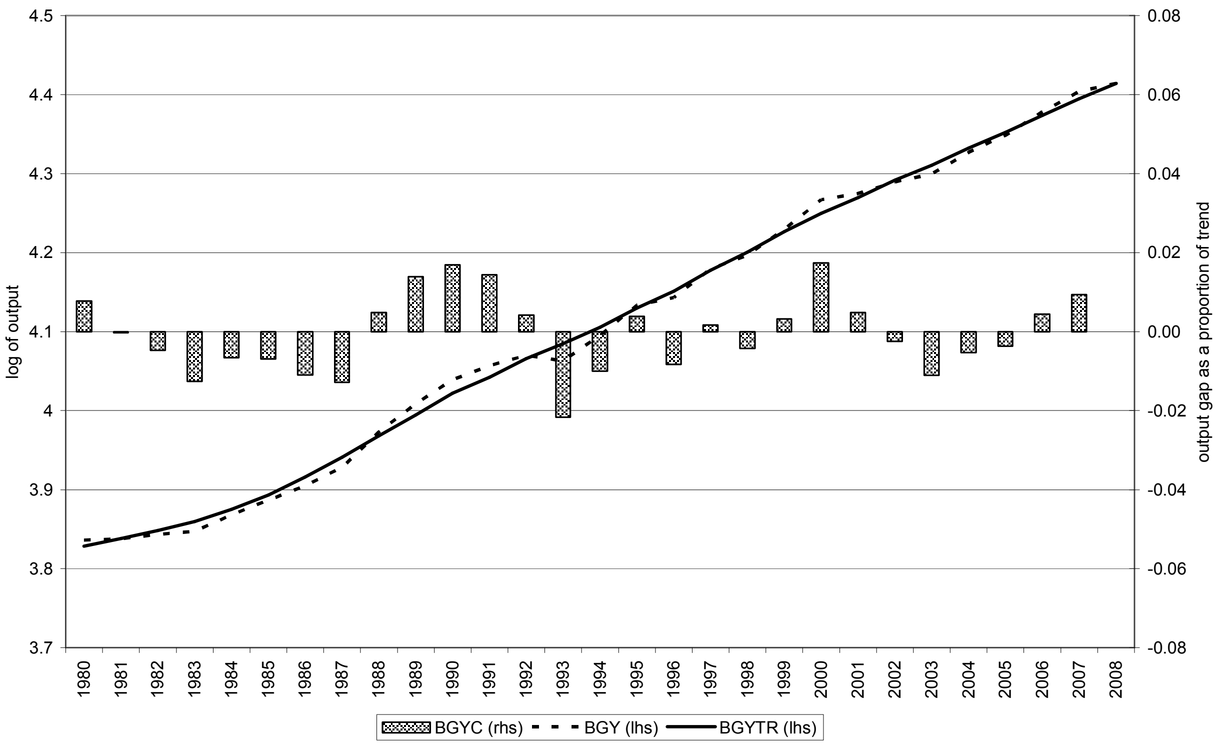
We have shown that the literature on banking crises focuses mainly on the short run demand side effects of crises, which link to the impact of recession, credit rationing and uncertainty on consumption and investment. Much less is known about the effects on the supply side of the economy, whereby a banking crisis may impact on labour productivity to the long run detriment of economic performance. We have calculated the average effect of a banking crisis on the sustainable level of output is likely to be around 2 ½ percentage points, and if the crisis is systemic, as were those in 2007 and 2008, it is likely to be closer to a 4 percentage points reduction in sustainable output. Simple time series estimates of the permanent effect of crises on sustainable output suffer from a number of problems that ours do not. We do not need either a common effect or a pre-existing estimate of trend output, as is the case in Cerra and Saxena (2008) and Furceri and Mourougane (2009) respectively.

We have set up a dynamic panel specification using Common Correlated Effects which allows for the principal influences on labour productivity and hence the supply side of the economy. We found long run effects of banking crises over and above conventional determinants of potential output. We note that the effect when it occurs is sizeable but it does not occur in all crises – around one in four. Only three crises in our sample have a clear long lasting impact on productivity and these are associated with systemic banking crises. We show that recessions accompanied by banking crisis are deeper and longer than other recessions, and that those associated with systemic crises are deeper still.

FIGURE 1: BELGIUM

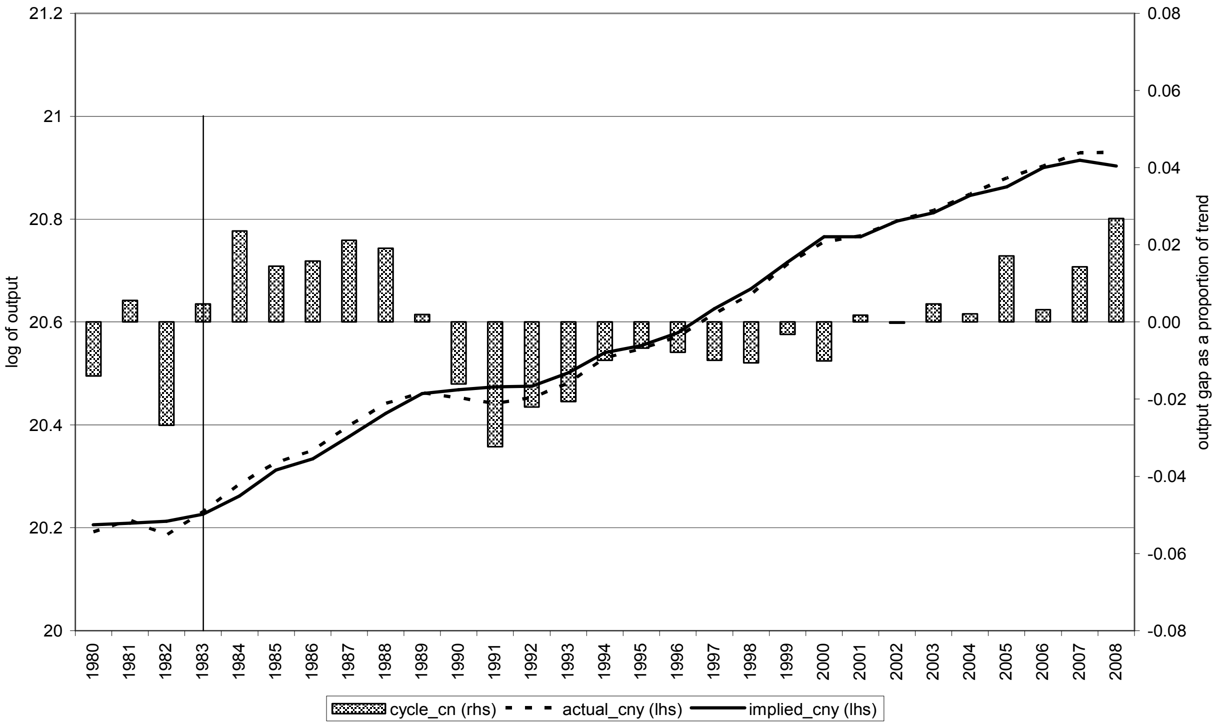


Production function based estimates

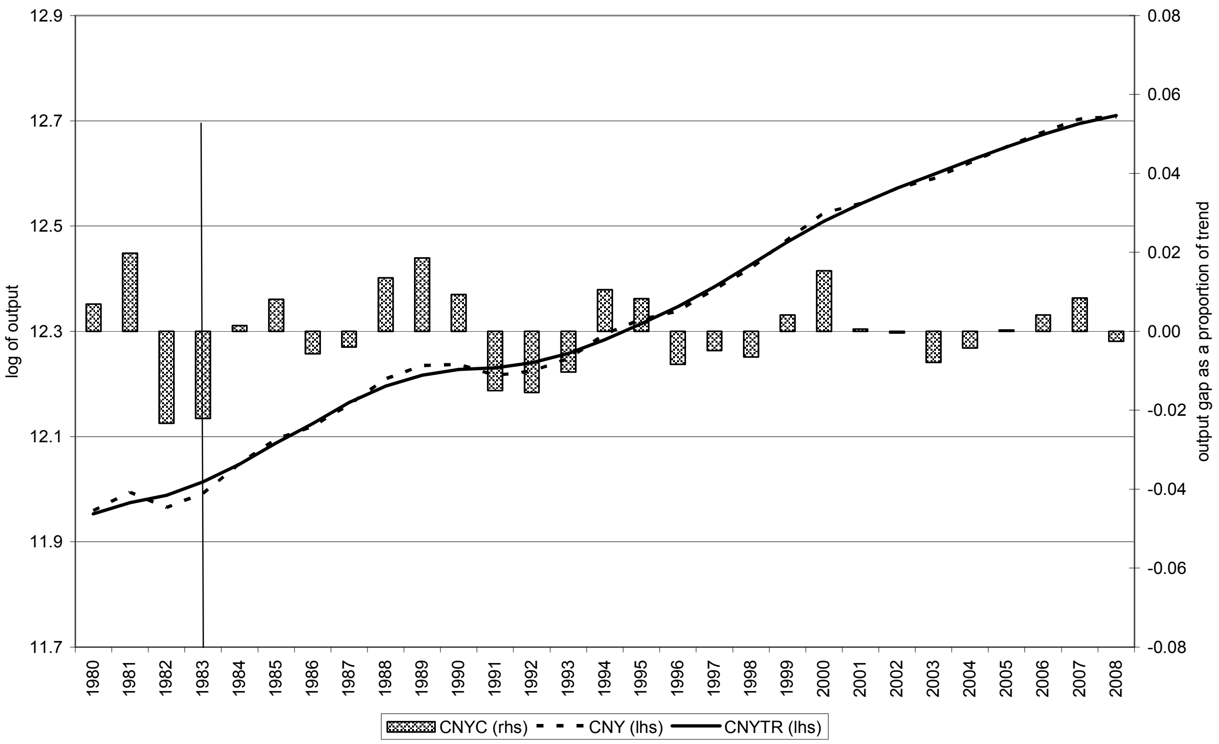


Baxter-King Filter based estimates

FIGURE 2: CANADA

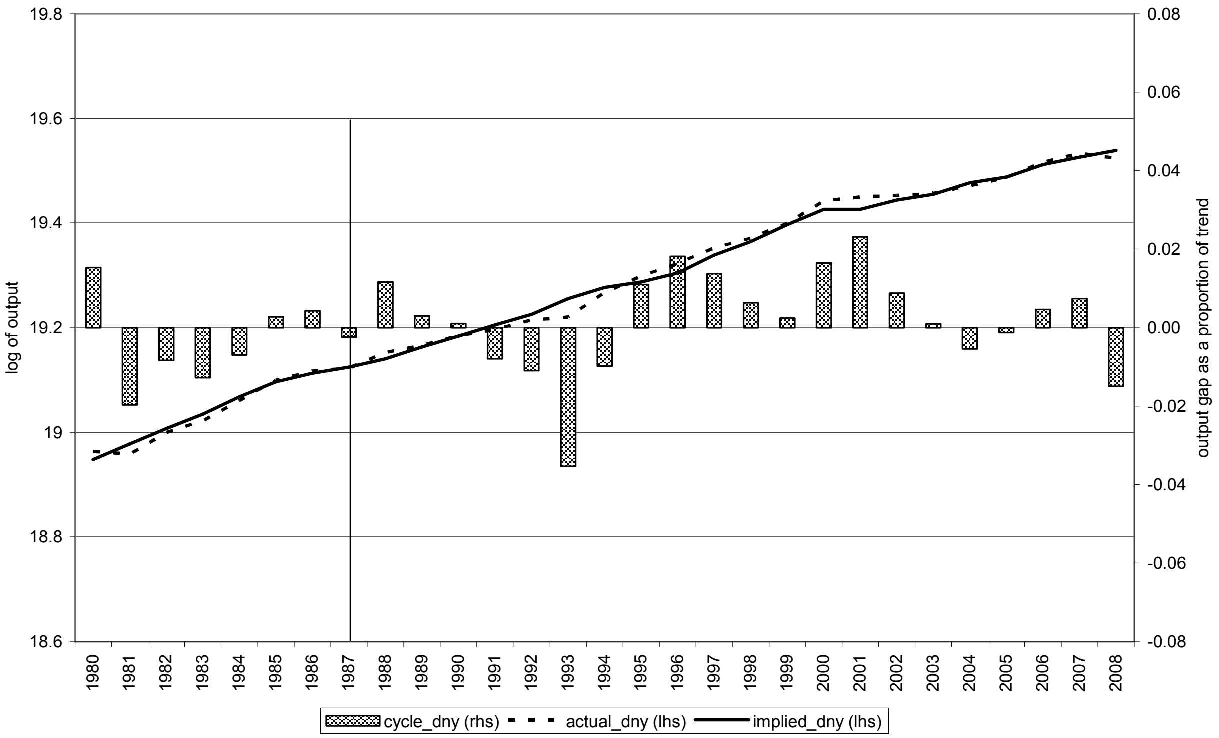


Production function based estimates



Baxter-King Filter based estimates

FIGURE 3: DENMARK



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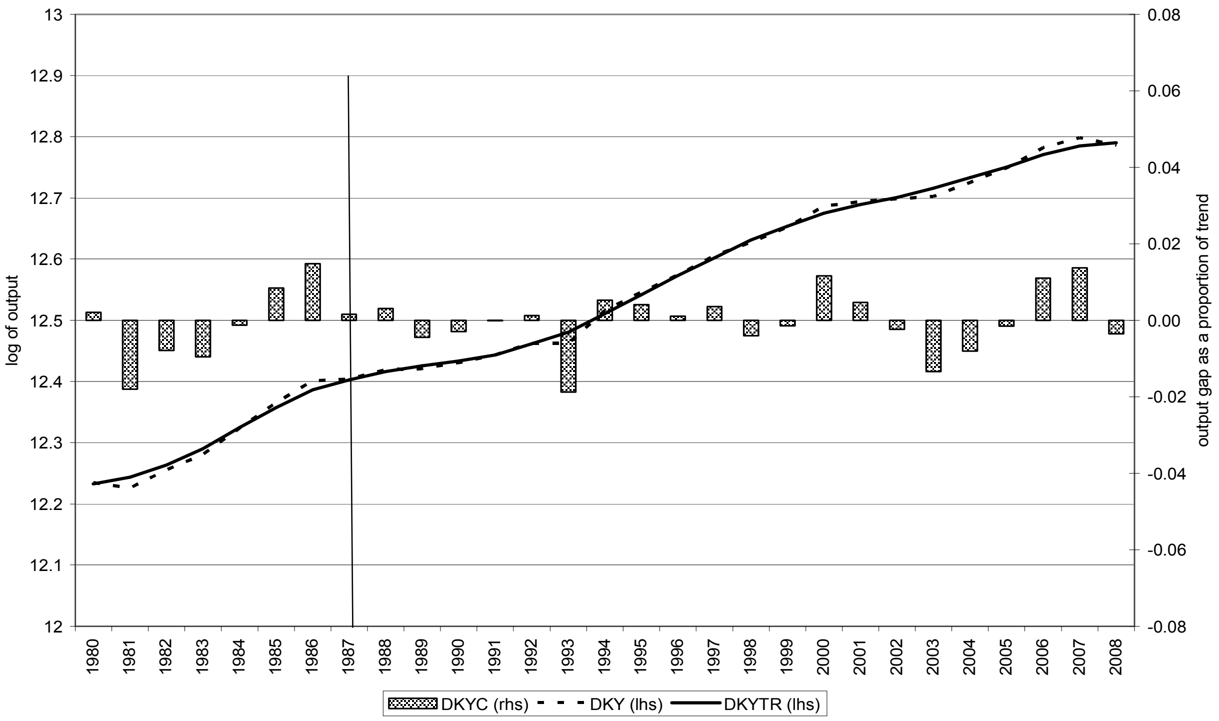
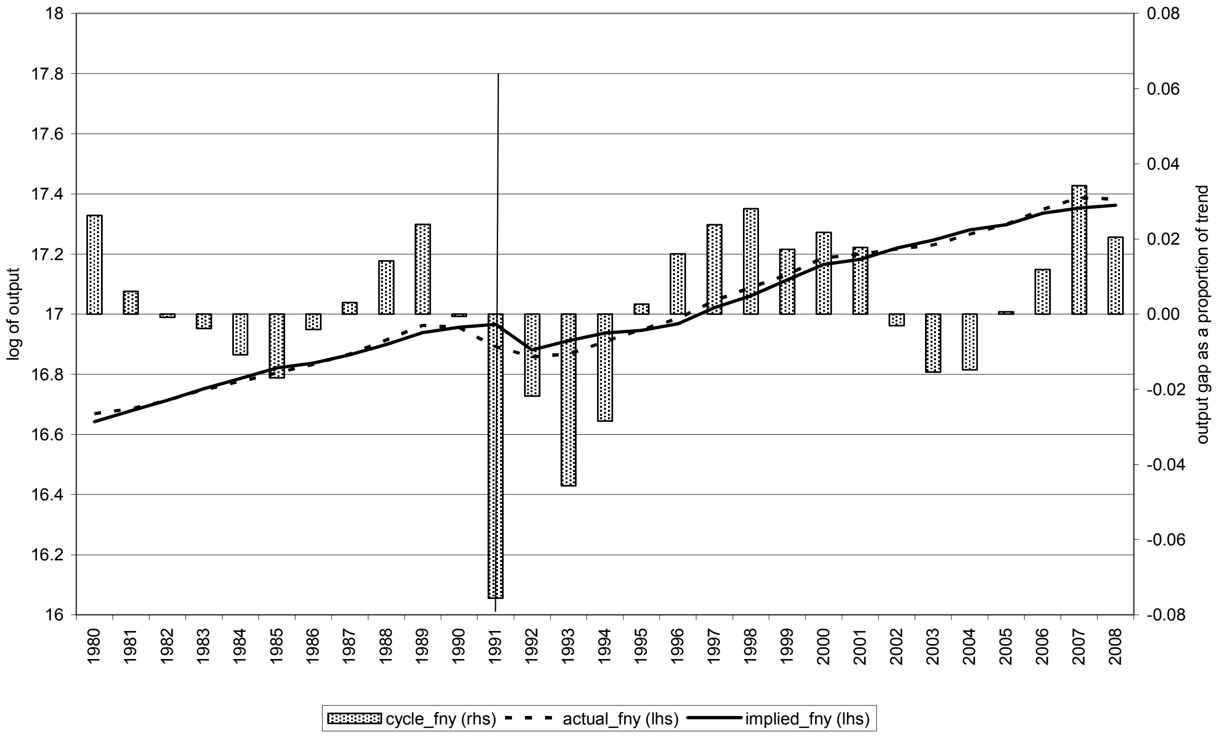


Baxter-King Filter based estimates

FIGURE 4: FINLAND



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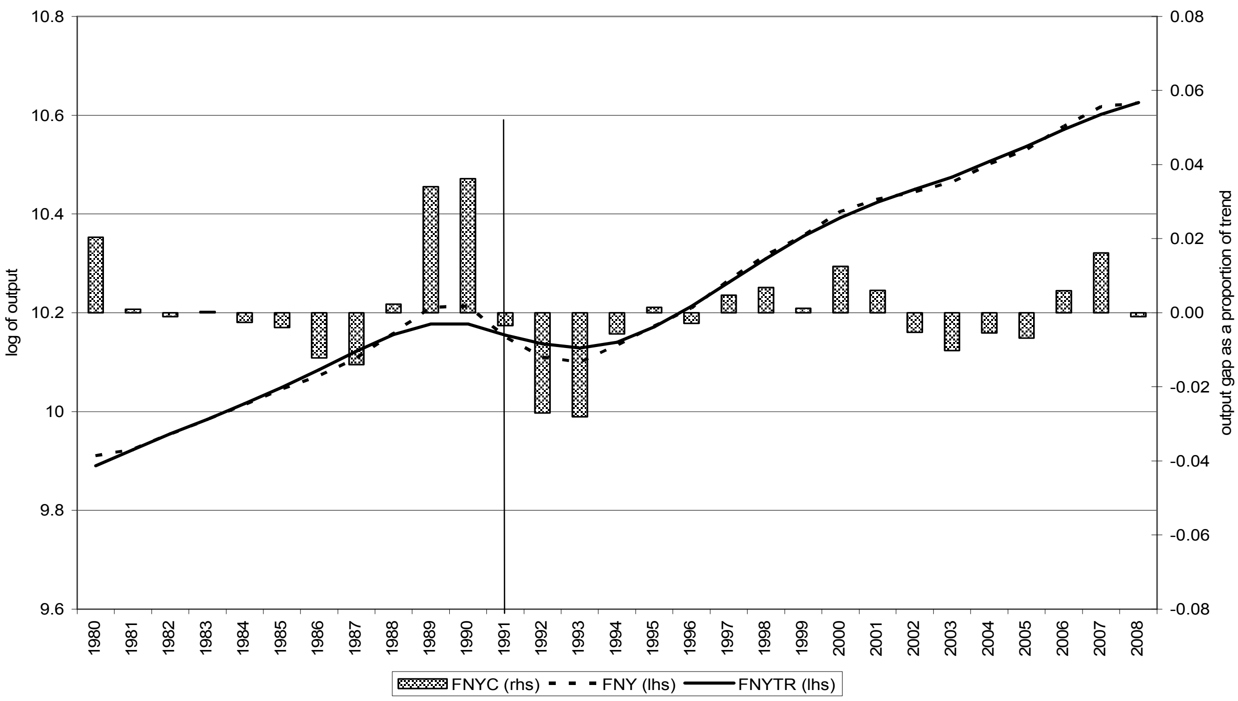
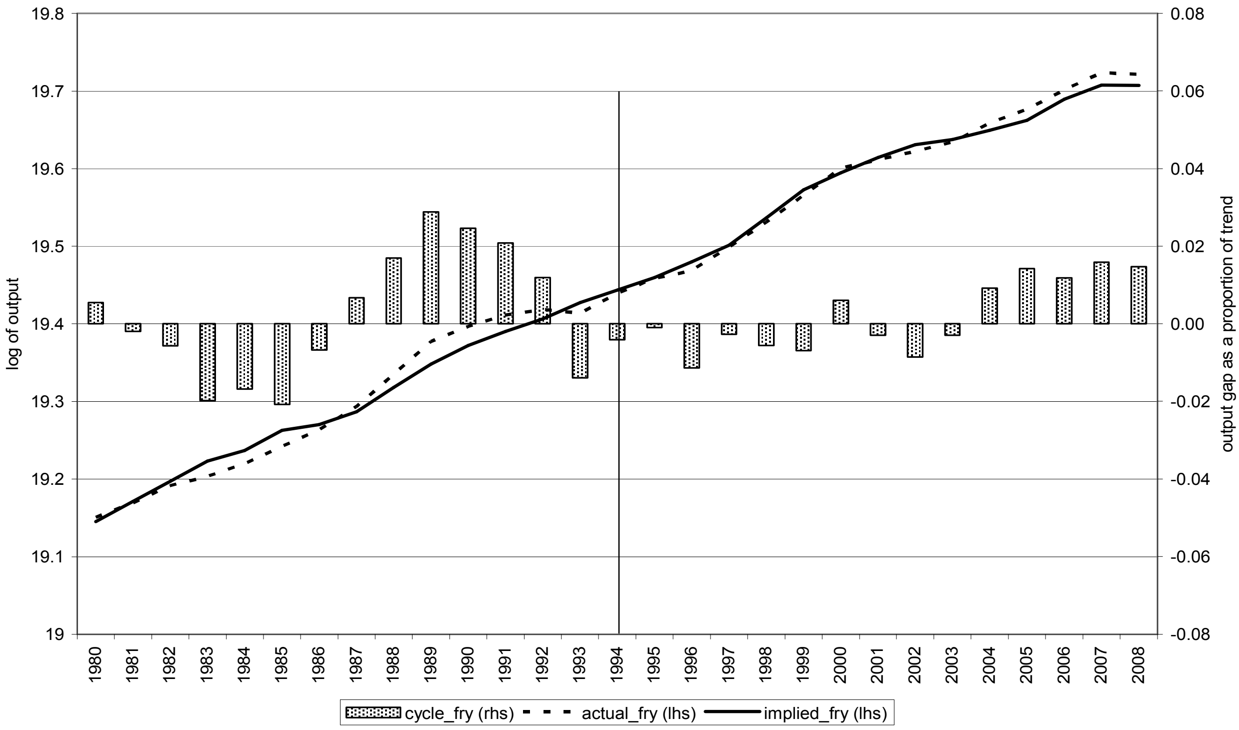
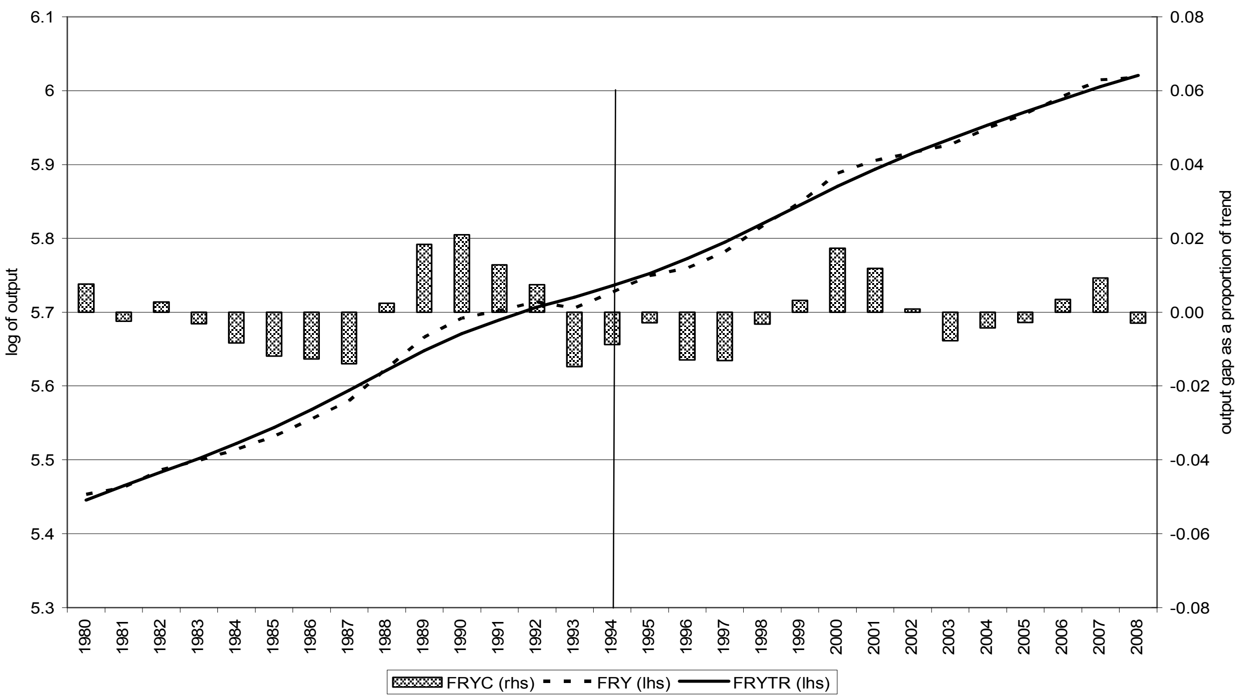


Baxter-King Filter based estimates

FIGURE 5: FRANCE

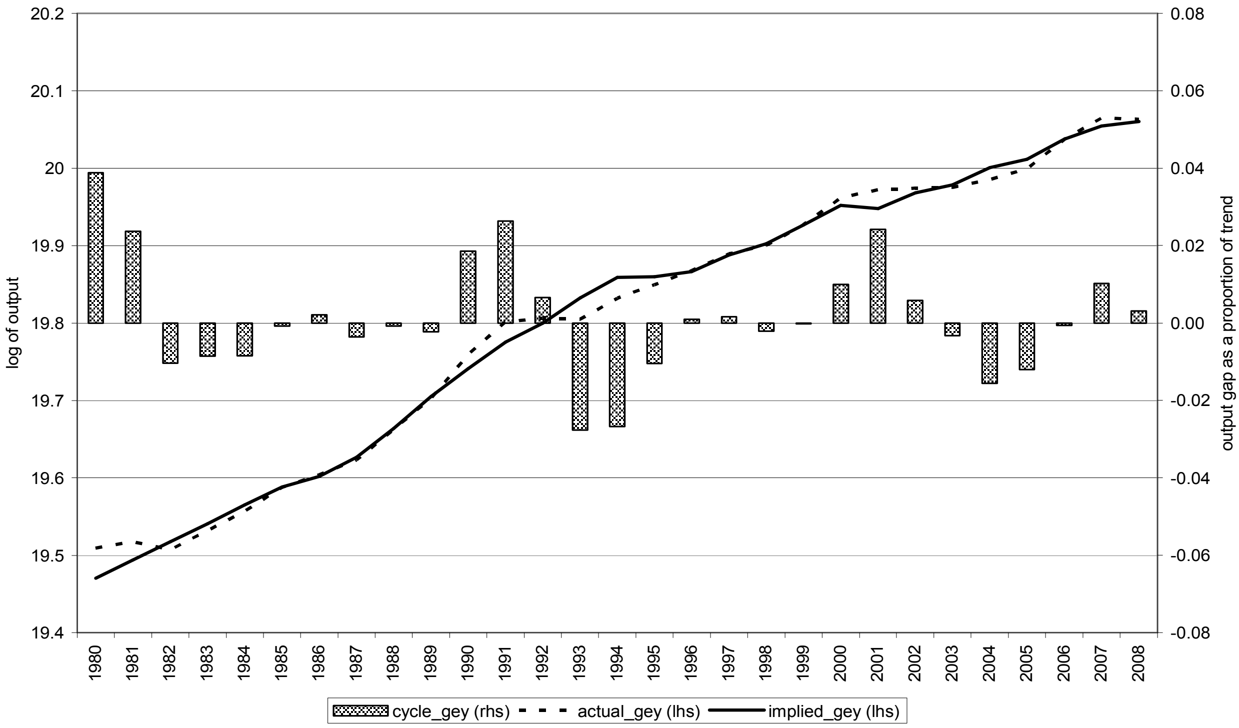


Production function based estimates



Baxter-King Filter based estimates

FIGURE 6: GERMANY



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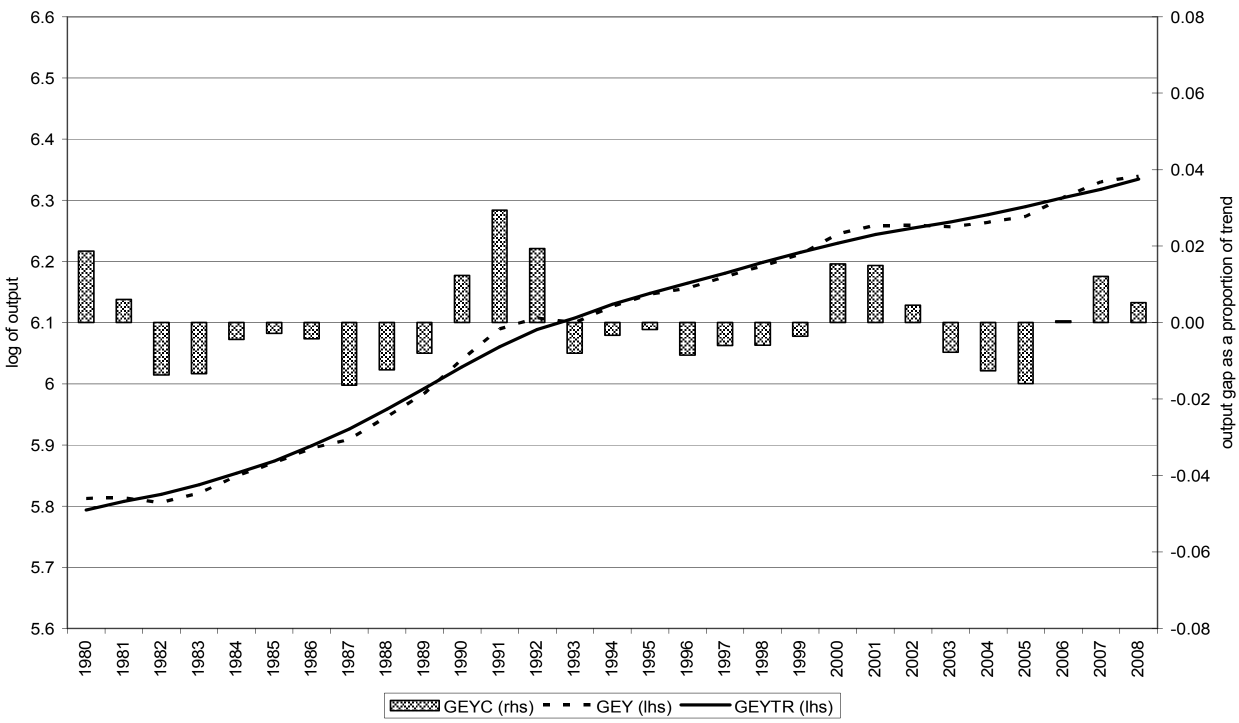
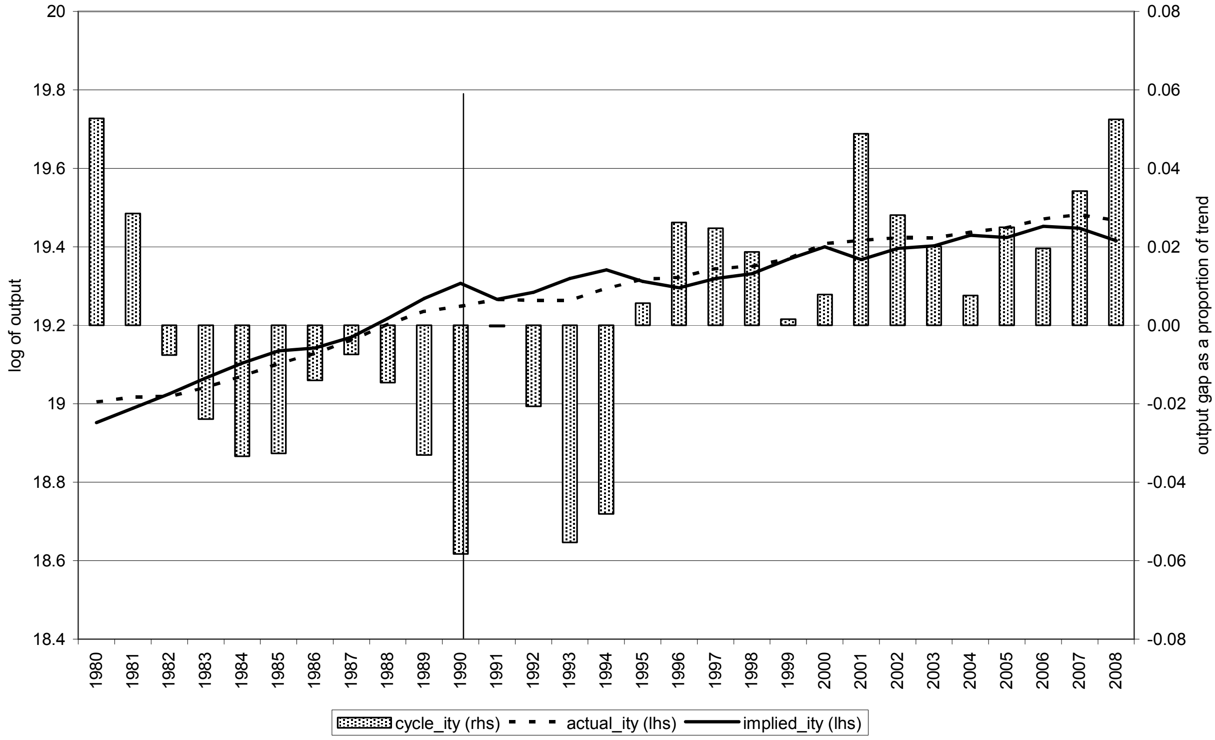
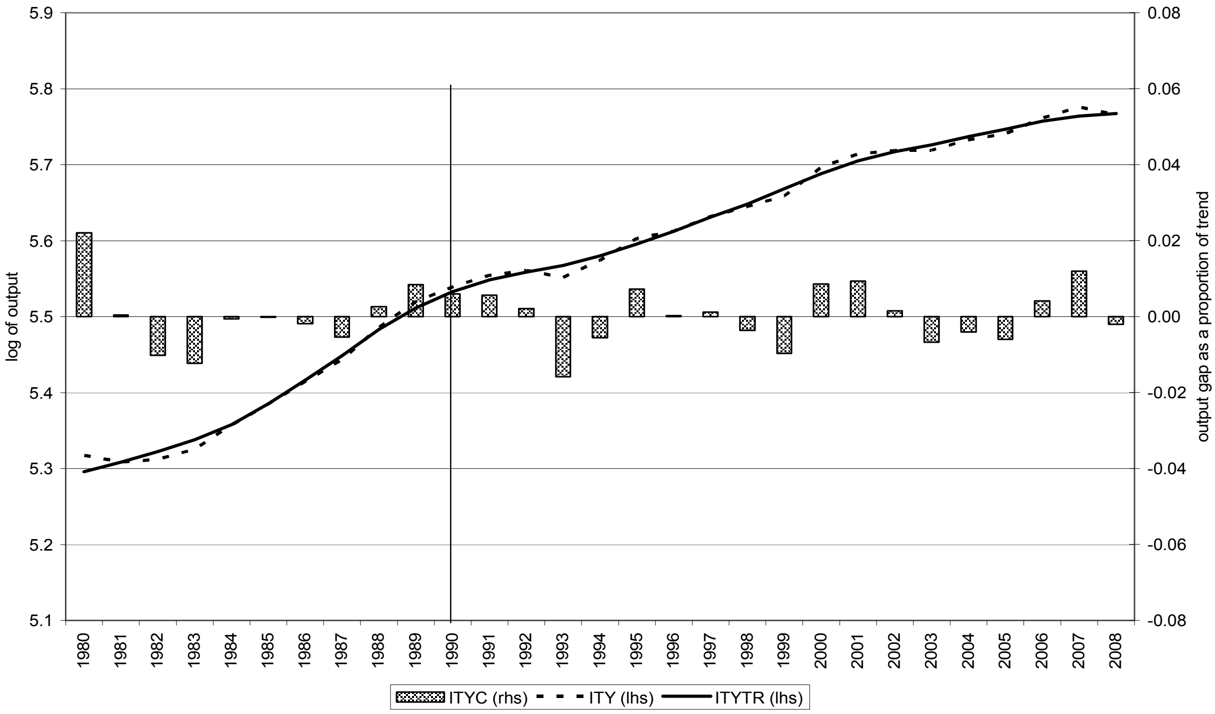


Baxter-King Filter based estimates

FIGURE 7: ITALY

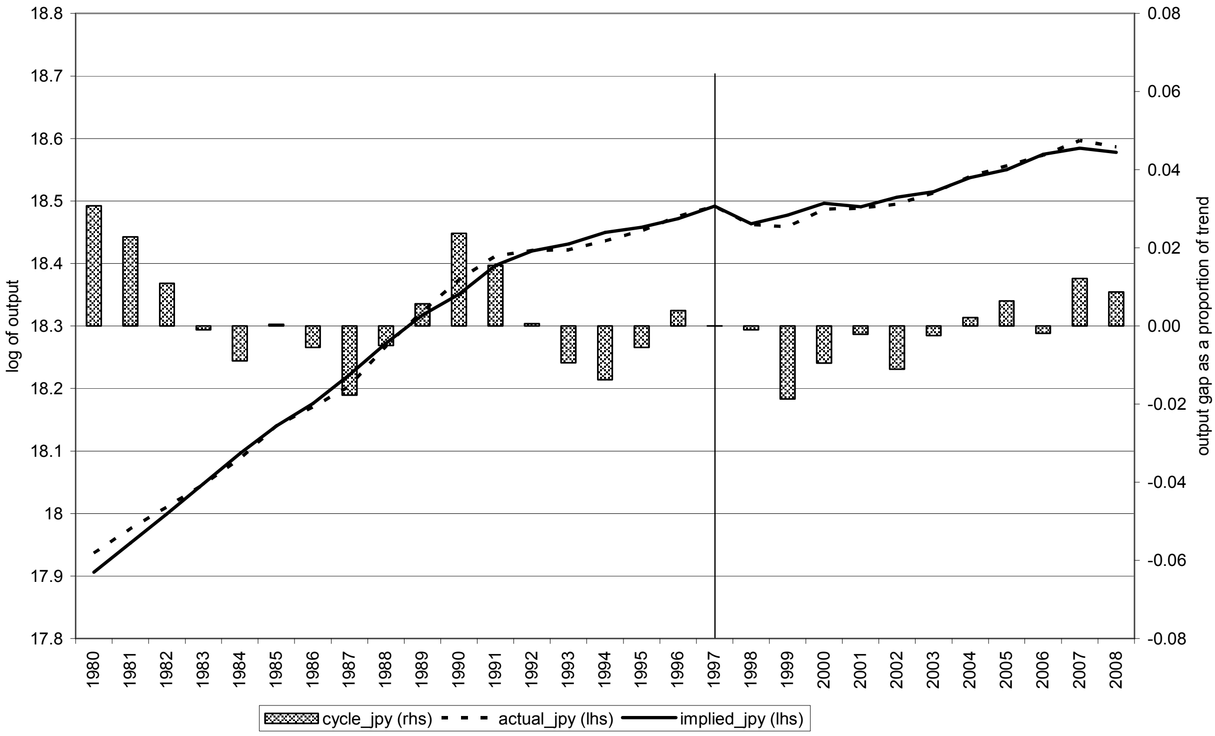


Production function based estimates

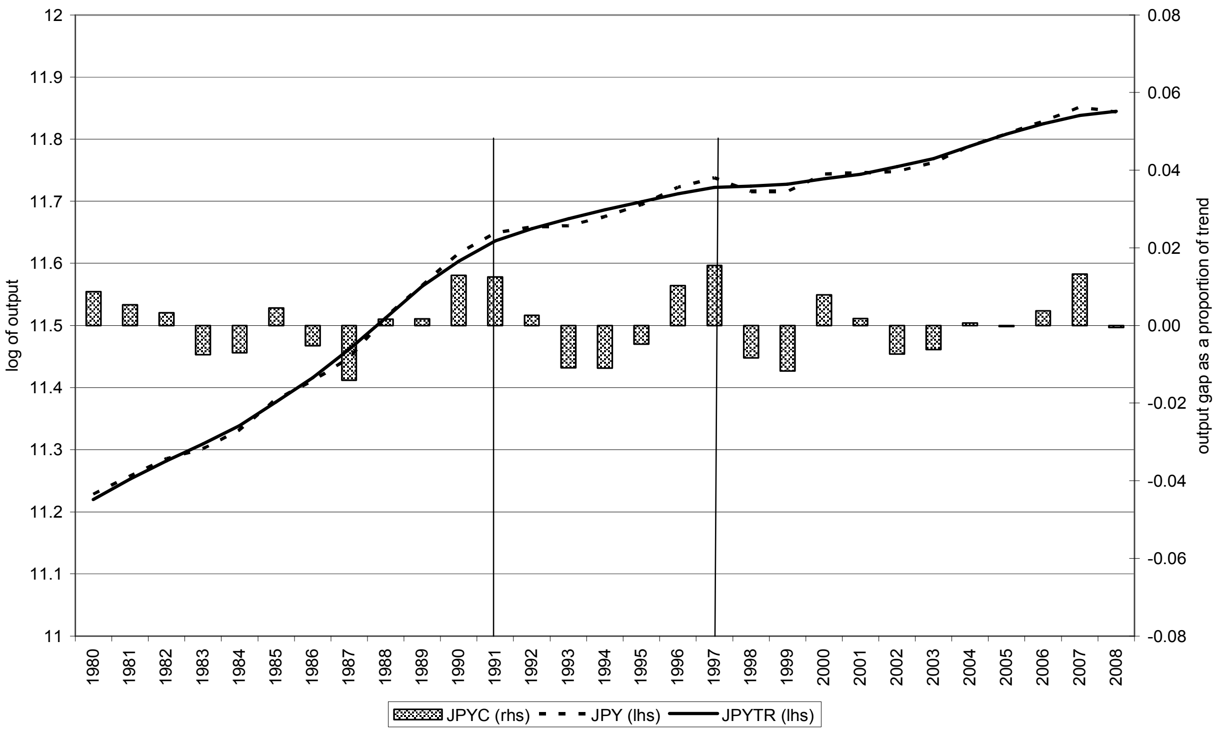


Baxter-King Filter based estimates

FIGURE 8: JAPAN

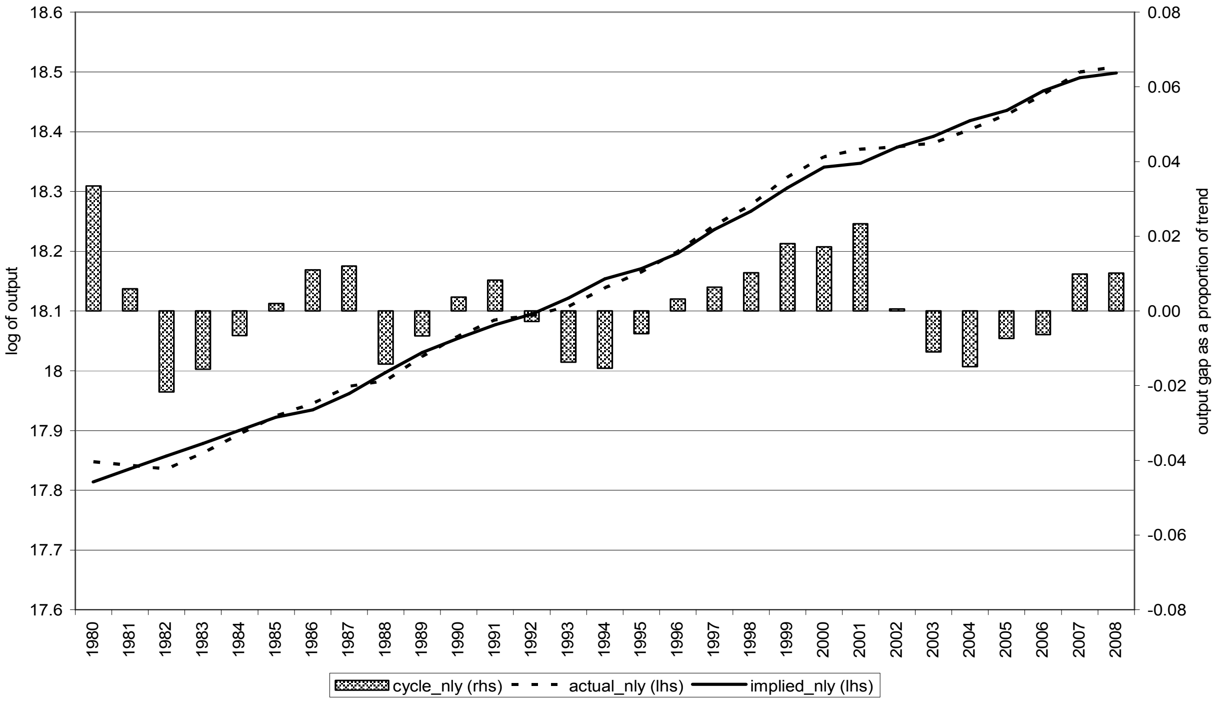


Production function based estimates



Baxter-King Filter based estimates

FIGURE 9: NETHERLANDS



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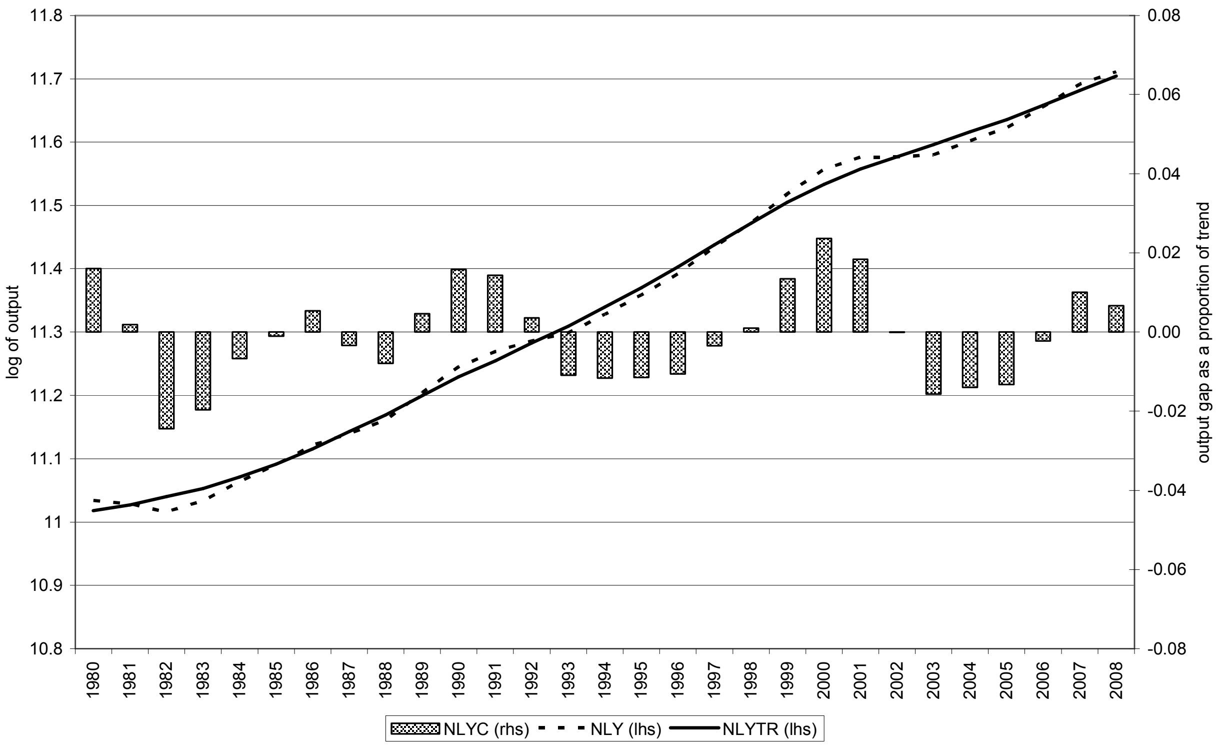
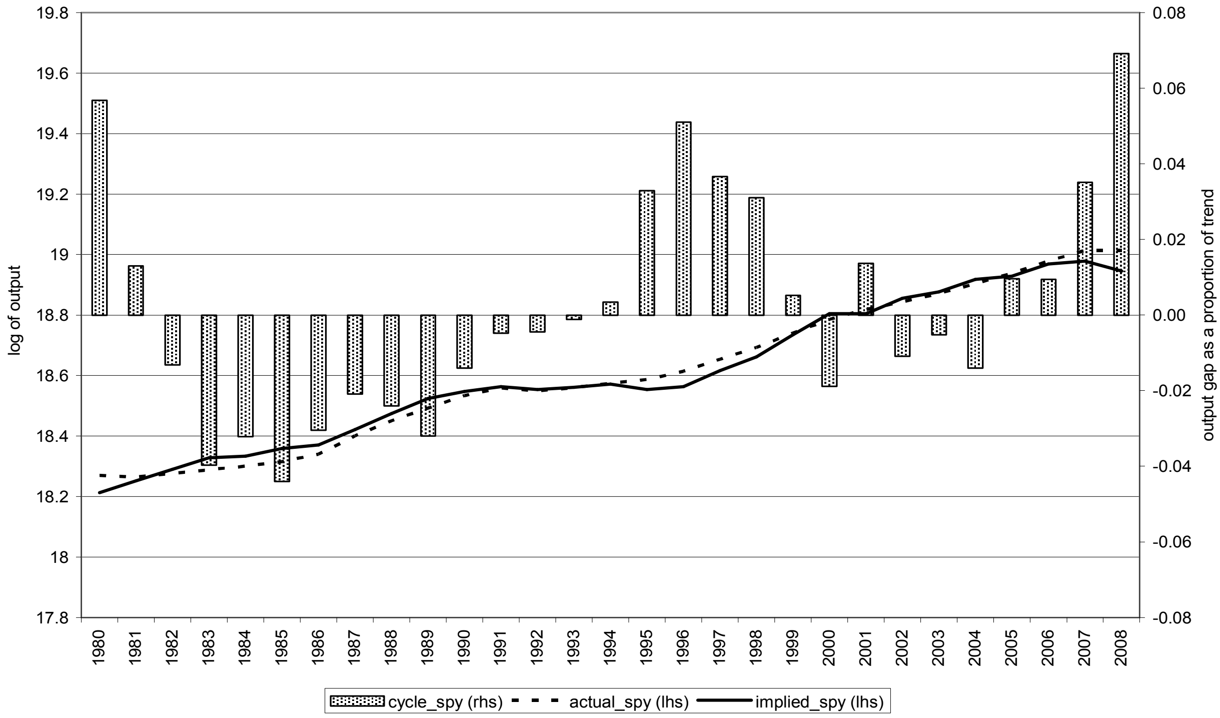
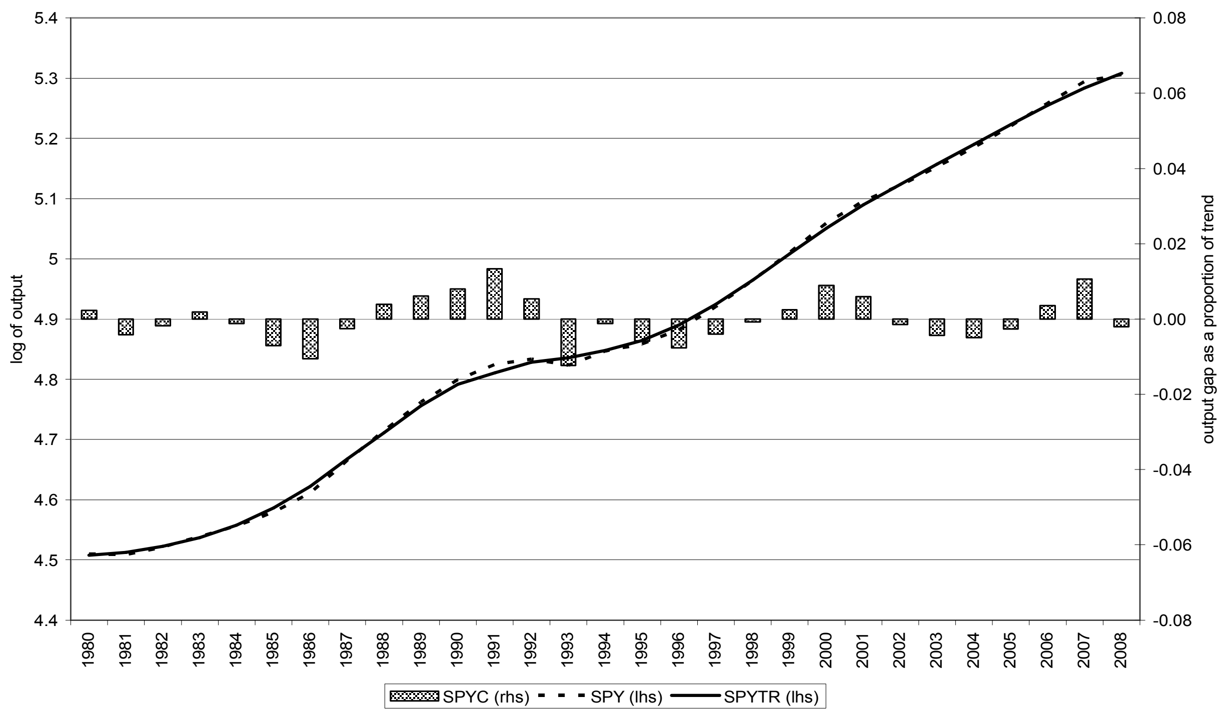


Baxter-King Filter based estimates

FIGURE 10: SPAIN

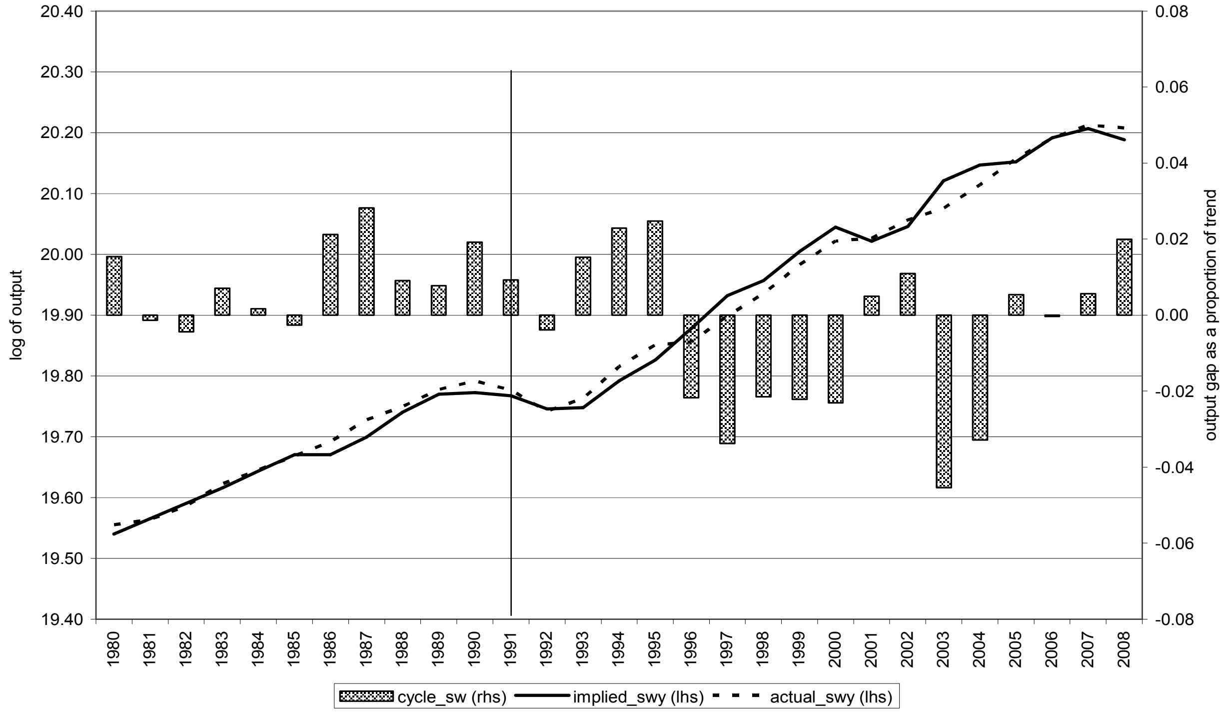


Production function based estimates

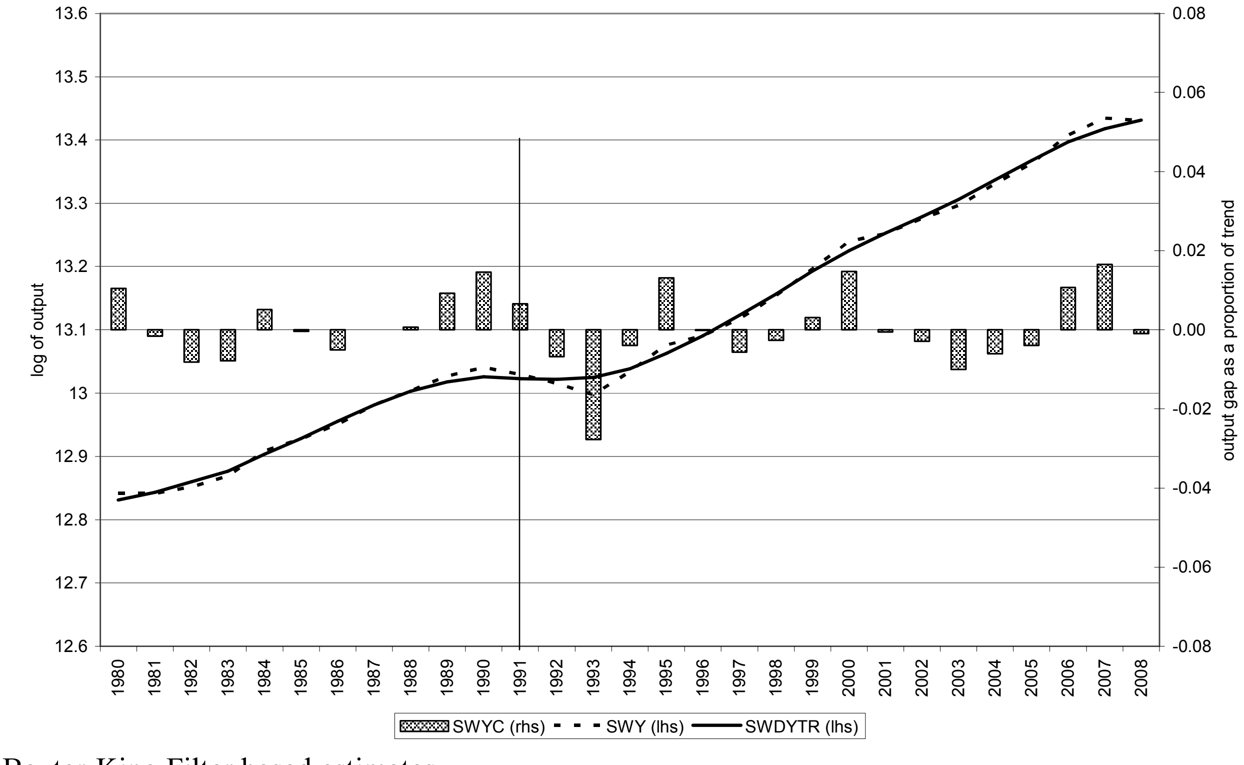


Baxter-King Filter based estimates

FIGURE 11: SWEDEN

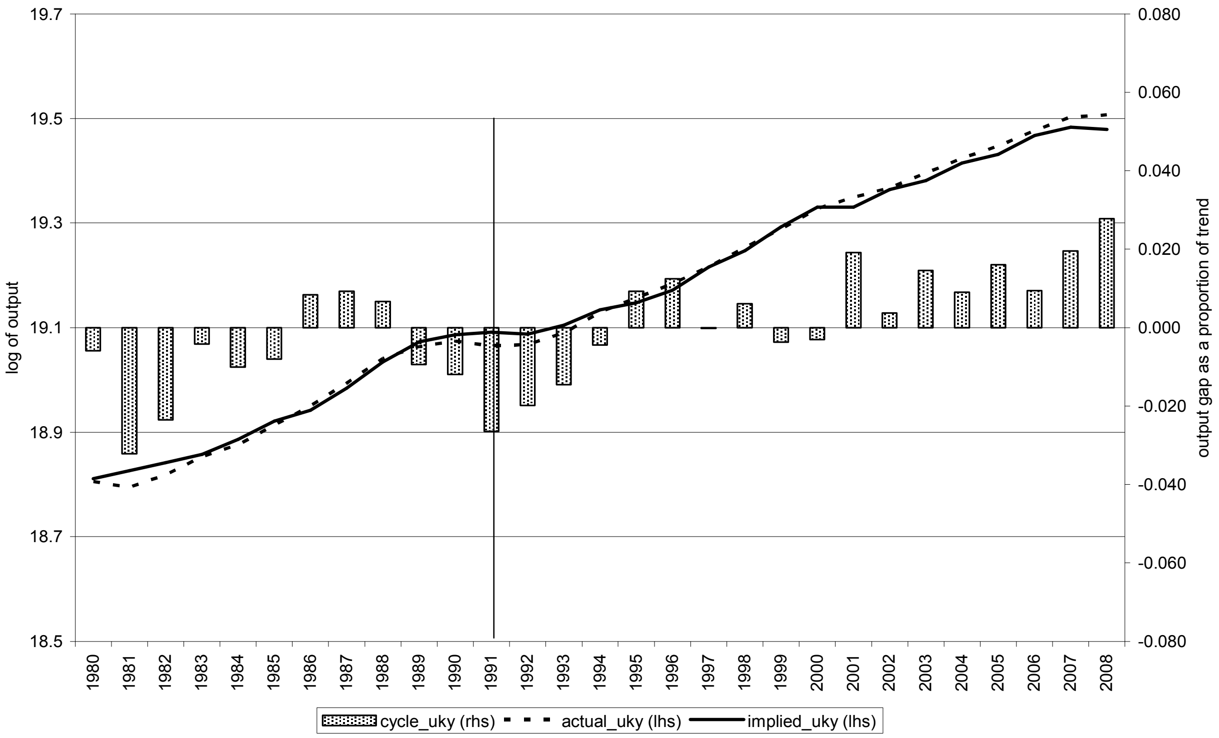


Production function based estimates

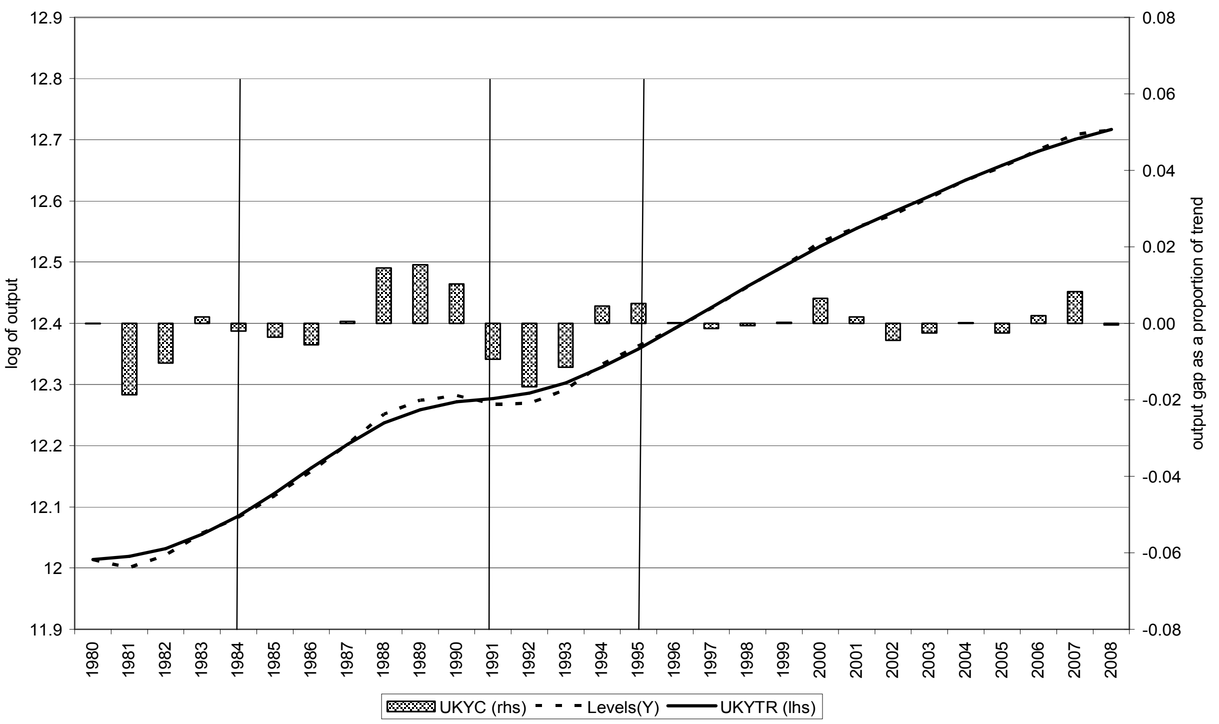


Baxter-King Filter based estimates

FIGURE 12: UNITED KINGDOM

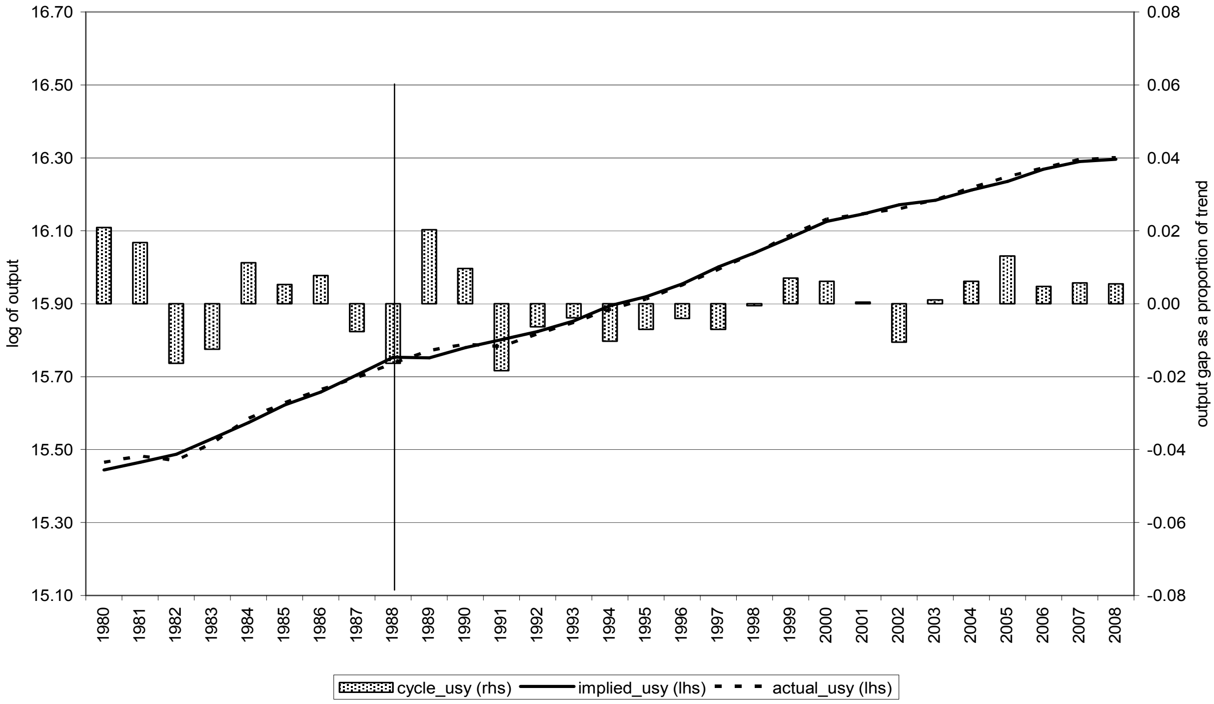


Production function based estimates

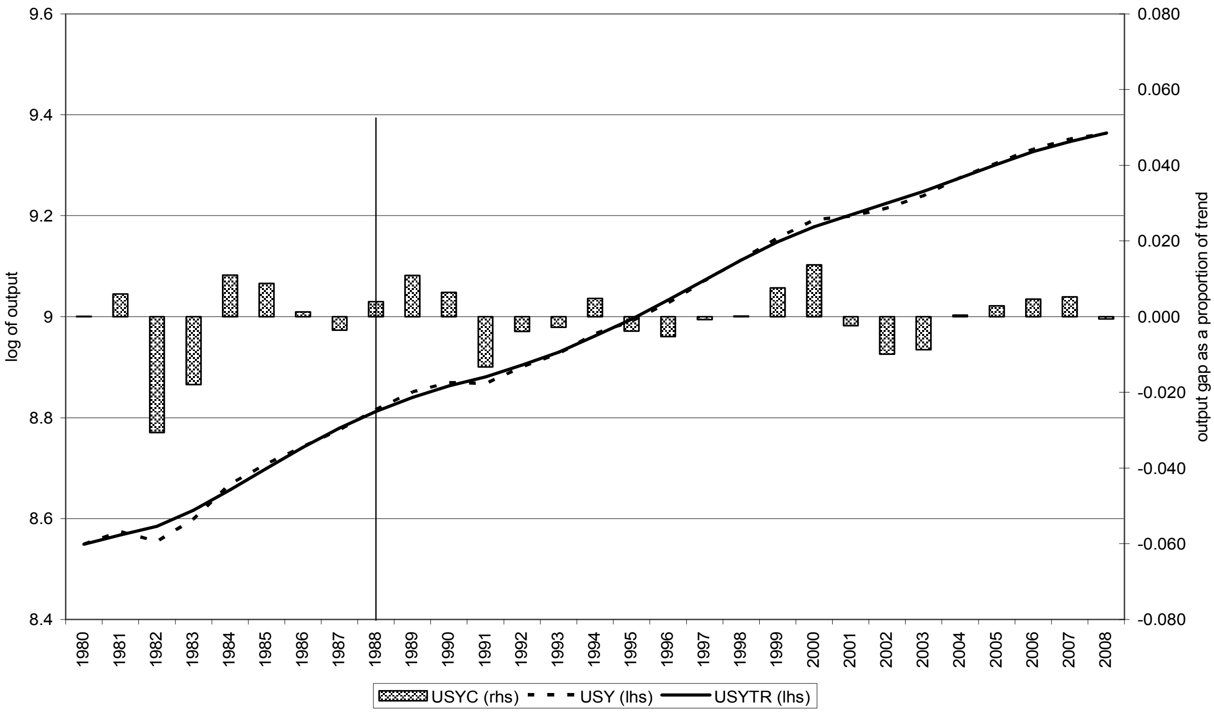


Baxter-King Filter based estimates

FIGURE 13: UNITED STATES



Production function based estimates



Baxter-King Filter based estimates

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Appendix :1

Table A1: Recessions with and without banking crises with Baxter-King filter trend to 2008

Country	Start	Cumulated Depth	Duration in years	Banking crisis
Belgium	1993	-0.032	2	
	2002	-0.022	4	
Canada	1982	*-0.045*	2	1983
	1986	-0.010	2	
	1991	-0.041	3	
	1996	-0.020	3	
	2002	-0.012	3	
Denmark	1981	-0.037	4	1987
	1989	-0.007	3	
	1998	-0.005	2	
	2002	-0.025	4	
Finland	1984	-0.033	4	**1991**
	1991	*-0.064*	*4*	
	2002	-0.028	4	
France	1983	-0.050	5	1994
	1993	-0.056	6	
	2003	-0.015	3	
	2003	-0.036	3	
Italy	1982	-0.030	6	1990
	1993	-0.021	2	
	1998	-0.013	2	
	2003	-0.017	3	
Japan	1983	-0.014	2	**1991**, **1997**
	1986	-0.019	2	
	1993	-0.027	3	
	1998	*-0.020*	*2*	
	2002	-0.014	2	
Netherlands	1982	-0.052	4	
	1987	-0.011	2	
	1993	-0.048	5	
	2002	-0.045	5	
Spain	1981	-0.006	2	
	1984	-0.021	4	
	1993	-0.032	6	
	2002	-0.013	4	
Sweden	1981	-0.017	3	**1991**
	1985	-0.005	2	
	1992	*-0.038*	*3*	
	1996	-0.008	3	
	2001	-0.024	5	
UK	1981	-0.029	2	1984, 1991, 1995
	1984	*-0.011*	*3*	
	1991	*-0.037*	*3*	
	1997	-0.002	2	
	2002	-0.007	2	
USA	1982	-0.049	2	**1988**
	1991	-0.020	3	
	1995	-0.010	3	
	2001	-0.021	3	
average loss per recession year		-0.008	3.2	

Note; Based on NiGEM model; systemic crisis in bold; recessions lasting from 2 to 6 consecutive years are included

APPENDIX 2: THREE RECENT STUDIES IN DETAIL

Article	Sample	Definition of output loss	Methodology	Results
Furceri D.and Mourougane A (2009), "The effect of financial crises on potential output: new empirical evidence from OECD countries"	• (1960-2007); • unbalanced panel of 30 OECD countries; • crises obtained from Laeven and Valencia (2008)	• authors wish to avoid g_i (potential output) estimates obtained via two-sided filters as this underestimates the crisis impact. Instead, g_i obtained from OECD whose measures are based on direct estimation of a production function. Authors check OECD g_i estimates using a H-P filter for robustness.	To see the impact of crises on potential output • univariate autoregressive growth equation (Cerra, V and S Saxena (2008) methodology) • $g_{it} = \alpha_i + \sum^4 \beta_j g_{i,t-j} + \sum^4 \delta_j D_{i},_{t-j} + \varepsilon_{it}$ where g is annual growth of potential GDP;D-crisis dummy (1 at start of crisis, 0 otherwise) and α is country fixed effects • restriction to 4 lags because additional lags were insignificant • impulse response functions (IRF) generated by shocking the crisis dummy where contemporaneous impact on g_{i0} is δ_0 and the one year ahead cumulative effect on g_{i1} is $(\delta_0 + (\delta_1 + \beta_0\delta_0))$	1. on average, crisis reduces g_{it} by 1.5% 2. H-P based measure of g_{it}: impact of crisis is worse at 2.1% 3. crisis exogeneity is tested: exogeneity assumption holds according to eq $\Pr ob(D_{it} = 1) = F(a + \sum_{j=1}^{4} \beta_j g_{i,t-j} +$ 4. $+ \sum_{j=}^{4} \delta_j D_{i},_{t-j} + \omega_{it})$ 5. omitted variables: possibility that reductions in g_{it} are due to non-financial shocks which have been omitted. Authors use time dummies (Cerra, V and S Saxena (2008)) which are significant, suggesting crises are correlated with time shocks. Consequent impact of crisis on g_{it} is 2%. 6. impact of crisis severity :BIG FIVE are tested and found to decrease g_{it} by 4% (double the average) 7. robustness: estimates may be biased due to inclusion of sub-prime so authors exclude these observations. Results remain robust Notes: crisis episodes never specified, countries included not specified

Article	Sample	Definition of output loss	Methodology	Results
Stephen G. Cecchetti S., Kohler M., and Upper C. (2009), "Financial crises and economic activity"	• 40 crises from Laeven and Valencia (2008) • 35 countries (emerging and developed) • 1980-2007	• authors use output costs which is captured via length of recession; depth of recession and a ratio of cumulative GDP loss over pre crisis GDP • long-term output costs:-use logGDP and trend of logGDP in levels and test for breaks due to crisis	• prediction of length(a) and depth(b) and cumulative output loss (c) of recession due to crisis: 1. test bivariate relationships between a,b,c and standard crisis determinants (e.g. Credit gap, fiscal balance) 2. based on above results, construct a multivariate model 3. use multivariate model to predict length, depth and cumulative output costs of recession due to out-of-sample crises • multivariate model includes 1. policy crisis determinants (e.g. Liquidity support, bank nationalization) 2. external conditions (e.g. Change in trading partner GDP) • estimation of long-term output costs: a simple assessment of whether crises cause a break in the level or trend of log GDP: $\ln y_t = \alpha + \tilde{\alpha} D_t + \beta_t + \tilde{\beta} D_t + \varepsilon_t))$ where D_t=0 if t<crisis date D_t=1 if t>=crisis date	• longer recessions cause deeper recessions which cause an increase in cumulative GDP loss • mean crisis length = 11.4 quarters • mean crisis depth = 8.6 quarters • mean cumulative loss (relative to peak GDP) = 18.4 % • recession length =f((-) GDP growth$_{t-1}$, (+) currency crisis, (-) debt crisis, (+) presence of asset management company) • depth of recession= f((+) currency crisis, (-) sovereign debt crisis; (-) GDP growth$_{t-1}$; (+) presence of asset management company) • cumulative output loss= f((+) sovereign debt crisis; (+) GDP growth$_{t-1}$; (-) regulatory forbearance) • endogeneity: including the contraction period in the estimation of changes to long-run GDP could bias results(GDP level becomes too negative, GDP trend becomes excessively positive) • authors i) ensure post-crisis period starts after contraction , ii) set post-crisis period as 3 tears after crisis start • when crises occur, in most cases: 1. GDP level drops sharply but 2. GDP grows faster for longer periods • if (1) outweighs (2), long-term losses are high. The authors find on average 22 quarters must pass before the higher GDP growth rate compensates the drop in GDP levels. NB, in the final specification external conditions are not important; negative coefficient on sovereign debt crises due to sample: most crises were associated with foreign holdings of domestic debt, which thus meant a debt crisis released resources.

Article	Sample	Definition of output loss	Methodology	Results
Cerra, V and S Saxena (2008): "Growth dynamics: the myth of economic recovery"	• 190 countries • 1960-2001 • unbalanced panel • regional groups: Africa, Asia, Latin America, Middle East, transition countries, Western Hemisphere, Industrial economies • Banking crises from Caprio and Klingebiel (2003)	• aim is to quantify the impact of financial and political crises on output • financial shock = currency, banking or twin crises	• use methodology of Romer and Romer (1989) who tested impacts of monetary shocks on output. Here, authors test political and financial shocks on output via impulse response functions (IRF) • IRFs are also conducted after partitioning sample to test differential impact of crises on growth depending on income or region • use the Nelson and Plosser (1982) autoregressive univariate model of GDP growth which accounts for nonstationarity and serial correlation • $g_{it}=a_i+\text{sum}(b_i g_{i,t-j})$ (1) where g=%change in real GDP • AR(4) is selected because additional lags are insignificant • this baseline model in then extended to include the current and lagged impact of the shock (see eq(2) in notes) • impulse response functions (with 1 standard deviation error bands derived from 1000 Monte Carlo Simulations) quantify the response of g to each crisis type • conduct similar analyses on disaggregated samples to check for differential effects of income and region • exogeneity – to test the possibility that low growth can cause crises, crises are modelled as functions of past growth which go on to influence future growth	impact of banking and currency crises only • impulse responses 1. banking crises exact negative and persistent losses on output: average =7.5%, reaching a trough in 5 years and showing remarkable persistence of losses, averaging 6% of GDP at 10 years 2. twin crises exert the biggest cost: average loss at trough is 10-11% and still 10% below trend after 10 years • distribution of shocks: 1. financial crises occur twice as often in low income countries than high income counties 2. since output costs are unconditionally higher for low-income countries, higher crisis probabilities compound output losses further • robustness checks- alternative crisis dates and growth estimates do not change the underlying results. • – lower GDP growth causes a higher crisis probability in the same year. Therefore estimating output losses by assuming exogenous crises overstates the extent of loss. Note: Eq(2) $g_{it} = \alpha_i + \sum_{j=1}^{4} \beta_j g_{i,t-j} + \sum_{s=0}^{4} \delta_s D_{i,t-s} + \varepsilon_{it}$

APPENDIX 3: DATA DESCRIPTIONS

Data Sample:

We conduct our analyses on 13 OECD countries which are listed in Table A3.1. The sample period covers the years 1980 to 2008.

Table A3.1: Cross-Sections Included in Sample

Belgium (BG)	Japan (JP)
Canada (CN)	Netherlands (NL)
Denmark (DN)	Spain (SP)
Finland (FN)	Sweden (SW)
France (FR)	United Kingdom (UK)
Germany (GE)	United States (US)
Italy (IT)	

Dependent Variable:

Output per Person Hour: Constructed using equation 1:

$$\ln\left(\frac{Y_t}{E_t H_t}\right) \qquad \text{(eqn. 1)}$$

where

Y_t is output. We use real GDP measured at basic prices to remove the different cross-sectional effects of indirect taxes.
E_t represents the units of labour. We use the total number of people employed.
H_t represents hours worked. We use the total hours worked by an average employee per week.

Independent Variables:

R&D: research and development expenditure as a % of GDP. This is a stock variable that has been computed by assuming a common 15% rate of depreciation of patents across all countries.

FDI: foreign direct investment as a % of GDP

Openness: exports plus imports as a % of GDP

User: the user cost of capital which is estimated using the standard Hall-Jorgensen formula in equation 2 (see Barrell et al, 2008 for further discussion on the user cost of capital):

$$user_t = \frac{\frac{pdk_t}{py_t}\left[c + kdep_t - \Delta \ln\left(\frac{pdk_t}{py_t}\right)^e\right]}{1 - ctaxr_t} \qquad \text{(eqn. 2)}$$

where

pdk_t is the investment deflator
py_t is the GDP deflator
c is the weighted average cost of capital (see Brealey and Myers, 2000) which takes into account the costs of debt and equity finance and thus represents the real costs of funds for a firm.
$kdep_t$ is the depreciation rate
$ctaxr_t$ is the corporate tax rate.

Country Specific Data Issues:

Where possible, each series was constructed using common data sources for all countries. These sources are listed in Table A3.2. For some countries, a small number of missing data required the use of alternative data sources which are also specified in Table II. For all countries, data inconsistencies were not an issue apart from Norway which requires special mention.

Table A3.2: Data Sources		
Variable	Main Source	
Output (Y)	BG, CN, DN, FN, FR, GE, IT, JP, NL, SP, SW, UK, US	NiGEM
Employment (E)	BG, CN, DN, FN, FR, GE, IT, JP, NL, SP, SW, UK, US	NiGEM
Hours (H)	BG, CN, DN, FN, FR, GE, IT, JP, NL, SP, SW, UK, US	NiGEM
Research and Development (R&D)	BG, CN, DN, FN, FR, GE, IT, JP, NL, SP, SW, UK, US	OECD
Foreign Direct Investment (FDI)	BG, CN, DN, FN, FR, GE, IT, JP, NL, SP, SW, UK, US	Foreign Direct Investment Database, UNCTAD
User Cost of Capital (U)	BG, CN, DN, FN, FR, GE, IT, JP, NL, SP, SW, UK, US	Nigem
Openness	BG, CN, DN, FN, FR, GE, IT, JP, NL, SP, SW, UK, US	NiGEM

Table A3.3: Crisis onset dates in our paper and sources

Crisis	Costs paper	WB	LV	DD	CK systemic	CK non systemic	BD
Belgium	2008						2008
Canada	1983	1983				1983	
Denmark	1987	1987				1987	
Finland	1991	1991	1991	1991	1991		
France	1994, 2008	1994				1994	2008
Germany	2008						2008
Italy	1990	1990				1990	
Japan	1991	1991	1997	1992	1991		
Netherlands	2008						2008
Sweden	1991	1991	1991	1990	1991		
UK	1984, 1991, 1995, 2007, 2008	1984, 1991, 1995	2007			1984, 1991, 1995	2008
US	1988, 2007, 2008	1988	1988, 2007	1980		1984	2008

WB – World Bank (2003)
LV – Laeven and Valencia (2007)
DD – Demirguc Kunt and Detragiache (2005)
CK – Caprio and Klingebiel (2003)
BD – Borio and Drehmann (2009) – definition 1