Banking crises and optimal bank regulation

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Abstract. The recent financial crisis has seen the end of the *Great Moderation* and can be expected to raise risk premia used in investment decisions over the next decade or more. This will mean that the crisis will leave a scar on the level of output in all OECD countries, and this may be as large as six per cent of GDP. Although the crisis was driven by unwise lending in the US in combination with complex balance sheet structures that hid significant risks, we show that increased capital and liquidity standards in the financial system would have reduced the risk of a crisis. Increased capital and liquidity raise bank costs and therefore the costs of bank borrowing. This in turn affects the user cost of capital and reduces equilibrium output. This loss is to be offset against the gains from any crisis probability reduction that higher standards might have brought. We suggest that tighter standards in the UK may well have been of value.

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Introduction

The last two years have seen a major financial crisis engulfing the major economies. It has caused both a severe recession and a re-evaluation of prospects for output in the medium to long term. In the first section of this paper we discuss the determination of the level of output in the medium term, focussing on supply side elements. We argue that the crisis, and the consequent re-evaluation of risk premia, will reduce the equilibrium capital output ratio and the equilibrium level of output. We may see these as the major costs of the crisis. In the second section we discuss the factors that affect the probability of crises, concentrating on new results that bring out the importance of both off balance sheet items and regulation related indicators such as capital and liquidity indicators and housing market bubbles. These results suggest that the probability of a crisis, and hence its costs, could have been reduced by regulatory actions. It is useful to evaluate the costs of those changes in regulation, and in order to do that we evaluate the factors affecting the cost of bank borrowing by the corporate sector, and the links between bank borrowing costs and the costs of issuing corporate bond. These relationships are then embedded into a multi-country structural macro model, NiGEM, in order to evaluate the impacts on output of an increase in bank lending margins. Given we can evaluate the benefits from tighter regulation as well as its costs, we conclude by beginning to evaluate the optimal level of regulation.

Long run equilibrium of the economy and the user cost of capital

Economists think of output being determined, at least in the long run, by factor inputs and technology and not by demand. It is common to summarise these factors into a production function, and we may write this in Constant Elasticity of Substitution (CES) form as

$$Q_t = \gamma \left(\delta K_t^{-\rho} + (1-\delta)(L_t \, e^{techl_t})^{-\rho}\right)^{-1/\rho}$$

Where Q_t is output, K_t is capital input, L_t is labour input and labour augmenting technical progress is denoted $techl_t$. There is some evidence that the elasticity of substitution, $\sigma = 1/(1+\rho)$ is around 0.5 (see Barrell and Pain 1997). We may write the associated cost minimising factor demands as

$$\text{Log}\,(K_t/Q_t) = a_1 + \sigma \,\text{Log}\,(user_t)$$

$$\text{Log}\,(L_t/Q_t) = a_2 + \sigma \,\text{Log}\,(rwage_t) + techl_t$$

Where $rwage_t$ is the real wage per unit of labour input and $user_t$ is the user cost of capital at t. We calculate the user cost of capital according to a standard Hall-Jorgensen formula:

$$user_t = \frac{pdk_t}{py_t}\left[c_t + kdep_t - \Delta \ln\left(\frac{pdk_t}{py_t}\right)^e\right] \Big/ (1 - ctaxr_t)$$

where *pdk* is an investment deflator, *py* is the GDP deflator, *c* is the real cost of finance, *kdep* is the depreciation rate, *e* denotes expectations and *ctaxr* is the corporate tax rate. The real cost of finance as defined by Brealey and Myers (2000)., c_t, can be written as the weighted average cost of capital,

$$c_t = b_{1t}(E_t/P_t) + (1-b_{1t})\,(c_{1t}\,(lrr_t+corpw_t)+(1-c_{1t})\,(lrr_t+iprem_t))*(1-ctaxr_t)$$

This weights together the cost of equity finance (r_E), which depends on the earning price ratio ((E/P) and cost of debt finance (r_D). The weights are given by the share of capital in the economy that is listed on the stock market which we denote b_1. The cost of debt finance follows from the average of bank and corporate bond borrowing costs, where c_{1t} is the share of borrowing that comes from banks. Borrowing costs are adjusted by the corporate tax rate, reflecting the tax deductibility of borrowing. It is calculated as the risk-free long real interest rate (lrr_t), plus a measure of corporate spreads ($iprem_t$) and corporate bank borrowing margins for ($corpw_t$). In our analysis below corporate spreads are calculated as the absolute difference between average corporate bond yields and yields on 10-year government bonds[2]. In general we can expect bank borrowing costs and bond spreads to move together, because if one source of finance becomes more expensive then firms can substitute into the other. However, we do not see borrowing and equity sources as perfect substitutes, as would be the case in a Modigliani Miller world, as such a world precludes the existence of banks.

A 10 percent rise in the user cost of capital (from 10 to 11 per cent say) reduces the equilibrium capital output ratio by 5 per cent and as long as labour supply is fixed then equilibrium output will fall by a about half of this amount, depending upon the elasticity of substitution and the elasticity of output with respect to capital. Hence equilibrium capital will fall by around 7 1/2 percent. If the user cost of capital falls in a trend-like way, as it did from the early 1990s to around 2005 (see Barrell, Holland, Liadze and Pomerantz, 2009), then we might see a period of capital deepening. The resulting increase in the capital–output ratio raises the level of output and hence, for a period, the rate of output growth. The *Great Moderation*1 led to a gradual fall in risk premia, and hence the margin charged on risky investments as compared to risk-free government borrowing, and appeared to have enhanced prospects for growth. Barrell, Holland Liadze and Pomerantz (2008) suggest that capital deepening contributed about 0.3 per cent to labour productivity growth between 1998–2005. Given the turbulence in financial markets, in the medium term we would not expect to see capital deepening generated by a further decline in the user cost of capital.

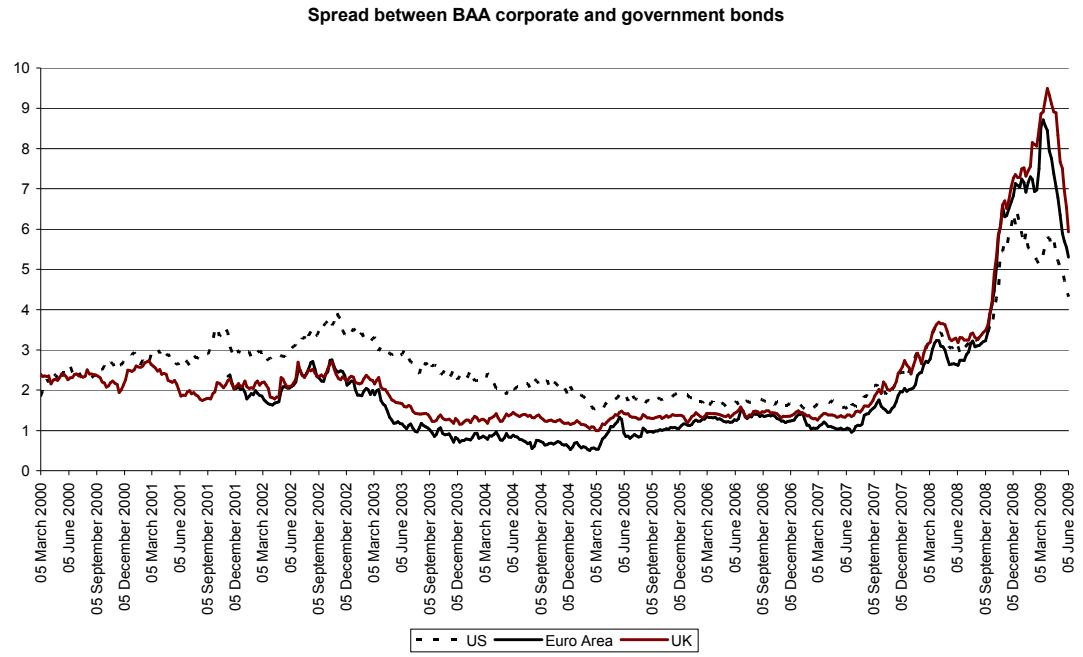
There were perhaps two major structural changes in 2007 and 2008 associated with a significant increase in risk premia, as we can see from Figure 1. Barrell and Kirby (2008) argued in early September 2008 that the increase in risk premia we had seen after the start of the crisis in mid-2007 would reduce the level of sustainable output in the UK by 1½–2 percentage points or perhaps more. Their estimate was based on the observed increase of 200 basis points over this period in the BAA spread for corporate bonds over risk-free government bonds. They suggested this would raise risk premia going forward and therefore increase the user cost of capital and hence reduce equilibrium output.

The near-collapse of the UK and other banking sectors in the wake of the failure of Lehman Brothers in mid-September led to an increase in risk premia well beyond the

[2] These data are available for the Euro Area, US, UK, and Denmark. Sweden is assumed to follow the corporate spreads for Denmark. Prior to 1984, the UK spread is assumed to move in line with the US, prior to 1994 the spread for Denmark is assumed to move in line with the US and UK average, and prior to 1999 Euro Area spreads is assumed to move in line with a proxy measure for Germany.

scenario reported in Barrell and Kirby (2008). Currently, we would double our estimate of the effect of the financial crisis on trend output via the impact of risk premia. In estimating the overall effect on trend output we must also take into account other factors. Of particular importance is the oil price. A permanent reduction in the oil price should boost trend output. If the sharp falls in oil prices experienced since July 2008 are permanent, then the net change in the level of trend output will be less than the increase in risk premia suggests, and we project a level of scarring from these sources of around 3–4 per cent of GDP.

Figure 1 Corporate bond spreads in the UK, the USA and the Euro Area



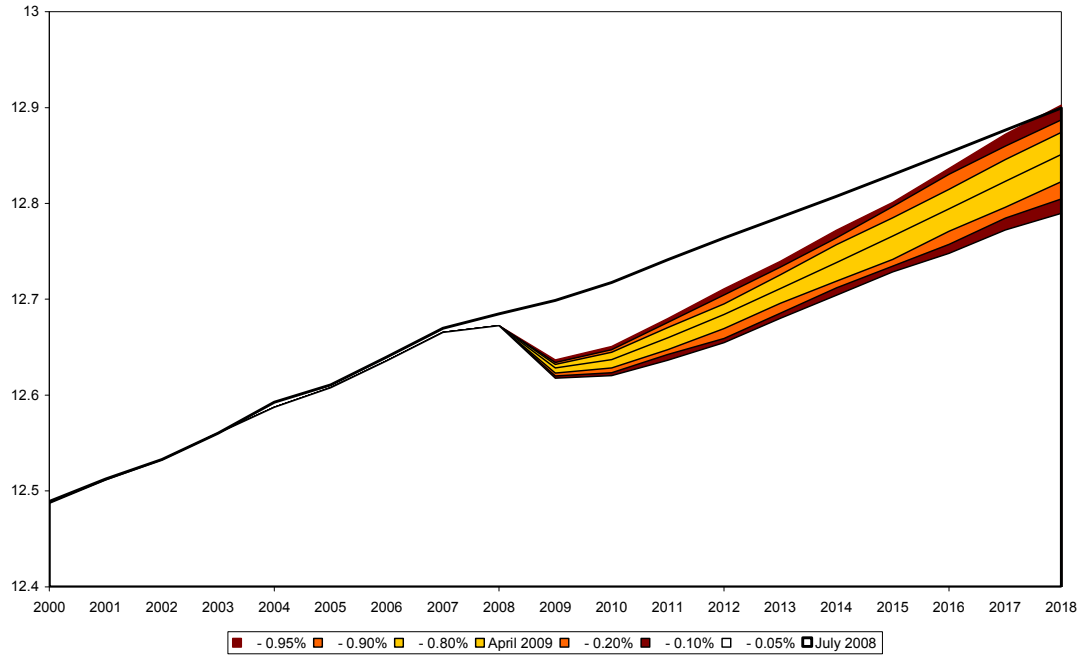
Source Thompson Datastream weekly data

The financial market events of the past two years raise other issues. We have to ask to what extent was the strong growth of the UK economy between 2003 and 2007 the result of the incorrect allocation of temporary capital gains to the income account of the financial sector? Weale (2009) suggests that they were a problem. Although they do not affect our estimates of TFP growth below (since they are for a different period), we have taken account of this going forward. However, the realisation that capital gains can also be reversed suggests we need to mark down our estimate of the sustainable level of output at the end of 2007. Weale (2009) suggests that this markdown should be in the range of 1–2 per cent.

In our April 2009 forecast in the *National Institute Economic Review* we suggested that, in the medium term, output in the UK, the US and the Euro Area would settle down around 4 to 5 per cent below our projection published in July 2008, as we can see from figures 2 to 4. As with all projections we are uncertain about this, and we have included on the chart error bounds generated by stochastic simulations on NiGEM. There is a better than 1 in 20 chance that by 2018 output in the UK will have reverted to the level we projected in July 2008, for instance. There is also a 1 in 20 chance it will be 9 per cent below that level. However, knowing where we were at the end of 2007 and where we expect to be by 2018 does not provide any information

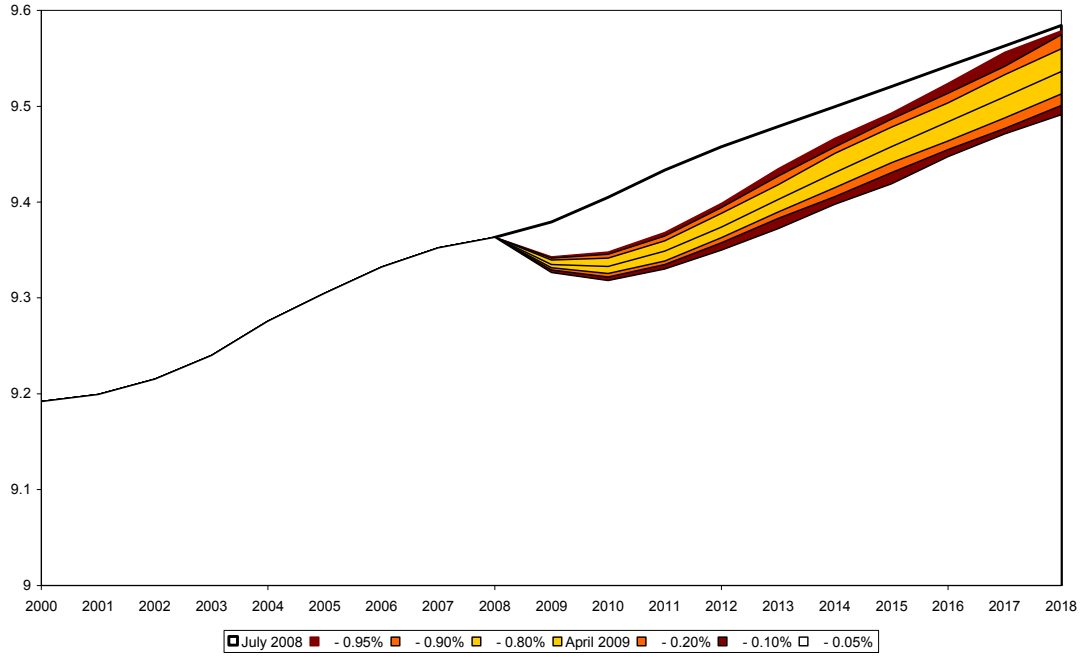
about the speed of adjustment of the capital stock to its equilibrium and hence on the output gap at present. The collapse of world trade in capital and equipment goods, along with declines in car production and in residential and other construction, suggests to us that the adjustment of capital stock is taking place relatively quickly.

Figure 2 Scarring from the Financial Crisis - projections for UK GDP



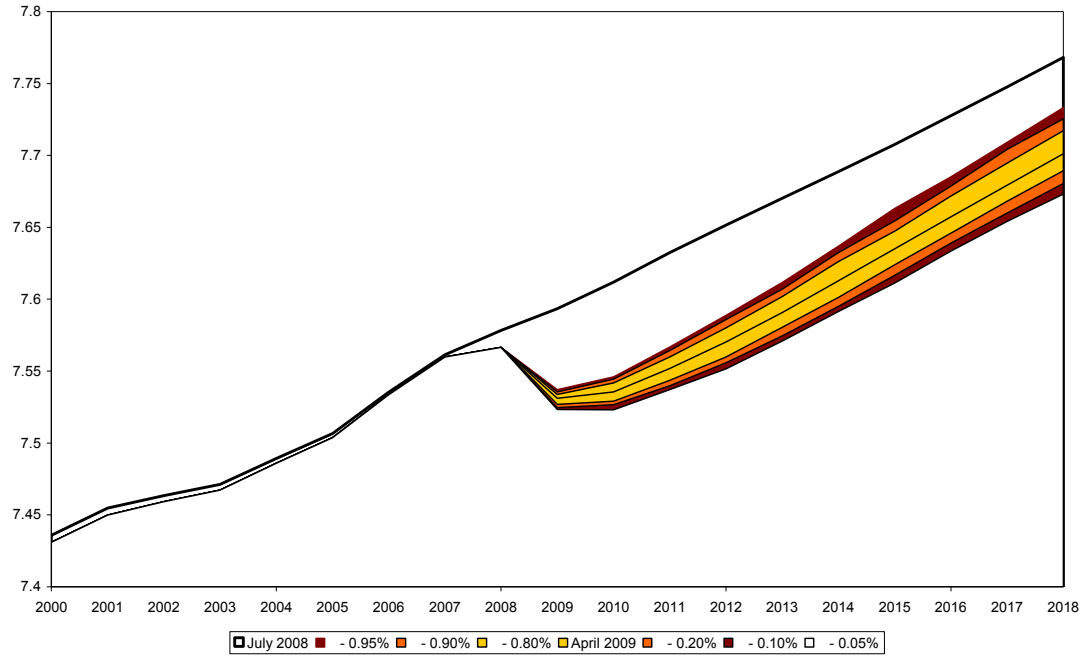
Source Stochastic evaluations around the April 2009 NIER forecast

Figure 3 Scarring from the Financial Crisis - projections for US GDP



Source Stochastic evaluations around the April 2009 NIER forecast

Figure 4 Scarring from the Financial Crisis - projections for Euro Area GDP



Source Stochastic evaluations around the April 2009 NIER forecast

What causes crises – can we reduce the risks

Barrel, Davis, Karim and Liadze (2009) develop an crisis prediction model for OECD economies which ultimately reveals that unweighted capital adequacy (often known as the leverage[3] ratio) and the liquidity ratio alongside real house price growth are the most important crisis determinants of the probability of financial crises in these countries. Moreover, their importance remains invariant to different robustness tests. The paper uses the information they convey to predict the sub-prime episode out-of-sample. Since these variables have hitherto been unexamined, their results have important policy implications for financial regulators and central banks; optimising the liquidity and capital adequacy[4] ratios of banks and suppressing rapid property price growth may well mitigate future OECD crises.

Barrell, Davis, Karim and Liadze (2009) follow Demirguc-Kunt and Detragiache (1998) and use the multivariate logit technique to relate the probabilities of systemic banking crises to a vector of explanatory variables. The banking crisis dependent variable, a binary banking crisis dummy, is defined in terms of observable stresses to a country's banking system, e.g. ratio of non-performing loans to total banking system assets exceeds 10%[5], and it occurs in around 5 per cent of all time and country

[3] Note this definition of the banking leverage ratio (i.e. capital/unadjusted assets) operates contrary to normal concepts of leverage, in the sense that a higher "leverage ratio" means lower "leverage" in an economic sense of debt-to-equity. Accordingly we prefer to use the term "unweighted capital adequacy" to avoid ambiguity.

[4] Note that although for data reasons we use the unweighted capital adequacy ratio, we expect that risk adjusted capital is also a crisis indicator. Our overall view is that both ratios need to be borne in mind in assessing crisis risk.

[5] Their actual criteria are: the proportion of non-performing loans to total banking system assets exceeded 10%, or the public bailout cost exceeded 2% of GDP, or systemic crisis caused large scale

observations in that paper. Their dataset includes 14 systemic and non systemic crises in 14 OECD countries. Information concerning systemic banking crises is taken from the IMF Financial Crisis Episodes database which covers the period of 1970-2007.[6] Non-systemic crises are collected from the World Bank database of banking crises over the period of 1974-2002.[7] The sample covers 14 countries[8]: Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, Netherlands, Norway, Sweden, Spain, UK and the US over the period 1980-2007.

Barrell, Davis, Karim and Liadze (2009) use the unweighted capital adequacy (leverage[9]) ratio and not risk-adjusted capital adequacy for the estimation. The unweighted capital adequacy ratio is the ratio of capital and reserves for all banks to the end of year total assets as shown by the balance sheet. The corresponding measure of liquidity is the ratio of the sum of cash and balances with central banks and securities for all banks over the end of year total assets as shown by the balance sheet. Unweighted capital adequacy and liquidity ratios were constructed using data from the OECD income statement and balance sheet database for all countries apart from the UK. Any missing OECD database observations, as well as the data for 2006 and 2007, were obtained from individual Central Banks and the BankScope[10] database. The OECD database did not supply figures for the UK. The unweighted capital adequacy ratio was defined as for other countries and was constructed using Bank of England aggregate data, and UK liquidity ratios were constructed using Financial Services Authority (FSA) data, where liquidity was defined as the ratio of liquid assets[11] over total assets.

Demirguc-Kunt and Detragiache (2005) found that crises were correlated with macroeconomic, banking sector and institutional indicators. Crises occurred in periods of low GDP growth, high interest rates and high inflation, as well as fiscal deficits. On the monetary side, the ratio of broad money to Foreign Exchange reserves and also the credit to the private sector/GDP ratio, as well as lagged credit growth were found to be significant. Institutionally, countries with low GDP per capita are more prone to crises, as are those with deposit insurance. Barrell, Davis, Karim and Liadze (2009) also include the explanatory variables used by Demirguc-Kunt and Detragiache (2005). In order to obtain their final model specification, they used a general to specific approach. At each stage, they omitted any variables that were insignificant in the previous stages. In order to capture developments in the economy prior to the crisis and to avoid endogenous effects of crises on the explanatory variables all variables were lagged by one period, apart from real house price growth which has 3 lags. They allowed house price growth to have a longer lag because it is an indicator of potential bad lending and consequent defaults that frequently develop as a consequence of a house price bubble. As expected in the context of the OECD, all

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bank nationalisation, or extensive bank runs were visible and if not, emergency government intervention was visible.

[6] See Laeven and Valencia (2007)

[7] See Caprio and Klingebiel (2003)

[8] Choice of the countries is limited by the availability of the data for our time period.

[9] See footnote 3.

[10] For the liquidity measure, the ratio of liquid assets to total assets for the top 200 banks in a country in question was calculated.

[11] Sum of cash, gold bullion and coin, central government and central bank loans, advances and bills held and central government and central bank investments (i.e. securities).

of the "traditional" variables proved insignificant, despite experimentation with different lag lengths. Their final logit model can be written, with LEV denoting the capital adequacy ratio, LIQ denoting liquid assets as a share of total assets and RHPG denoting the rate of change of real house prices, as

$$\log\left[\frac{p(crisis)}{1-p(crisis)}\right] = -0.333\ LEV(-1) - 0.118\ LIQ(-1) + 0.113\ RHPG(-3) \qquad (3)$$

$$(-2.85) \qquad (-3.55) \qquad (2.8)$$

Given these indicators, using data up until 2006 it is possible to say that the probability of a crisis in 2007 was higher than the sample average of 3.2 per cent in a number of countries, and as we can see from Table 1 it was particularly high in the UK where liquidity levels were low and crises had been more frequent than elsewhere in the sample. However, if capital adequacy and liquidity levels had been higher the probability of a crisis happening would have been lower, as we can also see from Table 1

Table 1 Probabilities of the occurance of the crises

	Initial probability of the cirsis in 2007	After 1 percentage point increase in LIQ and LEV	After 2 percentage point increase in LIQ and LEV	After 3 percentage point increase in LIQ and LEV
FR	0.066	0.043	0.028	0.018
GE	0.007	0.005	0.003	0.002
IT	0.035	0.023	0.014	0.009
SP	0.056	0.024	0.023	0.015
UK	0.217	0.150	0.101	0.067
US	0.006	0.004	0.003	0.002

Variables are taken with lag length (based on the model)

Given levels of capital and liquidity in 2006, it would have been possible to reduce the probability of a crisis noticeably, especially in the UK. Increasing the levels of capital and liquidity by one percentage point would have reduced the probability of a crisis in the UK by more than 6 percentage points, and by smaller amounts in other countries. Increasing regulatory requirements further would have reduced the probability further but the returns to increased regulatory standards are clearly declining, with the gains falling 5 per cent in the UK for a move from a one point increase to a two point increase, for instance. We should note that at the start of the crisis capital and liquidity seemed adequate in the US, reflecting the off balance sheet nature of many of the risks. Securitised assets were either missed, or hidden because they appeared to be insured.

What are thee effects of changing regulations

In order to assess the importance of capital adequacy and liquidity in determining the bank borrowing costs it is useful to look at bank balance sheets. We have undertaken an analysis of borrowing costs from banks using the difference between borrowing and deposit rates for non financial corporations (CORPW) for the UK, the US and Germany. This is the mark-up banks charge, and it is likely to reflect both their costs and the risks they face. In each case we investigated the role of corporate insolvencies, (INSOLVR – an insolvency rate) the ratio of liquid to total assets (LIQR) the non-risk weighted capital adequacy ratio (LEVRR) and the difference between this variable and the statutory target, which gives an indication of operational headroom, (HEAD) as well as its inverse (INVHEAD) in order to capture the role of free reserves and allow for some non-linear effects. Table 2 reports on the stationarity of these variables, along with that of the mark up of BAA corporate bonds over risk free long term real interest rates (IPREM) which are plotted in Figure 1 above. Given the short data periods for some series we are willing to accept evidence of stationarity at the 10 per cent level

Table 2 Test statistics from unit root test results on individual series

	Variables in levels			*Variables in first differences*		
	Germany	UK	US	Germany	UK	US
CORPW	*-3.45***	*-2.757**	*-2.755**	-	-	-
IPREM	*-3.97***	*-3.545***	*-3.449***	-	-	-
INSOLVR	*-1.819*	*-1.922*	*-2.431*	*-5.056***	*-2.807**	*-2.929***
LEVRR	*-1.501*	*-2.378*	*-0.692*	*-4.308***	*-3.623***	*-3.903****
INVHEAD	*-5.857****	*-1.666*	*-4.316****	-	*-2.847**	-
LIQR	*0.118*	*-2.518*	*-1.886*	*-5.786****	*-4.626****	*-4.2601****

*Note: *, **,*** indicate significance at 10%, 5% and 1% levels*

In order to avoid spurious regression we either need a set of variables that are I(0), or an I(0) dependent variables and a set of independent variables that form a cointegrating set by themselves. If we have neither if these we would need to work in equilibrium correction form. Fortunately the former conditions are met, as we might expect with mark up variables which are essentially stationary processes.

The general form of estimated single equation is as follows:

$$corpw = a_i + b_i*levrr + c_i*liqr + d_i*insolvr + e_i*invhead + error_i$$

where the lag length on some independent variables vary between countries[12]. Residuals for each country equation are tested for stationary with Augmented Dickey-Fuller test. In all cases presence of a unit root is rejected at least at 10% significance level. Existence of a cointegrating relationship between right hand side I(1) variables was checked with a Johansen's procedure as well. In all cases there is an indication of the existence of a single cointegrating vector. In all three capital adequacy has a significant role in determining the corporate borrowing mark-up, with the smallest

[12] Leverage ratio enters equations for the UK and US with one lag, and German with three lags. Liquidity ratios are lagged once in the US equation.

effect in the US, where equity finance is more easily available for firms. The liquid asset ratio is also significant in the US and Germany, but not in the UK. In that country it had fallen to very low levels anyway and it is not surprising it had no impact on the cost structure. The UK also shows a significant role for the inverse of HEAD, the difference between actual and target capital adequacy. As spare capital disappears lending charges rise relative to deposit rates in order to ration funds and also recoup capital from an increased gross operating surplus. The rate of increase rises as the amount spare reserves fall. The absence of this indicator in the other countries suggests that over the data period they were operating with more spare capital for more of the time.

Table 3 Singe equation estimation results

	Germany	UK	US
Constant	*-0.50* *(-0.31)*	*-1.20* *(-3.09)*	*-0.88* *(-4.06)*
INSOLVR	-	*0.11* *(3.10)*	-
LEVRR	*0.51* *(2.31)*	*0.30* *(9.56)*	*0.18* *(12.42)*
INVHEAD	-	*1.04* *(8.37)*	-
LIQR	*0.05* *(1.78)*	-	*0.09* *(8.88)*

Note: t-stats in parenthesis

Estimation periods *Germany* 1998q1 - 2007q4
UK 1989q2 - 2007q2,
US 1988q1 - 2008q1

Bank borrowing is an alternative form of debt to issuing corporate bonds, and we would expect the spread over the risk free bond rate (IPREM) to move approximately in line with the mark-up up on corporate borrowing. This (testable) assumption follows from a presumption that markets work, and that when bank borrowing costs rise, or when banks credit ration, firms can turn to the bond market, and they will drive the cost of borrowing up until at the margin it reflects the shadow price of bank borrowing. In order to test this proposition we estimated a system of equations looking at the dependence of iprem on corpw using SURE for the UK and the US over the period 1990q1 – 2008Q3. The coefficient for corpw was imposed to be the same for both countries and the validity of the imposition was checked with a Wald test indicating that a common coefficient can be applied.

$$Iprem = c_i + b*corpw,$$

Where c_{uk} *is -1.4 (-4.52),* c_{us} *is -088 (-2. 96)*
and b = 1.07(10.41). t statistics in brackets

These relationships can be embedded into our model NiGEM in order to evaluate the impacts of changing regulations on the equilibrium level of output in the economy

Bank Regulation in NiGEM

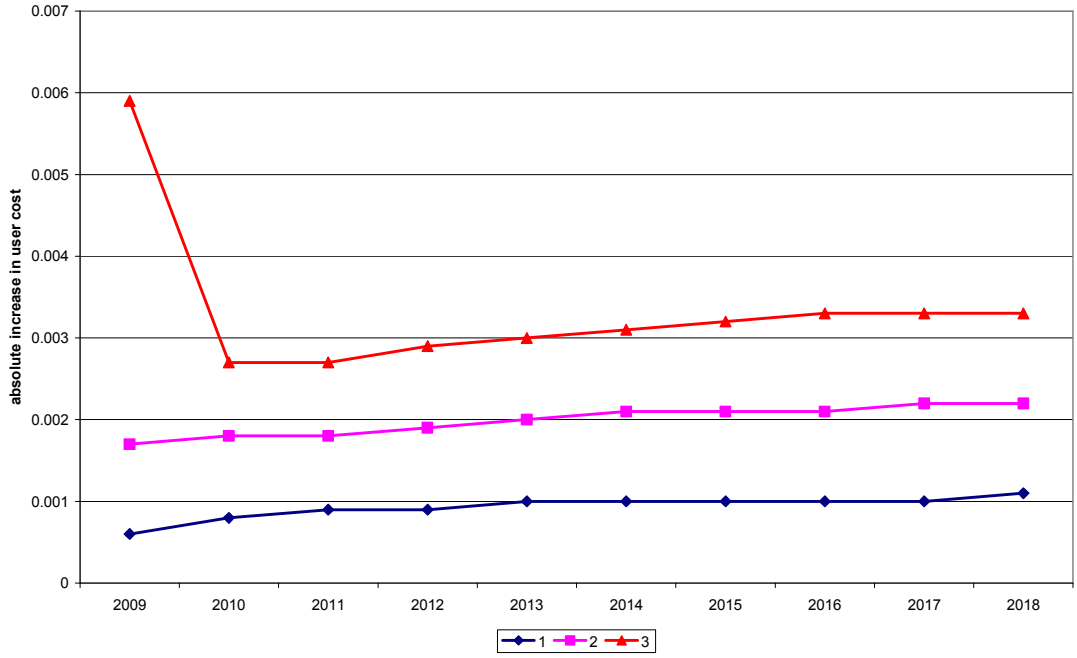
We can utilise these equations in our global macro model NiGEM to evaluate the costs of increased bank regulation. NiGEM, which is described in an annex, is a large scale, global structural model with forward looking exchange financial and labour markets. The production function in each of the countries covered is of the form above, and labour inputs, factor prices, technical progress and the parameters of the production function determine the level of output in the medium term. Inflation is determined by a monetary policy rule. Investment decisions look four years forward and follow from the production function and the cost of capital, whilst the rest of demand is driven by consumption, trade and government behaviour. Although changes in borrowing costs may change consumer behaviour, this will be reflected in the current account rather than in the level of output, at least in small open economies. Hence we do not need to concern ourselves with the effects of bank regulation on consumers, as it does not affect equilibrium output.

Bank borrowing costs and their follow on effects on corporate bond costs affect the user cost of capital on the model, and hence also affect the level of investment and in the long run the equilibrium capital stock We undertake three experiments, raising the capital adequacy target ratio and the liquid assets target ratio both by 1 percentage point, then by two percentage points and finally by three percentage points. Banks build up the increased assets they need by raising their charges and increasing their retentions from their profit margins. The effects on bank's corporate margins are plotted in Figures 4 to 7, whilst the impacts on the user cost of capital are plotted in figures 8 to 10. These effects are not large, and they are essentially linear, except in the case of the UK, where the three point rise in capital requirements takes banks close to their regulatory target and hence causes them to raise costs significantly to ration lending and raise capital.

These change in the user cost impact on the level of the capital stock in equilibrium and hence on the equilibrium level of output, as we can see from figures 11to 13. A one percentage point rise in the target level of the capital adequacy ratio and in the liquidity ratio will reduce equilibrium output by around 0.1 per cent in the UK and by marginally more in the Euro Area. As we can see the effects are approximately linear as we increase the target for capital and liquidity. The effects in the Euro Area are marginally larger because bank and bond finance are more significant in financing investment than they are in the UK and the equilibrium capital output ratio is higher. Conversely the long run effects in the US are around 40 per cent of the impact on the UK, reflecting the relative importance of equity finance in that country. In the short run the impact on the US is marginally positive, as long term real interest rates fall and partly as a consequence equity prices rise. The increase in the equity price stimulates investment rather more in the US[13] than in the UK or the Euro Area, where output monotonically declines, albeit by rather small amounts.

[13] Our estimated capital stock adjustment equation for the US includes a Tobin's q term that affects the speed of adjustment to long run equilibrium, and this changes the path for output in response to shocks

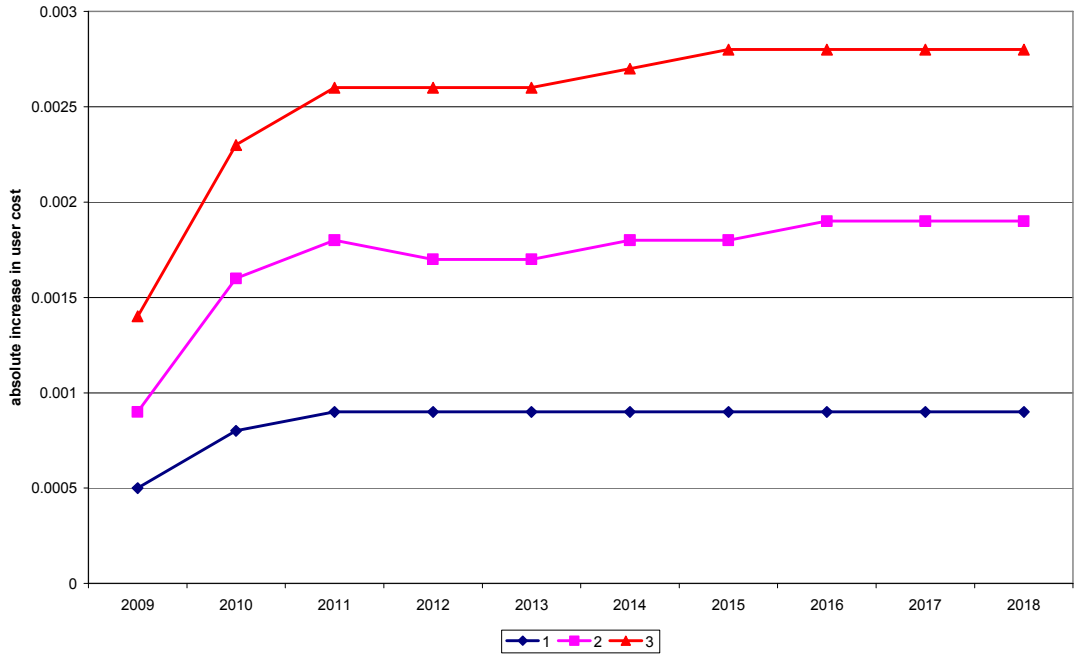
Figure 5 Impacts of increases in capital and liquidity targets on corporate bank borrowing margins in the UK



Increases in ratios by one percentage point (1), two percentage points (2) and three percentage points (3)

Source NiGEM simulations

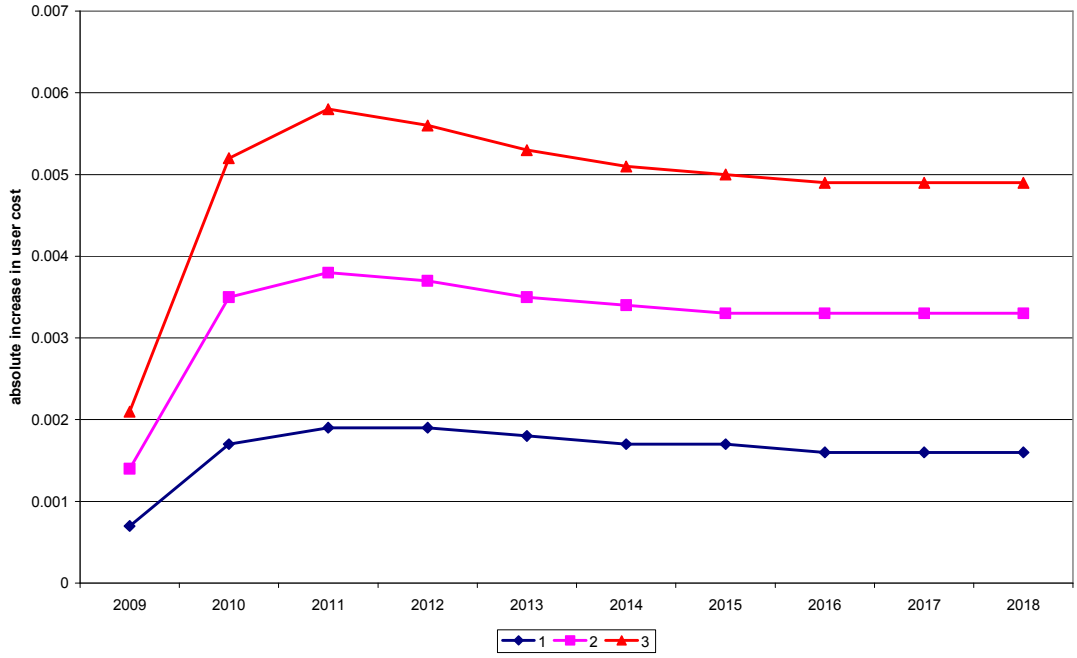
Figure 6 Impacts of increases in capital and liquidity targets on corporate bank borrowing margins in the US



Increases in ratios by one percentage point (1), two percentage points (2) and three percentage points (3)

Source NiGEM simulations

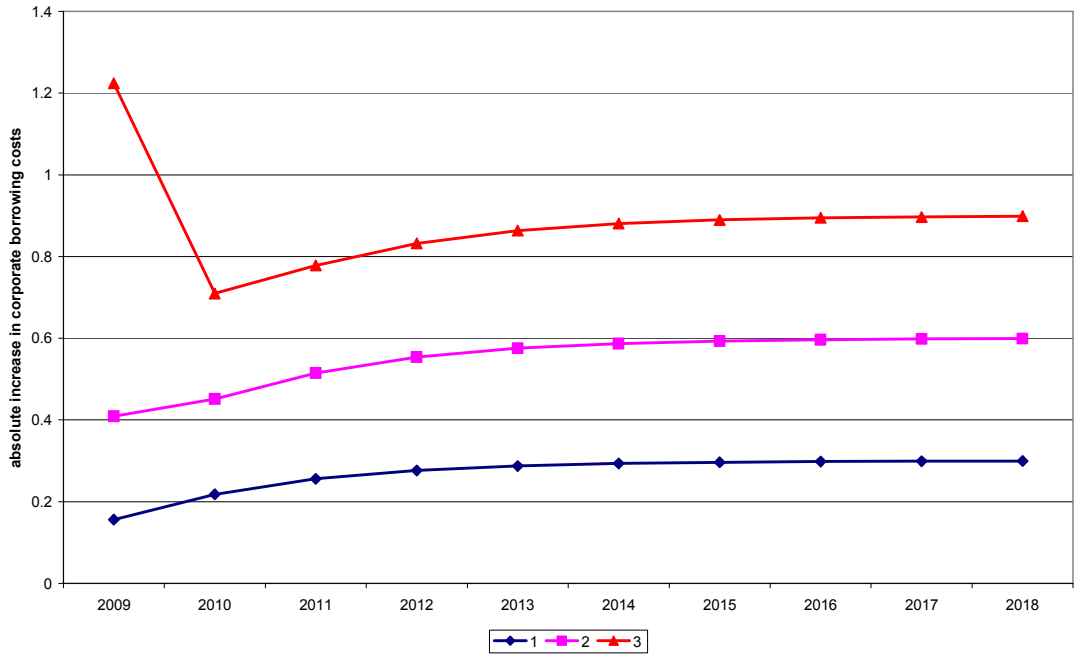
Figure 7 Impacts of increases in capital and liquidity targets on corporate bank borrowing margins in the Euro Area



Increases in ratios by one percentage point (1), two percentage points (2) and three percentage points (3)

Source NiGEM simulations

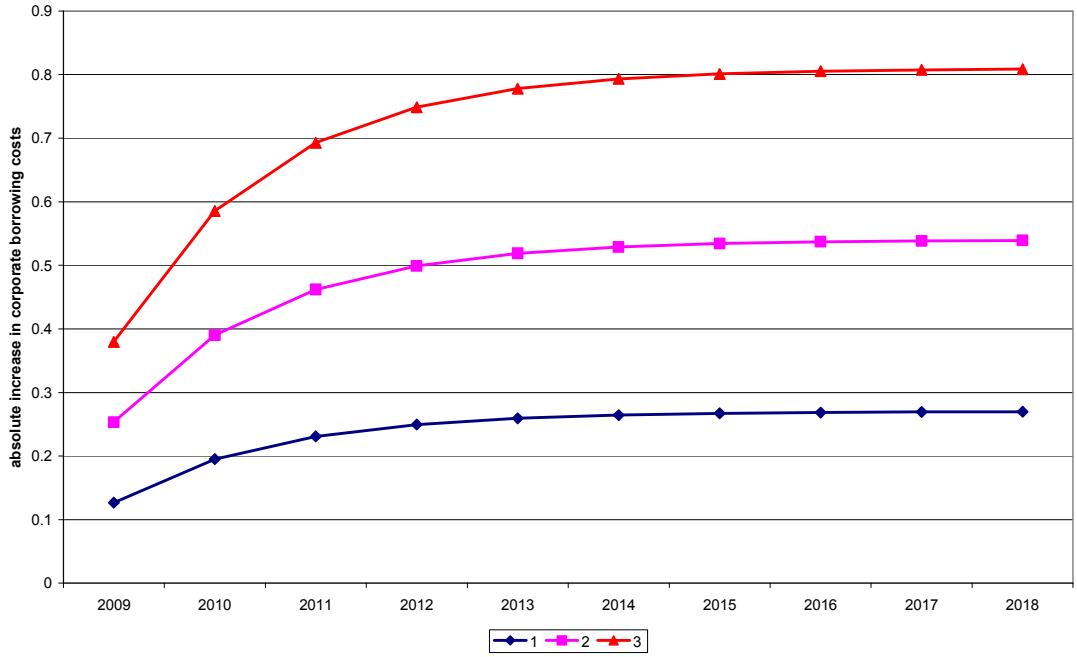
Figure 8 Impacts of increases in capital and liquidity targets on the user cost of capital in the UK



Increases in ratios by one percentage point (1), two percentage points (2) and three percentage points (3)

Source NiGEM simulations

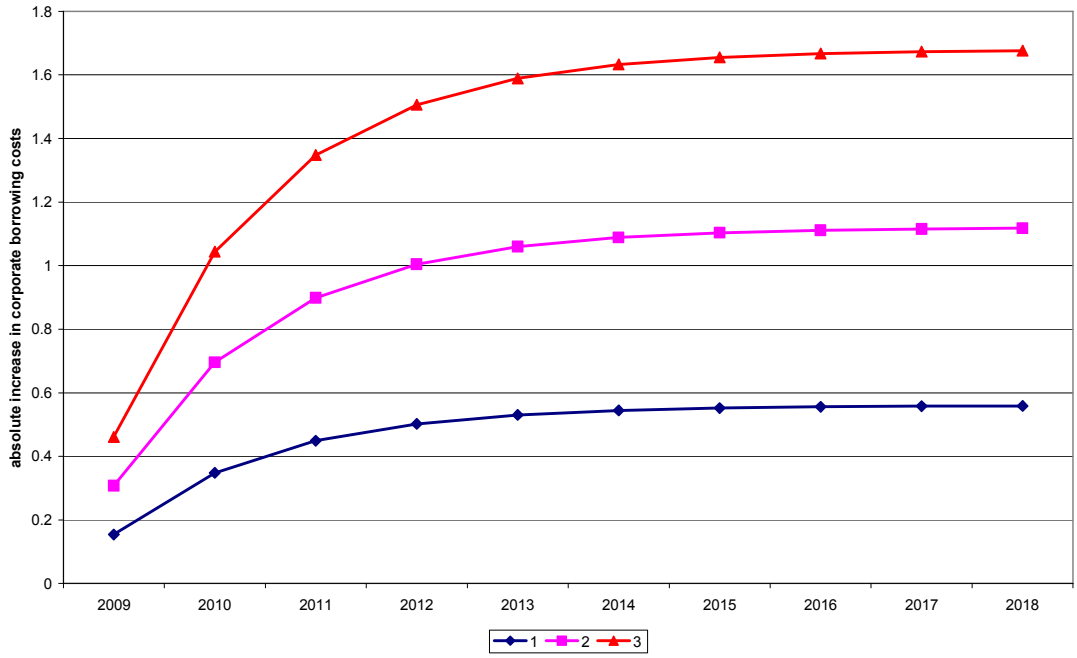
Figure 9 Impacts of increases in capital and liquidity targets on the user cost of capital in the US



Increases in ratios by one percentage point (1), two percentage points (2) and three percentage points (3)

Source NiGEM simulations

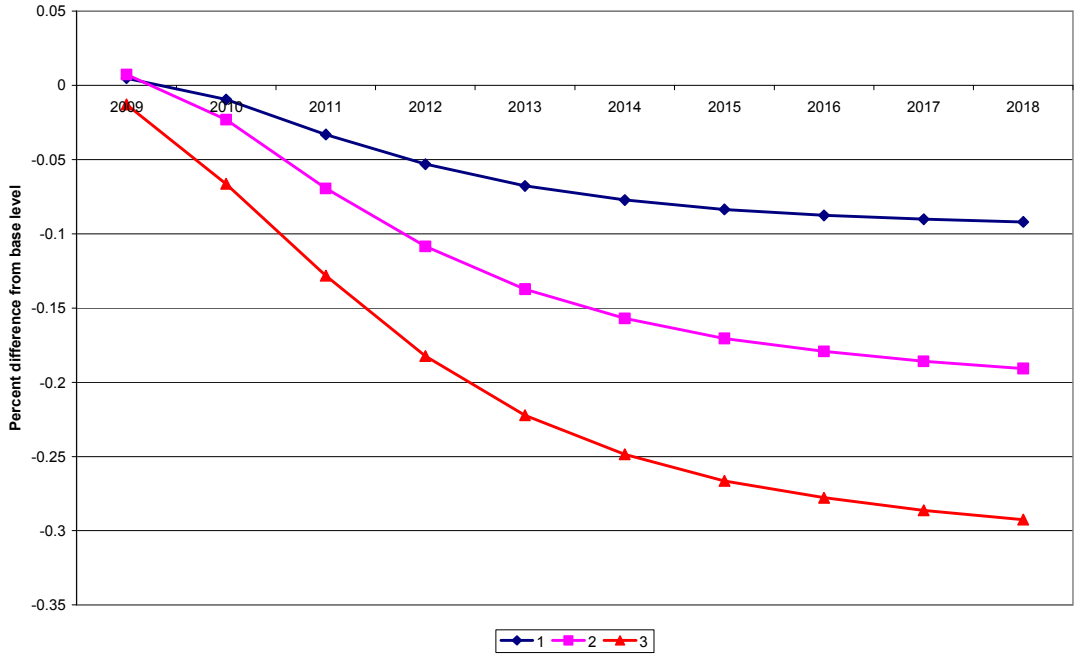
Figure 10 Impacts of increases in capital and liquidity targets on the user cost of capital in the Euro Area



Increases in ratios by one percentage point (1), two percentage points (2) and three percentage points (3)

Source NiGEM simulations

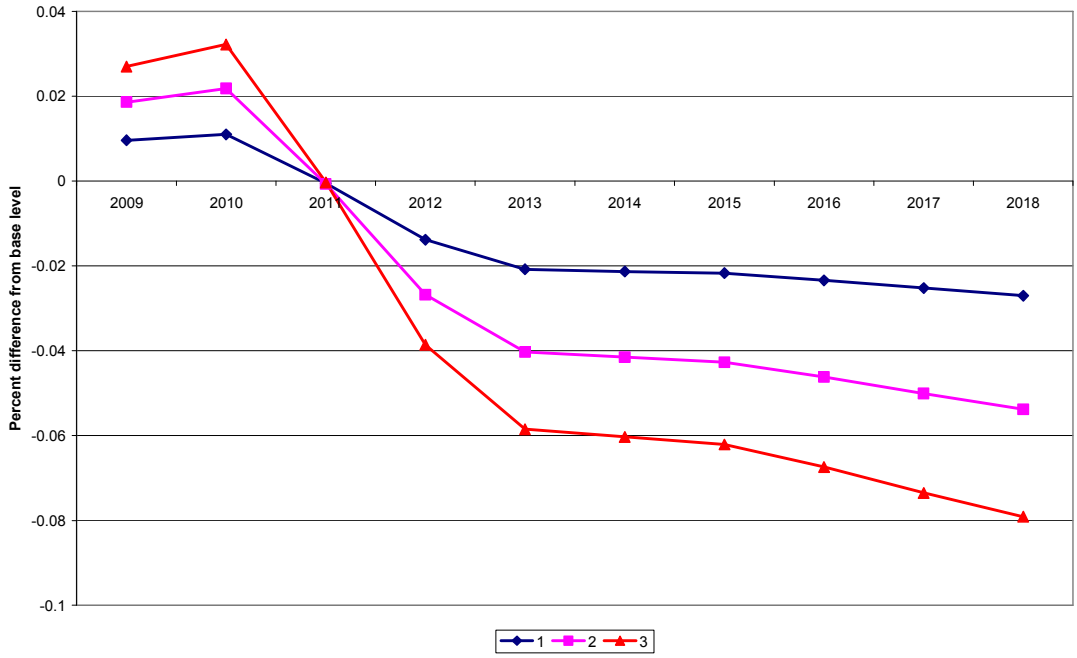
Figure 11 Impacts of increases in capital and liquidity targets on output in the UK



Increases in ratios by one percentage point (1), two percentage points (2) and three percentage points (3)

Source NiGEM simulations

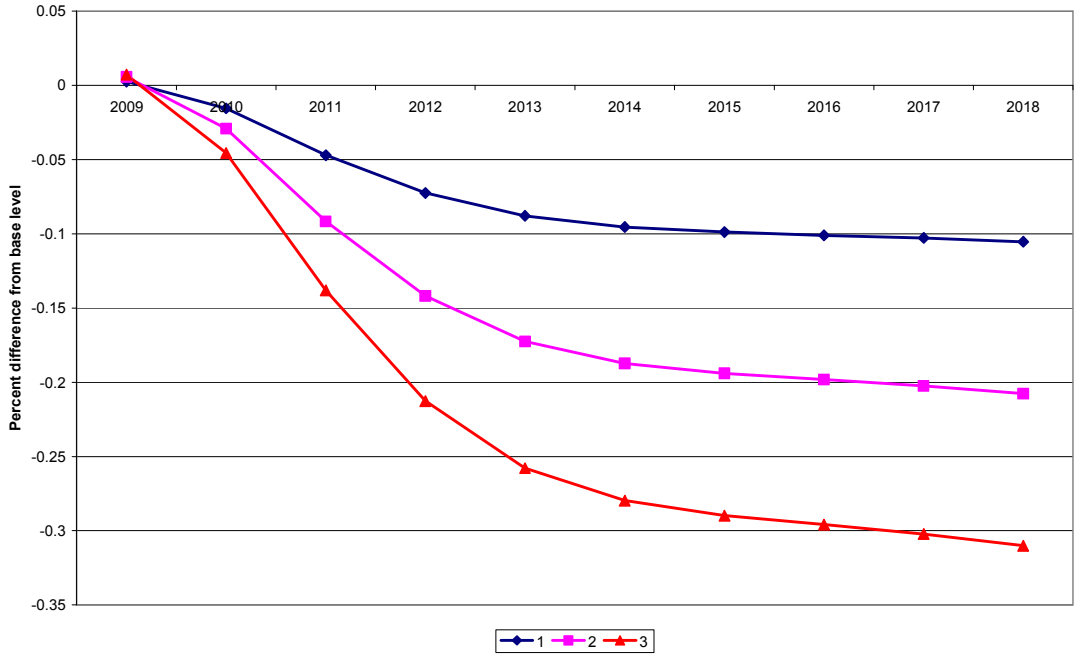
Figure 12 Impacts of increases in capital and liquidity targets on output in the US



Increases in ratios by one percentage point (1), two percentage points (2) and three percentage points (3)

Source NiGEM simulations

Figure 13 Impacts of increases in capital and liquidity targets on output in the Euro Area



Increases in ratios by one percentage point (1), two percentage points (2) and three percentage points (3)

Source NiGEM simulations

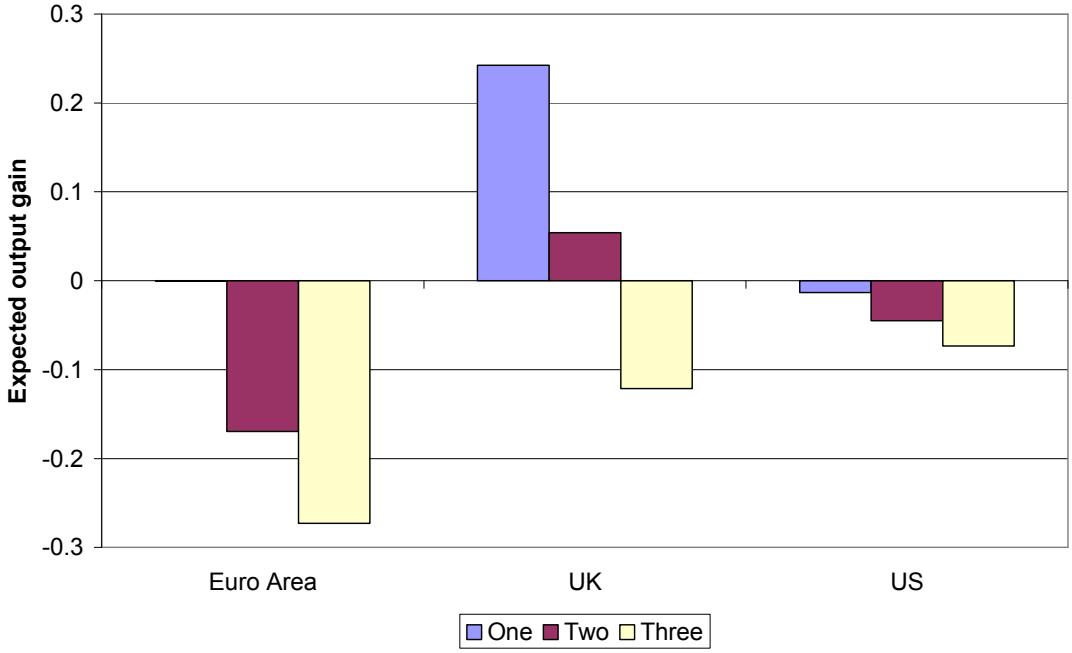
A simple cost benefit analysis of tighter regulation

Changing capital and liquidity ratios changes the probability of financial crises, and crises have clear costs for the economy when they are on the scale of that we have seen in the last two years. Hence we can calculate the expected gross gain from increasing capital and liquidity standards, and we can compare it to the gross costs in terms of output. If we were to take the net present value of all costs and benefits from tighter regulation we would have to take account of the costs incurred during a post crisis recession. This would require we analyse the effects of changes in capital and liquidity on all bank costs and hence on the path of consumption and investment over the short term. The short term costs of a crisis may be significant, and they are likely to be negative and could outweigh any other costs. We abstract from these short term effects here, and focus on the steady state impact of tighter regulation, analysing net gains from regulation in the tenth year of our analysis. By this time we would expect that all short term cost have washed out. It should be remembered that these are likely to be increase the net benefits from tighter regulation.

It is possible to make an initial calculation by taking the output costs of increased regulation and deduct it from the expected gain from tighter regulation. The expected gain in the tenth year is the change in the probability of a crisis between the columns of Table One multiplied by the output losses from Figures 2 to 4 minus the output costs for each level of increased regulation from Figures 11 to 13. Figure 14 plots the net gain from tighter regulation for the UK, the US and the Euro Area. The net gains are always negative for the US, reflecting the small changes in crisis probabilities between columns on Table One. However, the losses are small, as the output losses from higher capital and liquidity ratios are also smaller for the US than elsewhere, a one point increase in capital and liquidity standards may have reduced the probability

of a crisis enough for the short term gains to outweigh the longer term losses. The same point can be made even more clearly for the Euro Area.

Figure 14 Expected gains form tighter regulation



The cost benefit analysis of medium term, or steady state, gains from tighter regulation in the UK are much less ambiguous. The gains from regulation are much larger because crises probabilities are evaluated as being higher. Given this, there are clear steady state gains from a one percentage point and a two percentage point increase in capital and liquidity targets. As liquidity levels were so low in the UK, it is not clear what impact that changes in these alone might have, but the US and German evidence is that the costs of raising liquidity standards are noticeably lower than from raising capital adequacy standards.

Conclusions

Increasing capital and liquidity standards may well have reduced the risks of a crisis driven recession and the long term scarring that we may see as a result. Hence would have been wise to have had higher regulatory standards. However, this would not have prevented the crisis, as it stemmed for events in the US which standard regulatory practice would not have caught. Loose lending standards encouraged by politicians led to an increase in personal sector debt. This was based on an increase in the housing stock and on a house price bubble. When the bubble collapsed a combination of weak bankruptcy law and complex off balance sheet structures led to large losses that permeated throughout the whole of the OECD financial system. Tighter regulation might have reduced the costs. Only tighter international regulation of financial transactions would have reduced the costs significantly.

Data appendix

Corpw - the corporate sector margin defined as corporate lending rate less deposit rate. Data source: for the UK, Bank of England monthly data (cfmhsct and cfmhsdc) is interpolated into quarterly series; for the US, Federal Reserve monthly data on 'Bank prime loan' rate and 'US certificate of deposit offer rate: 1 month' is converted into quarterly series; for Germany, final series is a combination of an unweighted average of SU0506, SU0509 and a weighted average of SUD123, SUD127 monthly data from Bundesbank and intervention rate from European Central Bank.

Iprem - investment premium is defined as BAA spread over government bonds. Source NiGEM database.

Insolvr – business sector insolvency rate defined as a ratio of insolvent companies over total number of companies. Data source: for the US Datastream and County Business Patterns, U.S Census Bureau; for the UK, The Insolvency Service and Destatis for Germany.

Levrr – capital adequacy ratio, given the cross country dataset, is not risk-adjusted measure. For the US and Germany it is the ratio of capital and reserves for all banks to the end of year total assets as shown in OECD income statement and balance sheet database. As OECD database does not supply figures for the UK, the unweighted capital adequacy ratio is defined as for other countries and is constructed using Bank of England aggregate data.

Liqr – liquidity ratio is the sum of cash and balances with central banks and securities for all banks over the end of year total assets as shown in OECD income statement and balance sheet database. There are no figures supplied by the OECD for the UK and the liquidity ratio is constructed using Financial Services Authority (FSA) data, where liquidity is defined as the ratio of liquid assets (sum of cash, gold bullion and coin, central government and central bank loans, advances and bills held and central government and central bank investments (i.e. securities)) over total assets.

Any missing OECD database observations for the US liquidity or leverage ratios, are obtained from the BankScope[14] database.

Invhead - inverse of a headroom, which is the difference between measures of a capital adequacy (*levrr*) and regulatory minimum level (trigger ratios, *levrrt*).

[14] For the liquidity measure, the ratio of liquid assets to total assets for the top 200 banks in a country in question was calculated.

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The Structure and Use of the NiGEM Model

For a macroeconometric model to be useful for policy analyses, particular attention must be paid to its long-term equilibrium properties. At the same time, we need to ensure that short-term dynamic properties and underlying estimated properties are consistent with data and well-determined. As far as possible the same long run theoretical structure of NiGEM has been adopted for each of the major industrial countries, except where clear institutional or other factors prevent this. As a result, variations in the properties of each country model reflect genuine differences in data ratios and estimated parameters, rather than different theoretical approaches. The model has been in use at the National Institute since 1987, but it has developed and changed over that time. Some of its development was initially financed by the ESRC, but since 1995 it has been funded by its user community of public sector policy institutions. These currently include the Bank of England, the ECB, the IMF, the Bank of France, the Bank of Italy and the Bundesbank as well as most other central banks in Europe along with research institutes and finance ministries throughout Europe and elsewhere.

Each quarter since 1987 the model group has produced a forecast baseline that has been published in eth Institute *Review* and used by the subscribers as a starting point for their own forecasts. The forecast is currently constructed and used out to beyond 2031 each quarter, although the projection beyond 2015 is a stylized use of the long run properties of the model. Since 1998 the model has also been used by the EFN Euroframe group to produce forecasts for the European Commission. Forecasts are produced w based on assumptions and they do not always use forward looking behaviour. In policy analyses the model can be switched between forward, rational expectations mode and adaptive learning for consumers, firms, labour and financial markets. Policy environments are very flexible, allowing a number of monetary and fiscal policy responses. The model has been extensively used in projects for the European Commission, UK government departments and government bodies throughout the world. It has also contributed to a number of Institute ESRC projects.

Production and price setting

The major country models rely on an underlying constant-returns-to-scale CES production function with labour-augmenting technical progress.

$$Q = \gamma\left[s(K)^{-\rho} + (1-s)(Le^{\lambda t})^{-\rho}\right]^{-1/\rho} \qquad (1)$$

where is Q is real output, K is the total capital stock, L is total hours worked and t is an index of labour-augmenting technical progress. This constitutes the theoretical background for the specifications of the factor demand equations, forms the basis for unit total costs and provides a measure of capacity utilization, which then feed into the price system. Barrell and Pain (1997) show that the elasticity of substitution is estimated from the labour demand equation, and in general it is around 0.5. Demand for labour and capital are determined by profit maximisation of firms, implying that the long-run labour-output ratio depends on real wage costs and technical progress, while the long-run capital output ratio depends on the real user cost of capital

$$Ln(L) = \left[\sigma \ln\{\beta(1-s)\} - (1-\sigma)\ln(\gamma)\right] + \ln(Q) - (1-\sigma)\lambda t - \sigma \ln(w/p) \qquad (2)$$

$$Ln(K) = \left[\sigma \ln(\beta s) - (1-\sigma)\ln(\gamma)\right] + \ln(Q) - \sigma \ln(c/p) \qquad (3)$$

where w/p is the real wage and c/p is the real user cost of capital. The user cost of capital is influenced by corporate taxes and depreciation and is a weighted average of the cost of equity finance and the margin adjusted long real rate, with weights that vary with the size of equity markets as compared to the private sector capital stock. Business investment is determined by the error correction based relationship between actual and equilibrium capital stocks. Government investment depends upon trend output and the real interest rate in the long run. Prices are determined as a constant mark-up over marginal costs in the long term.

Labour market

NiGEM assumes that employers have a right to manage, and hence the bargain in the labour market is over the real wage. Real wages, therefore, depend on the level of trend labour productivity as well as the rate of unemployment. Labour markets embody rational expectations and that wage bargainers use model consistent expectations. The dynamics of the wage market depend upon the error correction term in the equation and on the split between lagged inflation and forward inflation as well as on the impact of unemployment on the wage bargain (Anderton and Barrell 1995). There is no explicit equation for sustainable employment in the model, but as the wage and price system is complete the model delivers equilibrium levels of employment and unemployment. An estimate of the NAIRU can be obtained by substituting the mark-up adjusted unit total cost equation into the wage equation and solving for the unemployment rate. Labour supply is determined by demographics, migration and the participation rate.

Consumption, personal income and wealth

Consumption decisions are presumed to depend on real disposable income and real wealth in the long run, and follow the pattern discussed in Barrell and Davis (2007). Total wealth is composed of both financial wealth and tangible (housing) wealth where the latter data is available.

$$\ln(C) = \alpha + \beta \ln(RPDI) + (1-\beta)\ln(RFN + RTW) \qquad (4)$$

where C is real consumption, *RPDI* is real personal disposable income, *RFN* is real net financial wealth and *RTW* is real tangible wealth. The dynamics of adjustment to the long run are largely data based, and differ between countries to take account of differences in the relative importance of types of wealth and of liquidity constraints. As Barrell and Davis (2007) show, changes in financial (dlnNW) and especially housing wealth (dlnHW) will affect consumption, with the impact of changes in housing wealth having five times the impact of changes in financial wealth in the short run. They also show that adjustment to the long run equilibrium shows some inertia as well.

$$dlnC_t = \lambda(lnC_{t-1} - lnPI_{t-1}) + b_1 dlnRPDI_t + b_2 dlnNW_t + b_3 dlnHW_t \qquad (5)$$

Al Eyd and Barrell (2005) discuss borrowing constraints, and investigate the role of changes in the number of borrowing constrained households. It is common to associate the severity of borrowing constraints with the coefficient on changes in

current income (dlnRPDI) in the equilibrium correction equation for consumption, where d is the change operator and ln is natural log,

Financial markets

We generally assume that exchange rates are forward looking, and 'jump' when there is news. The size of the jump depends on the expected future path of interest rates and risk premia, solving an uncovered interest parity condition, and these, in turn, are determined by policy rules adopted by monetary authorities as discussed in Barrell, Hall and Hurst (2006):

$$RX(t) = RX(t+1)[(1+rh)/(1+ra)](1+rprx) \qquad (6)$$

where *RX* is the exchange rate, *rh* is the home interest rate set in line with a policy rule, *ra* is the interest rate abroad and *rprx* is the risk premium. . Nominal short term interest rates are set in relation to a standard forward looking feedback rule. Forward looking long rates should be related to expected future short term rates

$$(1+LR_t) = \Pi^{T}_{j=1},\ (1+SR_{t+j})^{1/T} \qquad (7)$$

We assume that bond and equity markets are also forward looking, and long-term interest rates are a forward convolution of expected short-term interest rates. Forward looking equity prices are determined by the discounted present value of expected profits

Public sector

We model corporate (CTAX) and personal (TAX) direct taxes and indirect taxes (ITAX) on spending, along with government spending on investment and on current consumption, and separately identify transfers and government interest payments. Each source of taxes has an equation applying a tax rate (?TAXR) to a tax base (profits, personal incomes or consumption). As a default we have government spending on investment (GI) and consumption (GC) rising in line with trend output in the long run, with delayed adjustment to changes in the trend. They are re-valued in line with the consumers' expenditure deflator (CED). Government interest payments (GIP) are driven by a perpetual inventory of accumulated debts. Transfers (TRAN) to individual are composed of three elements, with those for the inactive of working age and the retired depending upon observed replacement rates. Spending minus receipts give us the budget deficit (BUD, and this flows onto the debt stock.

$$BUD = CED*(GC+GI)+TRAN+GIP-TAX-CTAX-MTAX \qquad (8)$$

We have to consider how the government deficit (BUD) is financed. We allow either money (M) or bond finance (debt).

$$BUD = \Delta M + \Delta DEBT \qquad (9)$$

rearranging gives:

$$DEBT = DEBT_{t-1} - BUD - \Delta M \qquad (10)$$

In all policy analyses we use a tax rule to ensure that Governments remain solvent in the long run (Barrell and Sefton 1997),. This ensures that the deficit and debt stock return to sustainable levels after any shock. A debt stock target can also be implemented. The tax rate equation is of the form:

$$TAXR = f(\text{target deficit ratio} - \text{actual deficit ratio}) \quad (11)$$

If the Government budget deficit is greater than the target,(e.g. -3 % of GDP and target is -1% of GDP) then the income tax rate is increased.

External trade

International linkages come from patterns of trade, the influence of trade prices on domestic price, the impacts of exchange rates and patterns of asset holding and associated income flows. The volumes of exports and imports of goods and services are determined by foreign or domestic demand, respectively, and by competitiveness as measured by relative prices or relative costs. The estimated relationships also include measures to capture globalization and European integration and sector-specific developments. It is assumed that exporters compete against others who export to the same market as well as domestic producers via relative prices; and demand is given by a share of imports in the markets to which the country has previously exported. Imports depend upon import prices relative to domestic prices and on domestic total final expenditure. As exports depend on imports, they will rise together in the model. The overall current balance depends upon the trade balance and net property income form abroad which comprised flows of income on gross foreign assets and outgoings on gross foreign liabilities. Gross National Product (GNP) is gross Domestic Product (GDP) plus net factor income from foreigners.

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