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WAS THE SUBPRIME CRISIS UNIQUE?
An analysis of the factors that help predict banking crises in OECD countries

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Abstract:, We assess whether the subprime crisis was in some way unique or unprecedented by testing for an impact of a set of determinants on the probability of banking crises in OECD countries since 1980. The hypothesis of an exogenous probability of a crisis is not considered in the literature, and we also address it, along with testing for the effect of variables that explain crises in emerging markets. We find that a parsimonious logit model can be estimated for OECD crises, including the subprime period, featuring bank capital adequacy, liquidity, the current account and changes in house prices as predictors, thus showing the patterns immediately preceding the subprime crisis were not unprecedented. Not only was the subprime crisis not unique, it was also predictable using data available five years earlier; our model, even if estimated over 1980-2003, could have helped authorities to forecast the subprime crisis and take appropriate regulatory measures.

Keywords: Banking crises, logit, current account, banking regulation

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1 Introduction

If we are to learn enduring lessons from the sub-prime crisis we need to know whether it was in some way unique, or whether it shared features in common with earlier banking crises. Certainly, the sub-prime crisis has been linked to some factors, which are unprecedented in a narrow sense, such as the emergence of the "originate and distribute" model of lending and creation of incorrectly-rated opaque financial instruments held in off-balance-sheet subsidiaries. Owing to international holdings, they generated losses across a range of banking systems, including countries whose economies showed no signs of financial stress. These innovative aspects can at most be compared in a qualitative manner with other innovations that preceded earlier crises and led to similar errors in pricing risk (such as the subordinated loan in the Latin American debt crisis of 1982).

Other factors can more readily be compared with earlier events. For example, in 2001-2007, there was widespread discussion of the emergence of global imbalances, which entailed large current account deficits in countries such as the US, UK and Spain, balanced by surpluses in China, Japan and Germany. These were thought in turn to induce downward pressure on real asset returns, prompting asset price bubbles and a "hunt for yield" through financial innovation, as well as large scale cross border capital flows which helped finance banks' expansion – and hence were part of the buildup of vulnerability to the subprime crisis. And of course real estate prices in a range of countries arguably had an impact on crisis probabilities in 2007-8, having risen sharply up to 2005-6 before falling, first in the US then elsewhere. Rapid growth in GDP and credit as well as low short term interest rates also preceded the subprime episode and their patterns can be compared with other crises. Other such "macroprudential" factors include low levels of bank liquidity and capital.

Accordingly, in this paper we seek to assess whether a common pattern can be detected across the subprime and earlier OECD banking crises, using a multivariate logit approach and testing variables which have both been commented in the subprime crisis and are control variables common in the literature. We also assess whether crises are in some sense inevitable and unpredictable random events like sunspots, which would be associated with there being a significant constant in the prediction model. The paper is structured as follows. In the first section we consider variables that need to be included to allow us to determine the most likely factors associated with financial crises and also to avoid omitted variables bias. Typically different sets of variables are found significant in global samples (see for example Demirguc Kunt and Detragiache (2005)) and in work on OECD crises (Barrell et al 2009 and 2010a). In the second section we outline our methodology, dataset (which includes both global and OECD-specific variables) and sample (OECD only from 1980-2008).

In the third section, we go on to test for precursors of crises, starting from a general equation. We find a role for unweighted bank capital adequacy, banks' (narrow) liquidity ratios and lagged house price growth as independent variables, but also for the current account/GDP ratio. The in-sample performance of our equation is very good. In the fourth section, we test the robustness of the specification by excluding countries and observations, and find it to be remarkably stable. Furthermore, the subprime crises in the US, UK, Belgium and France were predictable using parameters estimated on data up to 2003 with actual outturns for (the lagged) right hand side variables. In the fifth section, we focus on the US and derive the factors underlying growing vulnerability in the run up to the subprime crisis, as well as using the model to show the degree of regulatory policy tightening needed to offset the risks presented by developments in the other

predictor variables. The optimal degree of tightening has to be evaluated by comparing expected costs and expected benefits, an exercise Barrell et al (2009) undertake for the UK in the run up to crisis that developed in 2007 and 2008. This paper provides one side of such an analysis, and further work on the costs of regulatory tightening is needed.

1 Key banking crisis determinants

In order to assess whether the subprime crisis was unique, we wish to systematically test for common predictors of the subprime and earlier OECD banking crises, including both variables that have been highlighted in analyses of the subprime and variables seen as significant in past work on predicting crises. As noted above, factors seen as important prior to the crisis include the growth of property prices, global imbalances, rapid GDP growth, low short and long-term interest rates and high credit growth. In addition it may have been that banks had weak defences in the crisis, and tended to be undercapitalised given their ex post risks, and also held insufficient liquid assets. The tradition in the literature is to estimate global samples of banking crises using key macroeconomic and financial variables (see Demirguc Kunt and Detragiache 2005), so part of our assessment of is to test against the set of variables used in such studies. The possible set of variables can be usefully divided into macroeconomic, banking, policy and institutional variables.

In terms of macroeconomic indicators, as discussed in Beck et al (2006), variables such as growth of real GDP, changes in terms of trade and the rate of inflation can be seen to capture macroeconomic developments that affect banks' asset quality.[3] Some of these variables such as GDP growth have clear parallels in the subprime crisis but not others – inflation was subdued and terms of trade were fairly stable. The vulnerability of the banking system to sudden capital outflows may be indicated by the ratio of their deposits to foreign exchange reserves, although in most countries affected in the subprime, the level of reserves was quite high. Rapid credit growth may also indicate lax lending standards as well as potentially triggering an asset boom, as was commonly suggested prior to the subprime crisis.

Lax monetary policy, as indicated by the short term real interest rate may also induce lax lending and feed asset bubbles – and again this factor has been highlighted in analyses of the subprime. Fiscal deficits may also affect the risk of crises by overheating the economy. A large fiscal deficit also reduces the scope available to recapitalise banks should difficulties emerge, making a systemic crisis more likely. Fiscal difficulties were not present prior to the subprime but emerged afterwards, as the economy slowed and authorities had to recapitalise banks. Institutional variables such as a deposit insurance scheme may lead to greater moral hazard for banks[4], but these are common across OECD countries and hence are not useful discriminators between crisis and non crisis countries. Equally, crises are more common in poor and middle income countries, but GDP per capita does not discriminate between OECD countries.

A problem with these traditional variables is that existing research shows that they were poor predictors of the subprime crisis when used in econometric estimation. Davis and Karim (2008) estimated a multivariate logit model for crises using a sample of 105 countries over 1979-1999, featuring 72 systemic banking crises, of which 65 were in emerging markets and 7 in OECD

[3] We note that depreciation and the terms of trade were not significant in our comparator paper, Demirguc Kunt and Detragiache (2005).

[4] Structural features of bank regulation, the legal framework and economic freedom (Barth et al 2004) may also be used as institutional controls, but many of these indicators vary little across the OECD.

countries. Their significant variables were GDP growth, changes in terms of trade, GDP per capita and the M2/reserves ratio, although the equation also included exchange rate depreciation, the real interest rate, inflation, the fiscal balance, credit/GDP deposit insurance and credit growth. The logit model estimated up to 1999 is very poor at picking up the crises in 2007 and 2008 when run forward from 2000 to 2007. The model predicts the highest chance of banking crisis in the US in 2001 at almost 2 per cent (linked to the peak of the equity bubble and the start of the bear market). The predicted probabilities decline until 2004 (1.08 per cent) but begin to rise after this with another peak probability occurring in 2006 (1.28 per cent). However, the logit model then predicts the lowest crisis probability in 2007 (0.99 per cent) even given it uses recent values for the explanatory variables. All of these probabilities are well below the sample mean of around 5 per cent and would not have alerted the authorities to any significant risk. Borio and Drehmann (2009) have similarly poor out of sample performance using credit and output as indicators. This does imply a need to look more widely that the traditional variables for banking crisis predictors in the OECD, also informed by analyses of the subprime period.

One additional group of variables is key variables that are subject to regulatory influence, unweighted capital adequacy and bank liquidity ratios. These are regarded as defences against crises and where historically low levels are commonly considered to be precursors to crises (Brunnermeier et al 2009), with some commentators expressing concern about them prior to the subprime, especially the downtrend in bank liquidity. Capital is a buffer that protects banks against losses, so a higher level of capital makes banks more robust to asset value shocks. Lower capital not only leaves banks more vulnerable to asset value shocks but also offers incentives for risk taking due to the moral hazard generated by the mispriced "safety net" of lender of last resort and deposit insurance. Equally, liquidity ratios show the degree to which banks are robust to sudden demands for withdrawals by depositors. However, these variables are not typically available across a global sample, and hence they are seldom seen in the literature. A unique feature for OECD countries is the database of country-aggregates for banks' balance sheets and profit and loss, which is maintained by the OECD itself.

Rapid growth in real estate prices was a cause for concern prior to 2007, and indeed falling US real estate prices are key background to the subprime crisis, as house prices falling below loan values let to significant levels of default. Crises are often the result of poor quality lending, especially in real estate markets, as is discussed in Reinhart and Rogoff (2009), and such variables should be included in studies of crises, but residential property prices are again only available consistently for OECD countries[5]. A boom in real estate prices frequently foreshadows a crisis since in the upturn rising asset prices provide collateral for excessive lending (the financial accelerator) while when prices fall from unsustainable levels, this process goes into reverse, sharply tightening credit conditions, while overextended borrowers in the personal and construction sectors as well as property developers have strong incentives to default. Reinhart and Rogoff (2009) suggest that property price developments can change crisis probabilities, and Barrell et al (2010a) do find a role for these in OECD crises.

Global imbalances were a key background feature in the run up to the subprime crisis. Current account deficits reflect a reduction in national net wealth and may be accompanied by monetary inflows that enable banks to expand credit excessively, generating and reflecting a high demand

[5] We note that house prices are correlated with prices of commercial property, which has also been a source of major bank losses during financial crises. See Davis and Zhu (2009).

for credit, as well as boosting asset prices in an unsustainable manner.[6] A number of potential links can be traced from current account deficits to risk of banking crises.[7] For example, deficits may be accompanied by monetary inflows that enable banks to expand credit excessively and they may accompany an overheating economy. This may both generate and reflect a high demand for credit, as well as boosting asset prices in an unsustainable manner. These trends may be exacerbated by lower real interest rates than would otherwise be the case. The existence of a current account deficit may also indicate a shortfall of national saving over investment and hence a need for the banking sector to access the potentially volatile international wholesale market. In addition foreigners may cease to be willing to finance deficits in domestic currency if they consider their assets are vulnerable to monetization via inflation, and such a cessation can disrupt asset markets and banks' funding.[8].

As is the case for real estate bubbles, Reinhart and Rogoff (2009) suggest that widening current account imbalances have been common forerunners of banking crises in OECD, and a significant portion of the international finance literature links difficulties in the external account to financial crises. A typical example is McKinnon and Pill (1994) who show capital inflows in a weakly regulated banking system with a safety net may lead to overlending cycles, consumption booms, rising asset prices and further increases in current account deficits. This pattern leads in turn to exchange rate appreciation and loss of competitiveness and a slowdown in growth, much as we saw in the US in the middle of the last decade. It is also common that this leads to a banking crisis and a collapse in the currency, again much as we saw in the US toward the end of the last decade.

Unlike bank capital adequacy and liquidity, as well as real estate prices, the current account is generally available for assessment as a crisis predictor. In the empirical literature, the balance of payments itself is not commonly employed in logit models predicting banking crises, although some variables showing external pressures on the economy and financial system are usually included.[9] When it is included it is often not significant. Hardy and Pasarbasioglu (1999) estimate logit models of crises for both advanced and developing countries and find that the current account was not significant, although the change in the gross foreign liabilities of the banking sector (which may accompany a current account deficit) is often significant with a positive sign at a longer lag and a negative sign as the crisis nears. Using a probit approach, Eichengreen and Rose (1998) again find the current account insignificant as a predictor of banking crises in developing countries. However, in terms of simple statistical calculations, Reinhart and Reinhart (2008) derive a global sample of "capital flow bonanzas" which are based on the 20th percentile of levels of the current account/GDP ratio. They find that countries with such bonanzas are

[6] In addition foreigners may cease to be willing to finance deficits in domestic currencies if they consider their assets are vulnerable to monetization via inflation, and such a cessation can disrupt asset markets and banks' funding.

[7] There remain arguments that OECD countries should be less vulnerable to external pressures leading to banking crises than are emerging market and developing countries. For example, given typically low inflation, sound accounting systems and legal frameworks in OECD countries, there is scope for local firms to borrow abroad in domestic currency and the domestic currency can be used domestically to finance long-term borrowing. As noted by Eichengreen and Rose (1998), OECD countries should be less vulnerable to terms of trade shocks affecting the external sector, given more diversified industrial structures. There is scope for hedging exchange rate risk in derivatives markets. The quality of bank supervision and regulation should be higher and bank liabilities are longer-maturity on average.

[8] See Haldane et al (2007) for an assessment of the impact of such a hypothetical unwinding in the US.

[9] Indicators of external pressures have been used for global samples in Demirguc Kunt and Detragiache (2005) and in Beck et al (2006) which also highlights the impact of bank concentration on the risk of banking rises.

significantly more likely to have a banking crisis in the three years before or after such a bonanza[10].

Finally there is the issue of whether a constant should be included in estimation, which has not been systematically examined in the literature to date. This would allow the probability of crises to have an exogenous element, i.e. some of crises are inevitable and the subprime crisis could have been one such. This is implicit in early theoretical models of bank failures and banking crises such as Diamond and Dybvig (1983) which assumed bank failures were a form of "sunspot", arising from random shocks to depositor perceptions of the underlying solvency of banks. However, empirical work soon began to show that crises were not random within a national economy, but tended to occur during recessions (see for example Gorton (1988)), and this tradition is followed in the empirical literature such as Demirguc Kunt and Detragiache (2005) cited above. As a result much of the literature does not allow for any exogenous element by omitting a constant (or similar effect) from estimation.

2 Methodology and data

We utilise the multinomial logit, the workhorse approach to predicting crises (Demirguc Kunt and Detragiache (2005), Davis and Karim (2008)). The logit estimates the probability that a banking crisis will occur in a given country with a vector of explanatory variables X_{it}. The banking crisis variable Y_{it} is a zero-one dummy which is one at the onset of a banking crisis, and zero elsewhere. Then we have the equation:

$$\text{Prob}(Y_{it} = 1) = F(\beta X_{it}) = \frac{e^{\beta' X_{it}}}{1 + e^{\beta' X_{it}}} \qquad (1)$$

where β is the vector of unknown coefficients and $F(\beta X_{it})$ is the cumulative logistic distribution. The log likelihood function is:

$$Log_e\ L = \sum_{i=1}^{n}\sum_{t=1}^{T}\left[(Y_{it}\log_e F(\beta' X_{it})) + (1 - Y_{it})\log_e (1 - F(\beta' X_{it}))\right] \qquad (2)$$

Coefficients show the direction of the effect on crisis probability, although its magnitude is conditional on values of other explanatory variables at time t. $ß_i$ represents the effect of X_i when all other variables are held at their sample mean values. We include an intercept in the regression as an indicator of the exogenous probability of a crisis.

We do not follow the tradition in the literature of estimating a global sample, since our interest is in the potentially distinctive features of crises in OECD countries, following the argument that different predictors may be relevant, as the results of Davis and Karim (2008) also suggest. The subprime crisis is in our view more likely to resemble average OECD crises than average global ones, which are mainly in emerging market countries. In rejecting the global approach we follow Hardy and Pararbasioglu (1999) who showed there were distinctive features of crises in Asia compared to other developed, emerging and developing countries, as well as Eichengreen et al (1998) who as noted argue crises in developed countries have distinct precursors. We contend

[10] Kaminsky and Reinhart (1999) do not use the balance of payments as a leading indicator but they do use terms of trade, foreign reserves and exports which do relate to the balance of payments

that there are differences in financial structure in advanced countries vis a vis emerging market and developing economies, and this would explain the results of Davis and Karim (2008) cited above for logit models with traditional variables. In addition consistent data on property prices, bank capital adequacy and bank liquidity are not generally available for non-OECD countries and again this rules out a global sample.

Table 1: List of systemic and non-systemic crises

	BG	CN	DK	FN	FR	GE	IT	JP	NL	NW	SP	SD	UK	US
1980	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1983	0	1	0	0	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0	0	0	0	1	0
1985	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	1	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**
1989	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	1	0	0	**1**	0	0	0	0
1991	0	0	0	**1**	0	0	0	**1**	0	0	0	**1**	1	0
1992	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	1	0	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0	0	0	0	0	1	0
1996	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1998	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2006	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2007	0	0	0	0	0	0	0	0	0	0	0	0	**1**	**1**
2008	1	0	0	0	1	1	0	0	1	0	0	0	**1**	**1**

Note:BG-Belgium, CN-Canada, DK-Denmark, FN-Finland, FR-France, GE-Germany, IT-Italy, JP-Japan, NL-Netherlands, NW-Norway, SP-Spain, SD-Sweden, UK-United Kingdom, US-USA.

Our dataset includes 20 systemic and non systemic crises in OECD countries. The bulk of crises are from the World Bank database of banking crises from 1974-2002, dated 2003[11]. In extending the estimation further to 2008 we have used definitions from Borio and Drehmann (2009), whose Definition 1 suggests a crisis occurs in "countries where the government had to inject capital in more than one large bank and/ or more than one large bank failed". By the end of January 2009

[11] Appendix one compares different definitions of crises in the extensive literature. We wish to include systemic and non systemic crises in the OECD and hence we cannot rely on Laeven and Valencia (2007) who only include systemic crises. Their sample and ours include crises in the UK and the US in 2007. Note that in preferring the World Bank data for the pre-2002 period, we are retaining a 1991 onset date for the crisis in Japan rather than 1997 in the IMF work and 1990 for Norway rather than 1991 as in the IMF data. We note that other authors such as Demirguc Kunt and Detragiache (2005) and Reinhart and Rogoff (2009) concur with an earlier date for the Japanese crisis onset (in their case 1992) – 1997 was more an aggravation of an existing crisis situation. Meanwhile for Norway, the banks' guarantee fund was already depleted in 1990, serious problems of loan losses had appeared at the larger banks, while the government announced the setting up of a Government Bank Insurance Fund at the end of that year.

this definition classified the US, the UK, Belgium, France, Germany and the Netherlands as in crises. We date crises in these countries in 2008 with the UK and US having distinct crises in both 2007 and 2008. The full set of crises is shown in Table 2, with systemic crises shown in bold.

Crises may be inevitable, and if they are there is little that any policy maker can do about them. They may also be caused by factors outside the influence of either monetary of financial policy makers, and hence they may be difficult to prevent. However, they may be the consequence of developments within the financial sector, and there is the possibility that regulatory instruments may also change the probability of crises occurring. In order to test these propositions we include macroeconomic, banking-sector and policy variables from the existing literature as potential predictors in a general model to control for omitted variables bias, and we then test between the competing hypotheses.

Besides the current account/GDP ratio (CBR), macroeconomic variables are real GDP Growth (per cent) (YG), inflation (per cent) (INFL), and real house price growth (RHPG). Banking variables are the ratio M2/ Foreign Exchange Reserves (per cent) (M2RES), real domestic credit growth (per cent) (DCG), unweighted bank capital adequacy (LEV) and bank narrow liquidity/assets (NLIQ). Policy variables are the real interest rate (per cent) (RIR) and the fiscal surplus/GDP ratio (per cent) (BB). We include a constant to allow for the hypothesis that there is an exogenous probability of a crisis occurring. We do not include some typical institutional variables because they are clearly irrelevant to OECD countries, for example, GDP per capita is broadly comparable across OECD countries, while virtually all OECD countries have some form of deposit insurance scheme[12]. Variations in the level of credit/GDP (as opposed to credit growth) may reflect the differing nature of the financial system in OECD countries (i.e. bank versus market dominated) rather than risk of crisis, and we exclude this variable as well.

The above macroeconomic and financial data are from the IMF's IFS database, with the following exceptions. House prices are from NIESR's NiGEM database, while banks' unweighted capital adequacy (LEV) is obtained from the OECD Bank Income and Balance Sheet database, except for the UK where data are obtained from the Bank of England. We use narrow liquidity[13] (NLIQ) derived from IFS[14] rather than the broad measure provided in the OECD Bank Income and Balance Sheet database. This is because OECD broad liquidity includes private sector securities, whose illiquidity was an Achilles heel of banks in the recent crisis.

[12] . Institutional features of bank supervision as well as banking sector concentration were found insignificant in our earlier work (Barrell et al 2010a).

[13] Narrow liquidity is defined as a sum of banks' claims on general government and the central bank, while total assets comprise foreign assets, claims on general government, central bank and private sector.

[14] Narrow liquidity is calculated based on IFS series for all countries (except for the UK where the source is the FSA). The lowest ratio averaged over the whole sample is in the UK ratio where it averaged 5 per cent, comparable nonetheless with other countries such as Finland (7 per cent) and the US (11 per cent). Some countries had high ratios on this basis particularly in the early years of the sample, which may be attributable to high holdings of government bonds by EU banks in countries such as Italy, Spain and Belgium. It is notable that there has been a convergence in most countries on much lower levels of narrow liquidity in the most recent data shown. In 2007, 9 countries including the UK had narrow liquidity ratios of below 10 per cent. We note that EU member countries report only aggregated data on banking institutions which include money market funds, unlike non-EU countries where disaggregated data is available and depository banks series are used for calculations. Money market funds are important retail outlets in the US, and need to be distinguished from other institutions. They are less important in most EU countries, with the possible exception of France. Their inclusion must remain an empirical matter.

3 Estimation

Using these data, in line with the discussion above, we, undertook nested testing of a logit model of OECD banking crises over 1980-2008, starting from a full set of variables typically included in global banking crisis models discussed above. The aim is to find an equation that is significant in a sample covering both the subprime and earlier crises, giving a first piece of evidence that the subprime was not unique. We started our analysis with all of these variables included, and eliminated them one at a time, removing the least significant each time and repeating the reduced regression. This procedure was terminated when only significant regressors were left in our set.

Table 2: Nested testing of the crisis model, 1980-2008

Step	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
LEV(-1)	-0.17 (-1)	-0.17 (-1.1)	-0.17 (-1.1)	-0.2 (-1.3)	-0.23 (-1.5)	-0.34 (-3.5)	-0.31 (-3.5)	-0.34 (-4.1)
NLIQ(-1)	-0.11 (-2.4)	-0.11 (-2.5)	-0.12 (-2.5)	-0.11 (-2.4)	-0.1 (-2.2)	-0.12 (-3.3)	-0.11 (-3.3)	-0.11 (-3.3)
RHPG(-3)	0.1 (2.8)	0.1 (2.8)	0.1 (2.8)	0.11 (2.9)	0.09 (2.7)	0.09 (2.6)	0.08 (2.5)	0.08 (2.4)
CBR(-2)	-0.18 (-1.7)	-0.19 (-1.7)	-0.18 (-1.7)	-0.21 (-2.1)	-0.24 (-2.5)	-0.26 (-2.9)	-0.23 (-2.8)	-0.24 (-2.8)
DCG(-1)	-0.05 (-0.9)	-0.05 (-1)	-0.05 (-0.9)	-0.05 (-1)	-0.05 (-1.1)	-0.06 (-1.2)	-0.03 (-0.8)	
YG(-1)	0.21 (1.3)	0.21 (1.3)	0.21 (1.3)	0.2 (1.2)	0.16 (1.1)	0.14 (1)		
C	-1.85 (-1.4)	-1.83 (-1.5)	-1.86 (-1.5)	-1.32 (-1.2)	-1.04 (-1)			
BB(-1)	-0.07 (-0.8)	-0.07 (-0.8)	-0.07 (-0.9)	-0.08 (-0.9)			-	-
RIR(-1)	0.07 (0.7)	0.07 (0.7)	0.06 (0.9)			-	-	-
INFL(-1)	-0.02 (-0.1)	-0.02 (-0.1)			-	-	-	-
M2RES(-1)	0.000001 (0.02)			-	-	-	-	-

Note: estimation period 1980-2008; z-statistics in parentheses; NLIQ-banks' net liquidity ratio, LEV- banks' unweighted capital adequacy ratio, RHPG change in real house prices,, CBR current balance to GDP ratio, YG-real GDP growth, RPHG-real house price inflation, BB-budget balance to GDP ratio, DCG-domestic credit growth, M2RES-M2 to reserves ratio, RIR-real interest rates, INFL-inflation, C Constant term

As can be seen in Table 2, all of the variables typically used in global samples are insignificant – including factors highlighted prior to the subprime such as GDP growth, credit growth and real interest rates - while the current account/GDP ratio (CBR) [15], real house price growth (RHPG), unweighted bank capital adequacy (LEV), and bank narrow liquidity/assets (NLIQ) are

[15]We investigated the effect of the current account on banking crises, testing first for the appropriate lag. Up to four lags of the variable were included and the least significant ones eliminated one by one, until the most significant lag was left. We found that only the second lag was significant so retained it in subsequent estimation.

significant in all specifications. The first variable to be eliminated was the M2RES indicator, which is not surprising as FX reserves take on a different function in sophisticated financial markets as compared to emerging ones. The next variables to disappear (in order) were inflation, the real interest rate and the government budget. At no point was the constant term significant, and it dropped out before the cyclical variables, output and credit growth. We would conclude that there is no strong evidence that crises are inevitable if defences are strong enough and regulators vigilant regarding problems that might emerge from poor quality lending in housing markets and current account deficits.

In our final equation in the last column of Table 2 capital adequacy (LEV), the liquid asset ratio (NLIQ) significant in addition to the current account (CBR) [16] and the growth rate of real house prices (RHPG). Among the noteworthy exclusions in this testing-down process are credit growth and real interest rates. Although lax monetary policy and credit booms may at times contribute to banking crises, the nested test suggests that they are not the most powerful discriminators between times of crisis onset and other periods in OECD countries. [17]

Interpreting the equation, capital and liquidity show how robust the banking system is to shocks, in terms of capital and liquidity buffers. Meanwhile, the macroeconomic variables distinguish unbalanced booms – such as that preceding the subprime - which are characterised by rapid growth in consumption and housing investment, implying that supply fails to keep pace with respective demand. In such a context, the quality of lending is likely to deteriorate, given lending assets the banks take on in such booms will sharply deteriorate in the ensuing downturn.[18]

Crises often stem form excess demand growth which normally shows up directly in the current account, or excessive asset price growth which may stimulate demand and indirectly affect the current account[19]., In liberalised financial markets, credit will often be (Granger) caused by asset price increases, as Barrell, Holland and Karim (2010) show. Expectations of future income growth, for instance may be stimulated and house prices rise, and as a consequence purchasers have to borrow more. In these circumstances credit and GDP may not be good leading indicators of crises as they are a lagged consequence of the causes. In addition, as they may be poor predictors as they may expand not only in the run up to a crisis but also in a situation of balanced growth where supply and demand balance is maintained both economy-wide and in the property sector.

Of course the situation may be different in emerging markets where credit rationing may be common, but we should be careful of giving credence to any research that combines regulated and unregulated markets in their sample without testing for homogeneity. It is clear from our estimates that in OECD countries asset price booms, lax bank regulation and an accompanying current account imbalance are most important factors driving the probability of a banking crisis[20].

The in-sample performance is very good, as shown in Table 3. We use a more stringent crisis call criteria than Borio and Drehmann (2009) in that we require the call to be in the year of the crisis,

[16] Appendix Table 2 shows that these variables are not strongly correlated suggesting multicollinearity is not an issue
[17] Our result for insignificance of credit expansion is nevertheless consistent with Mendoza and Terrones (2008) who found that credit booms often link to banking crises in emerging market economies but less often in OECD countries.
[18] In Appendix 2 we show that the variables in our equation are not subject to collinearity,
[19] However, not all asset price booms and current account deficits can be treated as harbingers of crises.
[20] We also tested for the joint exclusion of all these variables using a Wald variable deletion test, and we found that they could all be dropped with 90 per cent probability.

whilst they require the cal to be in the three years in the run up to the year of the crisis. Given this we call 75 per cent, or 15, of the crises episodes in the sample are captured at a cutoff of 0.0555, which is the sample mean for onset of crises i.e. 20/364. We miss crises in the UK in 1995 (when the Singapore branch of Barings brought the bank down, and it was rescued), Italy in 1990, Denmark in 1987 and Germany and the Netherlands in 2008. With this stringent call criterion there is a false call rate when there is no crisis (a Type II error) of only 28 per cent. There are 92 false alarms when there is no crisis, but if we used the Borio and Drehmann call criteria this would be halved. Given there is a false call rate when there is a crisis (a Type I error) of 25 per cent there is an overall successful call rate is 72 per cent using our criterion and it would be 86 per cent using that of Borio and Drehmann (2009) .

Table 3: In sample model performance based on correct calls

	Dep=0	Dep=1	Total
P(Dep=1)<=C	247	5	252
P(Dep=1)>C	97	15	112
Total	344	20	364
Correct	247	15	262
per cent Correct	71.80	75.00	71.98
per cent Incorrect	28.20	25.00	28.02

Note we use the in sample crisis rate to as our call cut-off

We examined in more detail the in-sample performance of the model from 1996 onwards, during which there were no new crises up to 2007. This period contains exactly half of the total observations (182). The UK, US, Denmark and the Netherlands have the largest number of crises called over the period, which in the case of the first two countries is partly a sign of a build up of vulnerabilities in the economies, leading to the sub-prime crises in 2007. The first two have one third of all false calls in this period, suggesting they had faced systematic stress for some time. For the latter countries it reflects earlier house price booms that gave rise to unrealized concerns over systemic risk.[21] There were also calls around 1997 and 1998 in Japan, which we do not record as a crisis unlike Laeven and Valencia (2007). In-sample, the subprime crisis itself was correctly called for four countries, the US, UK, France and Belgium. Our model does not call the Netherlands and Germany in 2008. The former had a crisis because the Belgian domiciled but cross border operating Fortis bank had to be bailed out by both countries. The lack of a call Germany reflects the international rather than domestic source of its problems, which were based on excessive exposure to the US securitized mortgage market and associated structured investment vehicles. In other words, the German case was the sole example of a crisis in the sub prime period that was indeed unique and not detectable by current macroprudential variables.

4 Robustness tests

We undertook a set of robustness tests, first dropping groups of countries, second by varying lags on variable that are emphasised by others, and then changing the time period of estimation. This shows whether our conclusion that the subprime was not unique is dependent solely on our initial

[21] For instance, for the Netherlands, there were certainly concerns over asset price developments in the late 1990s, also expressed in official circles (De Nederlandsche Bank 2000), that help justify the estimated crisis probability in that period.

estimation. We first eliminated the US and Japan separately and together, then we excluded the UK which has 5 crises (considerably more crisis occurrences than any other country in the sample). We then went on to delete the Nordic countries (which had systemic crises) and Canada (the remaining non European country in the sample). These tests are reported in Table 4. In none of these cases was there a noticeable changes in coefficients on our driving variables and they remain significant at 95 per cent significance level, apart from real house price growth (RHPG) which is significant at 90 per cent level when Norway and Finland are excluded.

Table 4: Robustness tests based on country elimination

	Final panel	US not included	Japan not included	US and Japan not included	UK not included	Norway not included	Finland not included	Sweden not included	Canada not included
LEV(-1)	-0.342 (-4.05)	-0.405 (-4.15)	-0.344 (-4.09)	-0.408 (-4.21)	-0.373 (-3.92)	-0.317 (-3.54)	-0.301 (-3.44)	-0.329 (-3.85)	-0.319 (-3.84)
NLIQ(-1)	-0.113 (-3.26)	-0.101 (-2.87)	-0.108 (-3.14)	-0.096 (-2.75)	-0.115 (-3.13)	-0.118 (-3.13)	-0.12 (-3.36)	-0.114 (-3.26)	-0.113 (-3.32)
RHPG(-3)	0.079 (2.36)	0.093 (2.51)	0.078 (2.33)	0.092 (2.48)	0.109 (2.83)	0.066 (1.9)	0.066 (1.77)	0.074 (2.16)	0.073 (2.15)
CBR(-2)	-0.236 (-2.84)	-0.182 (-2.15)	-0.232 (-2.73)	-0.176 (-2.05)	-0.217 (-2.59)	-0.224 (-2.54)	-0.236 (-2.79)	-0.223 (-2.6)	-0.228 (-2.75)

A second aspect is to test further the importance of credit growth and GDP growth, which are considered to be important macroprudential indicators that should be incorporated in policy rules, see for example Brunnermeier et al (2009). As with house prices and the current account, we tested the robustness of our specification in the general equation by including the first three lags of each of these variables in turn, to see whether the first lag we have chosen is appropriate. For the case of credit it was indeed the first lag that was most significant of the three, whereas for GDP growth it was the third lag (with a negative sign). Accordingly, we re-estimated the nest shown in Table 2 with the third lag of GDP instead of the first. It proved insignificant, further justifying our specification, as shown in Appendix Table A3.

A further test having bearing on the subprime's uniqueness is to assess whether the success of the equation stems from the inclusion of the 8 of the 20 crises that occurred in the subprime period. This period might be responsible for the significance of the current account, and it might be argued that the run up to the subprime crisis had other specific features that may have influenced the choice of variables, and these might be poor predictors of earlier crises. To test this, we excluded the last five observations, estimating only up to 2003. As the model uses the third lag of house price growth we avoid the latest period of increase in property prices, while current account imbalances were somewhat less marked in 2001 (at the second lag) than later in the decade.

We may estimate the final model directly, or we may test down in a similar way to that set out in Table 2. In either case we produce the model set out in table 5A which illustrates the estimated parameters. The model and its parameters remain remarkably stable even with 5 years of the observations dropped, suggesting the estimation that includes the subprime crisis is not unduly influenced by that inclusion. The defences remain capital and liquidity, the problems remain house price bubbles and current account deficits. Hence worries about these issues were justified during the run up to the sub prime period. Table 5B shows the strong in-sample performance of

the model (given an in-sample cut off given by the proportion of crises in the reduced sample space of 0.0408), with 9 out of 12 crises prior to 2004 being correctly called.

Table 5A: Equation estimated over 1980-2003

Variable	Coefficient	z-Statistic
LEV(-1)	-0.48	-4.1
NLIQ(-1)	-0.097	-2.5
RHPG(-3)	0.08	2.1
CBR(-2)	-0.43	-2.9

Table 5B: In-sample model performance based on correct calls

	Dep=0	Dep=1	Total
P(Dep=1)<=C	209	3	212
P(Dep=1)>C	73	9	82
Total	282	12	294
Correct	209	9	218
per cent Correct	74.11	75.00	74.15
per cent Incorrect	25.89	25.00	25.85

Note we use the in sample crisis rate to as our call cut-off

Given we have data for 2007 and 2008, it is straightforward to use the equation in Table 5A to forecast the probability of a crisis in any country and in nay year over the period up to and including the subprime crisis using actual values for right hand side variables. This tests whether the variables we have chosen are the key discriminators of the subprime, unlike those used in Davis and Karim (2008). The ex ante probability of crisis, which we use as a cutoff, was 0.0408 over the 1983-2003 estimation period. As can be seen from Table 7, the model predicts crises in both 2007 and 2008 in the UK and US, as well as the French and Belgian crises of 2008. The false calls in Spain occur in the context of a major property slump in that country, apparently partly offset by the "dynamic provisioning" policy adopted by banks at the supervisors' behest, and because many of the losses that were incurred fell in the provincial state owned savings bank system and hence were covered by provincial taxpayers without obvious central government action taking place until after the end of our sample. We note that other than the 5 countries cited, the model does not give false alarms elsewhere (apart from the Netherlands in 2004 and Denmark in 2008[22]). Indeed, in countries such as Japan and Norway, which were little touched by the crisis, the probabilities are close to zero in both 2007 and 2008. Our conclusion that the subprime is not unique is strongly supported.

Using our stringent test of a false call, we have 14 false alarms out of 70 observations, and 6 correct calls out of eight crises. This gives a hit rate of 75 per cent, a type 2 error rate of 20 per cent and a false call rate of 22 per cent. We can compare this exercise to that undertaken by Borio and Drehmann (2009), who report out of sample performance over the same period. Using our criterion of a direct hit they have a success rate for crisis calls of 29 per cent and a type 2 error rate of 38 to 40 per cent. We would argue that our parametric approach is a great deal more successful than their non-parametric one

[22] As discussed above, these signals were linked to earlier house price booms which generated concerns for systemic stability.

Table 6: Out of sample predictions using 1980-2003 model

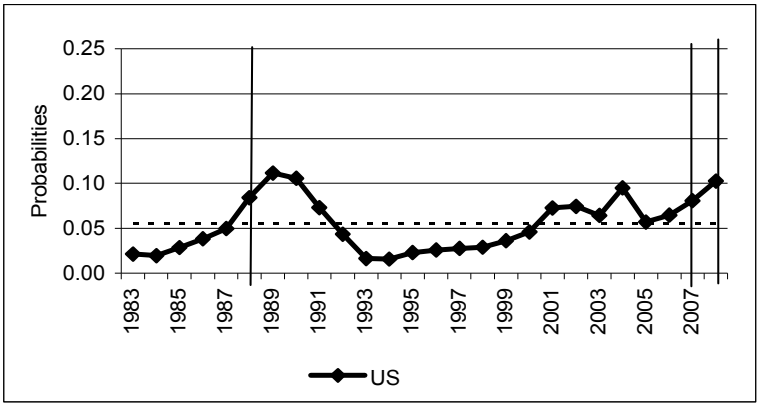
	2004	2005	2006	2007	2008
BG	0.003	0.008	0.015	0.031	**0.043**
CN	0.014	0.021	0.015	0.019	0.023
DK	0.021	0.013	0.020	0.011	**0.051**
FN	0.000	0.001	0.001	0.002	0.002
FR	0.019	0.034	**0.072**	**0.154**	**0.180**
GE	0.010	0.013	0.003	0.003	0.003
IT	0.016	0.026	0.021	0.037	0.013
JP	0.002	0.001	0.000	0.001	0.001
NL	**0.047**	0.013	0.007	0.007	0.002
NW	0.001	0.001	0.001	0.000	0.000
SD	0.006	0.001	0.003	0.003	0.002
SP	0.033	**0.066**	**0.232**	**0.531**	**0.637**
UK	**0.077**	**0.142**	**0.217**	**0.228**	**0.229**
US	**0.070**	**0.042**	**0.052**	**0.069**	**0.091**

Note:BG-Belgium, CN-Canada, DK-Denmark, FN-Finland, FR-France, GE-Germany, IT-Italy, JP-Japan, NL-Netherlands, NW-Norway, SP-Spain, SD-Sweden, UK-United Kingdom, US-USA.

5 Factors affecting the development of crisis in the US

As a case study, using the 1980-2008 model from Table 2, we focus on the long term pattern for the United States, where as noted the model predicts the subprime crisis well. In Chart 1, we show the pattern of US crisis probabilities, showing that besides the subprime crisis, the model predicts the peak of the Savings and Loans debacle and accompanying banking crisis in 1988, remains high in the run up to the credit crunch in 1991, and also indicates heightened risks in 2001-2 (during the equity bear market) and in 2004.

Chart 1: US crisis probability in-sample



It is possible to decompose the changes in the probabilities according to their drivers, and we do that in Table 7 for the 5 years preceding the sub-prime crisis, using the parsimonious logit estimate from 1980 to 2008 as shown in Table 2. The final equation for calculating the probability for the US in year *t* is shown below

$$pcrisis_{US,t} = \frac{1}{1+e^{-\left(-0.34 lev_{US,t-1} - 0.11 nliq_{US,t-1} + 0.08 rphg_{US,t-3} - 0.24 cbr_{US,t-2}\right)}} \quad (3)$$

The contribution of each variable to a change in the probability between the adjacent years (taking LEV for example) is calculated as follows:

$$pcrisis_{US,t} - pcrisis_{US,l,t-1} = \frac{1}{1+e^{-\left(-0.34 lev_{US,t-1} - 0.11 nliq_{US,t-1} + 0.08 rphg_{US,t-3} - 0.24 cbr_{US,t-2}\right)}} - \frac{1}{1+e^{-\left(-0.34 lev_{US,t-2} - 0.11 nliq_{US,t-1} + 0.08 rphg_{US,t-3} - 0.24 cbr_{US,t-2}\right)}} \quad (4)$$

Similar calculations were undertaken for the other three remaining variables. As the relationship is not linear, the sum of all contributions from the right hand side variables do not exactly equal to the change in the predicted probability. The remaining term accounts for the interaction between the independent variables which we can calculate by summing two or three individual marginal contributions and comparing that to a marginal contribution where two or three of the driving variables are allowed to vary. We call the sum of these terms the adjustment (Adj for interaction) and add it to the direct contributions of the right hand side variables. The cumulative change in the probability and its contributing variables over a certain time period is just a sum of the changes in the probabilities and the sum of contributions by each variable over that time span.

Table 7: Incremental contribution to change in US crisis probabilities from 2005-2008

	Initial level	Contribution from					TOTAL after adj
		NLIQ	LEV	RHPG	CBR	Adj for Interaction	
05-04	0.057	-0.019	-0.017	-0.002	0.005	0.003	-0.038
06-05	0.065	0.003	-0.000	-0.003	0.008	-0.000	0.007
07-06	0.081	0.002	-0.009	0.013	0.009	-0.000	0.016
08-07	0.103	0.005	0.005	0.012	0.003	0.002	0.022
cum change	0.046	0.010	-0.004	0.022	0.019	0.001	0.046

Note: Cumulative change in the initial level of probability refers to the difference between cells "08-07" and "05-04", while for all contributing components it is the sum of all cells from "06-05" to "08-07".

The first column of Table 7 shows the crisis probability level for the US in each year whilst the next five columns give the contributions of the year-by-year changes in the independent variables for the United States from 2005 to 2008. Looking at the cumulative effect from 2005-2008, it is evident that the largest contributions overall are from the change in real house prices and the current account, followed by narrow liquidity, with capital adequacy contributing negatively (i.e. better capitalisation according to the data, reducing the risk of crisis). However, in the interim between the initial and later crisis in 2007-8, all variables were heightening crisis risk, including

lowering of unweighted capital adequacy. Meanwhile, the adjustment term is non zero, and there are interactions between variables, which are mainly between real house price growth and the current account balance and not between either of these, and capital adequacy and liquidity.

We can use the same structure to estimate the extent to which banking regulation in the US could have been tightened sufficiently to reduce the probability of a crisis a given crisis probability in 2007 and 2008. In order to do this we construct counterfactual changes in order to assess how much tightening might have been needed to offset risks arising from external variables as well as to compensate for low levels of these variables themselves. As shown in Table 8, we calculate the impact of capital adequacy and liquidity on crisis probability by increasing requirements first for both variables and then one at a time. The overall pattern suggests that a balanced tightening of around 1.0 in the first year and 1.6 percentage points in the second year in both ratios would be sufficient to reduce the risk of crisis to the sample mean.

Table 8: Regulatory tightening required in the US to reduce crisis probabilities in 2007 and 2008 to sample mean of 0.0555.

	initial probability	initial level of nliq(-1)	initial level of lev(-1)	increase in					
				nliq(-1)	lev(-1)	nliq(-1)	lev(-1)	nliq(-1)	lev(-1)
2007	0.081	7.202	10.345	0.95	0.95	3.75	0	0	1.25
2008	0.103	6.750	10.195	1.55	1.55	6.1	0	0	2.05

The above is quite a modest policy adjustment since it only reduces the risk of crisis to the sample mean, which at 0.0555 is around one crisis every 18 years. It might be thought that this still puts the economy at too great a risk from the consequences of systemic banking crises (see Barrell et al (2010b) for a review of the literature on costs of crises). A more demanding criterion is to reduce the risk of crises to one in 100 years, reducing the probability to 0.01. As shown in Table 9, this necessitates a considerable rise in capital or liquidity if the relevant lever is utilized alone, requiring a 7 percentage point increase in unadjusted capital adequacy or a 21 percentage point rise in liquidity ratios. On the other hand, a balanced approach would need about 5 percentage points on each ratio, still a quite demanding rise from the point of view of the banks.

Table 9: Regulatory tightening required in the US to reduce crisis probabilities in 2007 and 2008 to one in 100 years (i.e. 0.01).

	initial probability	initial level of nliq(-1)	initial level of lev(-1)	increase in					
				nliq(-1)	lev(-1)	nliq(-1)	lev(-1)	nliq(-1)	lev(-1)
2007	0.081	7.202	10.345	4.7	4.7	18.8	0	0	6.2
2008	0.103	6.750	10.195	5.3	5.3	21.3	0	0	7

It is important to note that regulatory tightening would not be costless for the wider economy, since higher capital and liquidity requirements induce banks to raise lending margins, and hence adversely affecting the user cost of capital, investment and the capital stock. As Barrell et al (2009) show, deciding on the appropriate level of regulatory tightening necessitates a balancing of such costs of regulation with the benefits of lower crisis risk that we have estimated in this

paper. Global agreement will necessitate assessing the differing effects of regulation between countries also and finding an appropriate compromise.

As regards such costs, Barrell et al (2009) suggest that reforms introduced solely in the UK gradually should have a long run impact of around –0.1 per cent on GDP per percentage point increase in required capital and liquidity. The Financial Stability Board (2010) has comparable median predictions for individual countries. Barrell, Holland and Karim (2010) show that the effects are much lower than –0.1 per cent if all countries move together to tighter regulation – around –0.03 per cent or lower per percentage point increase in liquidity and capital. This is because, when all OECD countries act together, the initial impact is to lower investment and raise saving. Real interest rates fall as a result. As equity markets reflect the discounted value of future profits and the discount rate has fallen the equity price rises and the cost of equity finance falls. These two effects offset about two thirds of the output costs we identified when the UK acted alone.

6 Conclusion

We have shown that bank regulatory variables and asset prices along with the current balance impacted on the probability of banking crises in OECD countries over 1980-2008. The subprime crisis was not unique - the specification we uncover with these variables is stable to the exclusion of individual countries and of the last 5 years of data. This exercise illustrates that not only are the patterns preceding the recent subprime crisis in many ways not unprecedented, but also a model such as that outlined here could have helped the authorities to forecast the crisis and to take appropriate regulatory measures. This was notably the case for the US, the epicenter of the subprime crisis, as well as the UK, the country hardest hit. Indeed we have shown that the crisis would have been predicted a number of years ahead if the actual values of right hand side variables were employed, using logit estimates developed on data available up to 2003. This is in sharp contrast to the results of Davis and Karim (2008) using traditional variables and a global sample, which was totally unable to forecast the crisis in the US.

Decomposing the estimates for the US, we find that the 2005-2008 period was characterized by a rise in risk largely from aspects external to the banking system, namely current account imbalances and asset prices. But in the last year before Lehman's failure, regulatory slackness was also a contributing factor, as unweighted capital adequacy and narrow liquidity ratios were allowed to decline.

We have calculated the degree of tightening of regulation that would be needed to bring the probability of a crisis down to one in 100 years for that country requires a substantial regulatory tightening, of around 7 percentage points on capital or no less than 21 percentage points more liquidity. Whereas this would be very challenging to the banking system, and would itself adversely affect the real economy via widening of bank margins, such a policy should not be ruled out a priori, given the extremely high costs of banking crises.[23] These prescriptions could be either "levels" increases in capital and liquidity to be sustained at all times or a "target" level to be attained at the peak of the boom in a countercyclical macroprudential policy. The macroeconomic effects would be mitigated if all countries act together in tightening.

[23] A calculation of overall costs and benefits of regulatory tightening in the UK is provided in Barrell et al (2009).

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APPENDIX 1: CRISIS SAMPLE

Table A1: Crisis onset dates

Crisis	BDKL	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
Norway	1990	1990	**1991**	**1987**	**1987**		
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)

APPENDIX 2: CORRELATIONS

It can be seen from Table A2 below, that correlations between the independent variables are low, thus reducing concern about multicollinearity. More systematically we use the Breusch Pagan (1980) test for cross section dependence to investigate the orthogonality of regressors. According to the test, the correlation coefficients are distributed as a standard normal variate where N is the cross section dimension and T is the time dimension

$$CD = (1/(N(N-1))^{**}(1/2)^{*}(\sum_{i=1,N}\sum_{j=i+1,\,N-1}(T\,\rho_{ij}^{\,**2} - 1)$$

In neither case below is there any significant indication of correlation, In the first case of contemporaneous variables the standard normal deviate is -0.73 and in the case of the chosen lags it is -0.71 whereas the 95 percent two sided bound is 1.96. Hence we can be certain there are no interdependences in the data set.

Table A2: Correlations between independent variables

Contemporaneous correlations

	LEV	NLIQ	RHPG
NLIQ	-0.14		
RHPG	0.17	-0.13	
CBR	-0.22	-0.06	0.08

Correlations of chosen lags

	LEV(-1)	NLIQ(-1)	RHPG(-3)
NLIQ(-1)	-0.14		
RHPG(-3)	0.15	-0.20	
CBR(-2)	-0.22	-0.07	-0.03

APPENDIX 3: NEST WITH THIRD LAG OF GDP GROWTH

Table A3: Nested logit

Step	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
LEV(-1)	-0.16 (-1)	-0.16 (-1)	-0.16 (-1)	-0.17 (-1.1)	-0.16 (-1)	-0.19 (-1.3)	-0.27 (-3)	-0.34 (-4.1)
NLIQ(-1)	-0.1 (-2.2)	-0.1 (-2.2)	-0.1 (-2.3)	-0.09 (-2.3)	-0.09 (-2.4)	-0.09 (-2.2)	-0.11 (-3.2)	-0.11 (-3.3)
RHPG(-3)	0.11 (2.8)	0.11 (2.8)	0.11 (2.8)	0.1 (2.8)	0.1 (2.8)	0.1 (2.8)	0.1 (2.8)	0.08 (2.4)
CBR(-2)	-0.17 (-1.7)	-0.17 (-1.7)	-0.17 (-1.7)	-0.19 (-2)	-0.18 (-1.9)	-0.21 (-2.4)	-0.23 (-2.7)	-0.24 (-2.8)
DCG(-1)	-0.01 (-0.2)	-0.01 (-0.2)	0	0	0	0	0	0
YG(-3)	-0.2 (-1.2)	-0.2 (-1.2)	-0.21 (-1.2)	-0.22 (-1.3)	-0.2 (-1.3)	-0.19 (-1.2)	-0.21 (-1.4)	0
C	-1.27 (-1)	-1.27 (-1)	-1.24 (-1)	-1.14 (-1)	-1.23 (-1.1)	-0.71 (-0.7)	0	0
BB(-1)	-0.02 (-0.3)	-0.02 (-0.3)	-0.03 (-0.4)	0	0	0	0	0
RIR(-1)	0.1 (1)	0.1 (1)	0.09 (1)	0.1 (1)	0.06 (0.9)	0	0	0
INFL(-1)	-0.08 (-0.5)	-0.08 (-0.5)	-0.08 (-0.5)	-0.09 (-0.6)	0	0	0	0
M2RES(-1)	0.0000085 (0.2)	0	0	0	0	0	0	0