Financial protection and global and regional product regulation:

EVALUATING OFF BALANCE SHEET EXPOSURES IN CRISIS DETERMINATION MODELS

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Abstract: Given the effect off-balance sheet activity of banks' have had on vulnerability to crises, we test for the impact of off balance sheet exposures on the probability of banking crises in OECD countries since 1980. Variables capturing off balance sheet activity has been neglected in most early warning models to date, mainly due to the lack of the data. We find that a proxy of off-balance sheet activity of banks' is significant in a parsimonious logit model also featuring bank capital adequacy, liquidity, changes in house prices and current account balance to GDP ratio, hence adding one more dimension to the explanation of the patterns immediately preceding the subprime crisis. We consider it essential that regulators take into account above proxy to allow successful estimation of the impact of off-balance sheet exposures on systemic risk.

Keywords: Banking crises, logit, off balance sheet activity

1 Introduction

Public commentary on the recent sub-prime crisis has repeatedly highlighted the role of banks' off-balance sheet (henceforth OBS) activities. Figures highlighting the exposure of banks to OBS risks have been widely cited[1]. Structured investment vehicle (SIVs) and conduits for example were often lightly regulated with little capital cover, and the authorities were in some cases surprised by the volume of such activity that came to light in the crisis. Academic commentators have also started to focus on the design of banks' OBS vehicles, but to our knowledge there are no formal systematic cross country empirical investigations of their impact in the context of the sub-prime episode. We suggest the dearth of empirical work arises largely from a paucity of data and not from a lack of underlying justification. Indeed, both banking theory and the major impact OBS activities have had on banks' profits argue for a major effort to be made with research.

We investigate the effect of off-balance sheet activity on banks' vulnerability to crises. First, we briefly provide a theoretical justification for research into off-balance sheet activity, and then based on recent work by Barrell et al (2010) illustrate that alongside regulatory variables such as leverage and liquidity ratios and macro indicators such as the change in house prices and current account balance to GDP ratio, the change in the ratio of off to on balance sheet actvity plays a significant role in predicting banking crisis.

The paper is structured as follows. In the first section, we provide some background and overview of the literature concerning the off balance sheet asset exposures in OECD country banking crises generally. In the second section we go through the methodology for constructing a variable proxying off balance sheet asset activity of banks and reflect on the data issues. The third section covers the estimation and analyzes the results. The fourth section concludes.

2 Background and literature

The key difficulty for researchers in this area is finding appropriate data or estimates of OBS. The basis of our calculations of OBS comes from Boyd and Gertler (1994) who investigated the contemporary claim that the role of bank intermediation in credit allocation had declined in the US. They found that such claims were made on the basis of standard measures of banking activity (such as the ratio of bank assets to total credit or bank credit to GDP). These measures did not take into account banks' securitizations and other off balance sheet and non-interest activities (which also include loan sales, backup lines of credit, and risk sharing through derivatives). The process involved is often referred to as the unbundling of intermediation. Other key forms of non interest income are profits on proprietary trading, fees and service charges on deposits, securities underwriting fees and commissions on brokered securities transactions for third parties. Technical change, deregulation, globalization, increased and transformed wealth of individuals and increased competition are factors

[1] See http://articles.moneycentral.msn.com/Investing/ContrarianChronicles/BanksDarkOffBalanceSheetWorld.aspx, http://blogs.reuters.com/rolfe-winkler/2009/09/17/ending-the-off-balance-sheet-charade/ and http://www.bloomberg.com/apps/news?pid=20601110&sid=akv_p6LBNIdw for recent examples.

that underlie these shifts, as well as historically lower capital adequacy requirements for off balance sheet activities, see also Davis and Tuori (2000).

Boyd and Gertler took into account the shift of commercial banking towards OBS activities and showed that the declining role of US banks was no longer apparent in their estimates. They used the rate of return on balance sheet assets to derive a measure of OBS assets based on the scale of non interest income. It was assumed that non interest income was generated by implicit off balance sheet assets with the same risk and return characteristics as that of on balance sheet activity as indicated by net interest income. The authors note that a similar form of capitalization of certain OBS activities that entailed risk exposure into credit equivalents was required under Basel 1 for capital adequacy purposes. More details of the methodology are provided below.

The pattern of growing non interest income and its implications for intermediation were also noted by Rogers (1998) who pointed out that from the late 1960s US banks had reduced their reliance on interest income from traditional activities, placing increasing importance on the fee-based incomes they generated from securitization. Davis and Tuori (2000) found similar patterns in Europe.

Recently Acharya and Richardson (2009) noted that the move towards securitization-generated income was a feature that characterized the market based banking systems of several OECD economies. They argue that the post-2000 explosion of asset backed security (ABS) issuance was driven by banks' desire to avoid holding costly capital against their assets. One way banks did this was by removing assets off the balance sheet by holding asset backed securities in SIVs and conduits, for which banks then guaranteed the asset backed commercial paper financing. The other was holding other banks' AAA ABS tranches on balance sheet. The authors suggest that this regulatory arbitrage was the main cause of the sub-prime episode. Only the on balance sheet form of regulatory arbitrage will be captured by conventional measures of capital-assets ratios, and even there, a leverage based measure rather than a risk based capital adequacy measure would best have indicated the risks.

The increase in OBS throughout many banking systems may be due to banks' desire to mimic the business strategies of their peers. Farhi and Tirole (2009) suggest that the maturity mismatch within SIVs and conduits (between long-term mortgage backed assets and the short term commercial paper used to finance them) was a structural feature of the business models of most banks who displayed strategic complementarities with their peers. When authorities use monetary policy to bail out failing banks, society incurs a fixed cost which is only justified if sufficient banks need bailing out. Therefore each individual bank correlates its risk exposure with other banks such that OBS risks can become systemically high.

Finally Feldman and Lueck (2007) replicated the Boyd-Gertler calculations for US data up to 2006. They found that capitalizing non interest income gave a roughly constant share of banks in total intermediation. They noted limitations to the Boyd-Gertler approach, notably the assumption that banks generate equal profitability from on and off balance sheet activity, but nonetheless found it plausible, Clearly, if banks

are more competitive in traditional lending than in non interest generation,[2] the latter could include a wider margin and hence OBS could be overestimated. Meanwhile conclusions about banks' overall share of intermediation cannot be drawn without allowing for the non interest activity of non banks for which data are not available. However, the method should capture trends in OBS even if the scale of activity is not correctly measured, and it is these trends that are central to our argument below.

As the recent crisis has shown, capital adequacy and liquidity ratios that did not take into account the riskiness of OBS activities and assets may have appeared healthy or consistent with regulatory rules, but were in fact weak due to the undercapitalization of OBS activity. Accordingly, our aim is to take into account the degree of overall OBS activity by banks and the first step therefore is to estimate the amount of OBS assets held by the banking system of each sample country.

3 Methodology and Data

In this section we discuss approaches and methodology used to arrive at the measure of banks' OBS activity, as well as data problems and limitations encountered together with the steps taken to overcome the constraints.

We first sought to obtain a time series of the OBS assets of each 14[3] OECD economy's banking system in our sample using the "Bankscope" data base which actually lists several variables related to banks' off-balance sheets. However several problems with deriving off balance sheet data from this source emerged, mostly arising from inconsistency and patchy reporting in the underlying financial statements of banks. A list of issues connected to the "Bankscope" data provided in appendix 1.

Given the problems associated with the Bankscope data, we decided to investigate whether more consistent and reliable time series of banking systems' OBS positions could be constructed. Accordingly we opted to use the approach of Boyd and Gertler (1994) who had already estimated US banks OBS activities during 1961 – 1993.

Boyd and Gertler (1994) assume that all non-interest income is generated by securitizations and similar forms of assets that are stored off balance sheet, and that the return on assets on and off balance sheet are equal. These assumptions allow us to capitalize non-interest income using the balance sheet return in order to derive an estimate of OBS assets. We may write:-

$$\Pi = I - E - P - N + Y \qquad (1)$$

Where Π are bank profits, I is interest income, E is interest expense, P is loan loss provisions, N is non interest expense (i.e. staff and other operating costs shared across the institution) and Y is non interest income. Balance sheet values for I, E and P cover

[2] De Bandt and Davis (2000) in a study of the competitiveness of banking systems, found that the competitive position for interest generating and non interest generating activities varied between countries. In the US non interest income was found to be a more competitive market than interest income, while in France the opposite was true. In Germany and Italy positions were comparable.

[3] 14 OECD countries included in our analysis together with their abbreviations are: Belgium-BG, Denmark-DK, Canada-CN, Finland-FN, France-FR, Germany-GE, Italy-IT, Japan-JP, Netherlands-NL, Norway-NW, Spain-SP, Sweden-SD, the United Kingdom-UK and the U.S.A.-US

only on balance sheet activity whilst Π, N and Y cover all activities. In our decomposition below the subscript o denotes on balance sheet and b denotes off balance sheet. If we assume rates of return are equal we have the following identity of on balance sheet (A_b) and implicit off balance sheet assets (A_o), where the latter generates the non-interest income Y which can be decomposed into I_b , E_b and P_b.

$$(I_b - E_b - P_b - N_b)/A_b = (I_o - E_o - P_o - N_o)/A_o \quad (2)$$

We follow Boyd and Gertler and assume that there is symmetry between on balance sheet and on balance sheet assets in terms of non interest expenses.

$$N_b/A_b = N_o/A_o \quad (3)$$

Combining the equations (2) and (3) and rearranging gives:

$$A_b = A_o(I_b - E_b - P_b)/(I_o - E_o - P_o) \quad (4)$$

The denominator of (4) is net interest income minus loan loss provisions, while the numerator is not directly observable. However we know that Y is the net income generated by OBS activities before deducing non interest expense, and if we substitute this into (4) and suppress the on balance sheet subscript we may write

$$A_b = A_o\,[Y/(I - E - P)] \quad (5)$$

All these variables can be found on profit and loss statements, including the OECD Income and Balance Sheet database. We have included fee income as if it were an income flow on an asset, whilst Boyd and Gertler adjust OBS activity down for non-risky off balance sheet activities by assuming all OBS in 1961-70 were non-risky trust type activities and service charges on deposits, and that the proportion stayed constant. We did not have scope to make this latter adjustment and have generated a series which is in effect an upper bound of risky OBS

The advantage of the Boyd and Gertler approach is that it utilizes balance sheet and profit and loss series which are easier to obtain than OBS data and are more consistently reported. The variables used to construct the OBS estimate are net interest income, net non-interest income, provisions on loans and total assets. These are reported in the OECD Banking Income Statement and Balance Sheet online database for our sample period. Table 1 shows the ratios of OBS assets to on balance sheet assets computed using the Boyd and Gertler method and the corresponding OECD data coverage. This can also be seen as the ratio of on to off balance sheet activities, and if off balance sheet activity is more risky (because less regulated) then this ratio should play a role in crisis determination models.

An immediate problem with this table is the gaps in the data for Belgium, Canada, France, Italy and Japan. A further problem arises with the OECD data, namely the OECD's figures for net non-interest income for Japan and Denmark are negative in some years, indicating higher non-interest expenses incurred compared to non-interest income. The negative ratio of OBS assets/ on balance sheet assets for Norway comes from very large net provisions figure in a corresponding year.

Table 1: Off to on balance sheet assets ratios

	Belgium	Canada	Denmark	Finland	France	Germany	Italy	Japan	Neths	Norway	Spain	Sweden	UK	US
1980	na	na	0.66	0.66	na	0.29	na	na	0.46	0.26	0.21	0.54	0.41	0.36
1981	0.18	na	0.74	0.76	na	0.29	na	na	0.55	0.28	0.20	0.53	0.39	0.46
1982	0.24	na	1.05	0.80	na	0.28	na	na	0.47	0.28	0.23	0.57	0.57	0.58
1983	0.29	na	3.13	0.87	na	0.26	na	na	0.41	0.30	0.22	0.57	0.65	0.57
1984	0.22	na	0.25	0.97	na	0.27	0.43	na	0.45	0.40	0.21	0.55	0.71	0.51
1985	0.28	na	2.01	1.19	na	0.32	0.45	na	0.41	0.50	0.23	0.70	0.64	0.54
1986	0.30	na	-0.21	1.18	na	0.31	0.45	na	0.37	0.54	0.22	0.69	0.69	0.64
1987	0.34	na	0.24	1.16	na	0.30	0.39	na	0.36	0.28	0.27	0.49	1.14	0.63
1988	0.44	0.46	0.94	1.57	0.27	0.26	0.38	na	0.39	0.65	0.29	0.56	0.63	0.52
1989	0.42	0.58	0.42	1.09	0.28	0.45	0.34	0.52	0.46	0.66	0.25	0.56	1.22	0.72
1990	0.26	0.49	0.26	0.99	0.34	0.48	0.35	0.52	0.46	0.60	0.26	0.40	0.92	0.62
1991	0.33	0.53	0.30	1.07	0.43	0.38	0.34	0.27	0.50	-1.47	0.28	0.16	1.18	0.63
1992	0.37	0.68	-0.23	1.40	0.76	0.39	0.25	0.16	0.48	0.61	0.32	0.55	1.38	0.55
1993	0.49	0.63	0.46	1.37	1.46	0.40	0.47	0.20	0.59	0.63	0.61	0.88	1.24	0.54
1994	0.40	0.60	-0.19	0.87	1.09	0.32	0.40	0.09	0.44	0.25	0.37	0.51	0.87	0.48
1995	0.51	0.57	0.64	0.27	1.67	0.32	0.33	0.30	0.55	0.34	0.37	0.51	0.86	0.51
1996	0.54	0.60	0.58	0.53	1.45	0.32	0.42	0.12	0.62	0.34	0.45	0.72	0.71	0.56
1997	0.75	0.84	0.54	0.57	1.71	0.39	0.55	1.55	0.73	0.39	0.50	0.89	0.68	0.60
1998	0.79	0.91	0.68	0.36	2.06	0.69	0.68	-0.69	0.78	0.33	0.58	1.35	0.73	0.70
1999	0.68	1.11	0.71	0.53	1.48	0.52	0.71	0.33	0.82	0.36	0.52	1.04	0.77	0.73
2000	1.10	1.32	0.94	0.65	1.94	0.74	0.66	0.08	0.97	0.39	0.67	1.20	0.86	0.76
2001	1.10	1.27	0.81	1.67	2.38	0.79	0.57	-0.82	0.97	0.40	0.52	1.11	0.92	0.83
2002	0.77	1.14	0.71	0.73	1.65	0.90	0.51	-0.67	0.80	0.34	0.58	0.80	0.99	0.81
2003	0.79	0.99	0.80	1.38	1.65	0.60	0.57	0.19	0.75	0.42	0.58	0.85	1.15	0.83
2004	0.57	0.98	0.94	0.67	1.86	0.35	0.53	na	0.77	0.39	0.56	0.82	1.56	0.75
2005	0.64	1.09	0.91	0.51	1.64	0.66	0.55	na	0.89	0.44	0.63	1.07	1.71	0.76
2006	1.39	1.20	1.22	0.60	3.30	0.62	0.76	na	1.09	0.40	0.78	2.24	1.83	0.78
2007	1.69	1.17	1.07	0.75	3.91	0.62	0.61	na	1.32	0.43	0.74	1.36	1.57	0.80

Source: OECD and FSA (for the UK)

Missing observations can be filled in using older versions of the OECD[4] reports or national data where feasible. In limited cases, when no other data are available, gaps are filled by applying average growth rate of the adjacent three years to the missing year. This is the case in Belgium, Canada, France, Italy and Japan in 1980 and Canada 1980 and 1981.

As for the negative ratios of OBS assets/on balance sheet assets or activities, while the Japanese, Norwegian and Danish banking systems may have faced some stresses around the time of the negative observations, we still need to consider if these negative figures for estimated OBS are realistic. A more appropriate method may be to assume that OBS activity on a gross basis can become zero but cannot be negative. The data after the adjustments and additions are shown in Table 2.

Table 2 illustrates different patterns of OBS activity across countries as well as over the time. The majority of countries exhibit higher ratios of off/on balance sheet assets or activities over the second half of the period as compared to the first half, although some show much stronger rises in OBS exposures than others. The lowest average ratio over the sample period is observable for Germany, Italy, Japan, Norway and Spain, while France, UK, Finland, Sweden, Canada and Denmark have the highest average ratios. It can be seen that countries often grew their off-balance sheet exposures during tranquil times. For example, UK OBS activity grew strongly in the period up to 2006. Hence it may be that the change in off-balance sheet exposures and not just the measure for the size of off-balance sheet assets is an important crisis predictor.

[4] Bank profitability; Financial statements of banks OECD (hard copy)

Table 2: Off balance sheet/on balance sheet asset ratios with gaps filled and negatives smoothed out

	Belgium	Canada	Denmark	Finland	France	Germany	Italy	Japan	Neths	Norway	Spain	Sweden	UK	US
1980	0.14	0.31	0.66	0.66	0.20	0.29	0.59	0.35	0.46	0.26	0.21	0.54	0.41	0.36
1981	0.18	0.31	0.74	0.76	0.22	0.29	0.52	0.31	0.55	0.28	0.20	0.53	0.39	0.46
1982	0.24	0.34	1.05	0.80	0.23	0.28	0.53	0.24	0.47	0.28	0.23	0.57	0.57	0.58
1983	0.29	0.33	3.13	0.87	0.25	0.26	0.39	0.25	0.41	0.30	0.22	0.57	0.65	0.57
1984	0.22	0.36	0.25	0.97	0.18	0.27	0.43	0.31	0.45	0.40	0.21	0.55	0.71	0.51
1985	0.28	0.38	2.01	1.19	0.21	0.32	0.45	0.37	0.41	0.50	0.23	0.70	0.64	0.54
1986	0.30	0.40	1.07	1.18	0.23	0.31	0.45	0.35	0.37	0.54	0.22	0.69	0.69	0.64
1987	0.34	0.49	0.24	1.16	0.27	0.30	0.39	0.49	0.36	0.28	0.27	0.49	1.14	0.63
1988	0.44	0.46	0.94	1.57	0.27	0.26	0.38	0.62	0.39	0.65	0.29	0.56	0.63	0.52
1989	0.42	0.58	0.42	1.09	0.28	0.45	0.34	0.52	0.46	0.66	0.25	0.56	1.22	0.72
1990	0.26	0.49	0.26	0.99	0.34	0.48	0.35	0.52	0.46	0.60	0.26	0.40	0.92	0.62
1991	0.33	0.53	0.30	1.07	0.43	0.38	0.34	0.27	0.50	0.64	0.28	0.16	1.18	0.63
1992	0.37	0.68	0.42	1.40	0.76	0.39	0.25	0.16	0.48	0.61	0.32	0.55	1.38	0.55
1993	0.49	0.63	0.46	1.37	1.46	0.40	0.47	0.20	0.59	0.63	0.61	0.88	1.24	0.54
1994	0.40	0.60	0.60	0.87	1.09	0.32	0.40	0.09	0.44	0.25	0.37	0.51	0.87	0.48
1995	0.51	0.57	0.64	0.27	1.67	0.32	0.33	0.30	0.55	0.34	0.37	0.51	0.86	0.51
1996	0.54	0.60	0.58	0.53	1.45	0.32	0.42	0.12	0.62	0.34	0.45	0.72	0.71	0.56
1997	0.75	0.84	0.54	0.57	1.71	0.39	0.55	1.55	0.73	0.39	0.50	0.89	0.68	0.60
1998	0.79	0.91	0.68	0.36	2.06	0.69	0.68	1.02	0.78	0.33	0.58	1.35	0.73	0.70
1999	0.68	1.11	0.71	0.53	1.48	0.52	0.71	0.33	0.82	0.36	0.52	1.04	0.77	0.73
2000	1.10	1.32	0.94	0.65	1.94	0.74	0.66	0.08	0.97	0.39	0.67	1.20	0.86	0.76
2001	1.10	1.27	0.81	1.67	2.38	0.79	0.57	0.12	0.97	0.40	0.52	1.11	0.92	0.83
2002	0.77	1.14	0.71	0.73	1.65	0.90	0.51	0.15	0.80	0.34	0.58	0.80	0.99	0.81
2003	0.79	0.99	0.80	1.38	1.65	0.60	0.57	0.19	0.75	0.42	0.58	0.85	1.15	0.83
2004	0.57	0.98	0.94	0.67	1.86	0.35	0.53	0.08	0.77	0.39	0.56	0.82	1.56	0.75
2005	0.64	1.09	0.91	0.51	1.64	0.66	0.55	0.15	0.89	0.44	0.63	1.07	1.71	0.76
2006	1.39	1.20	1.22	0.60	3.30	0.62	0.76	0.10	1.09	0.40	0.78	2.24	1.83	0.78
2007	1.69	1.17	1.07	0.75	3.91	0.62	0.61	0.03	1.32	0.43	0.74	1.36	1.57	0.80
Average	0.57	0.72	0.83	0.90	1.18	0.45	0.49	0.33	0.64	0.42	0.42	0.79	0.96	0.64

Table 3: Breakdown of activity by components

(Annual averages of growth rates)

	Net interest income		Net non-interest income		Net provisions	
	2001-1996	2007-2002	2001-1996	2007-2002	2001-1996	2007-2002
Belgium	0.007	0.002	0.174	0.096	-0.028	0.191
Canada	0.047	0.037	0.188	0.045	0.142	0.030
Denmark	0.031	0.036	0.094	0.119	0.024	0.281
Finland	0.045	0.051	0.518	0.053	-3.840	0.186
France	-0.019	-0.041	0.105	0.069	-0.057	-9.118
Germany	0.028	0.026	0.199	0.070	0.128	0.025
Italy	0.044	0.019	0.151	0.080	0.094	-0.164
Japan	-0.018	-0.019	-2.077	-0.243	0.168	-0.268
Neths	0.126	0.032	0.232	0.103	0.278	0.063
Norway	0.067	0.044	0.074	0.100	-3.225	0.243
Spain	0.067	0.080	0.118	0.153	0.220	0.080
Sweden	-0.010	0.052	0.142	0.157	-0.204	-1.977
UK	0.090	0.062	0.100	0.147	0.123	0.186
US	0.052	0.057	0.120	0.049	0.212	0.161

Table 3 decomposes the factors affecting the balance sheet and average annual growth rates of net income, net non-interest income and net provisions are compared over the last two six year periods (chosen as such to compare activities leading to the subprime crisis to ones that were not "contaminated" by the same type of actions). It can be seen that countries with the lowest average ratios of OBS activity did not have their non-interest income outstripping interest income over the course of the last decade. However for countries having the highest ratios of OBS exposures, in general we observe non-interest income growth being higher compared to net interest income. Increases in net non-interest income for example outstripped rises in net interest

income in Denmark, while in the UK for the last six years, non-interest income on average has grown 1.5 times faster as compared to the previous period and interest income growth has slowed by around 30%. Charts containing developments in all the above components over the entire sample period (allowing for missing observations) are illustrated in appendix 4.

5 Estimation and results

As already noted above, the baseline for our analysis is the approach by Barrell et al (2010). The look at the role of capital adequacy, liquidity provisions, real house price growth and the current balance as a percent of GDP along with the more traditionally used variables, GDP growth, domestic credit growth, the M2/FX reserves ratio, inflation, real interest rates and budget balance to GDP ratio (see for example, Demirguc-Kunt and Detragiache, 1998, 2005). In this paper we add variables that are intended to capture the OBS activity by banks and use the general to specific approach to arrive at the final specification of the equation. We check for in sample performance of the model and conduct a set of robustness test to assess the sensitivity of our results. We look at crises in 14 OECD countries over the period 1980 to 2008, as do Barrell et al (2010)

Barrell et al (2010) demonstrated that, the probability of banking crisis in 14 OECD countries can be predicted by four variables: two macroprudential indicators, banks' unadjusted capital adequacy and narrow liquidity and two real economy "vulnerability" variables, the change in residential property prices and the current account (to GDP ratio). Although this model was shown to be extremely robust, a more subtle model would encompass the uncompensated risks generated by banks' off-balance sheet positions. As previously noted, capital adequacy and liquidity ratios may appear healthy in terms of on-balance sheet activity but do not necessarily compensate for risky off- balance sheet holding. Therefore we introduce and test for the significance of the proxy variables for overall OBS exposures by banks.

We use a multinomial logit method to regress a banking crisis variable (which is one for the onset of the crisis and 0 otherwise, with a full list of crisis given in appendix 6) on the four variables sited in Barrell et al (2010) together with all the "traditional" crisis determinants mentioned in the literature[5] and measures of banks' OBS activity. Both the ratios (defined as OBR) and the change in the ratios (defined as DOFFTOON) of off to on balance sheet assets or activities are used as a proxy for off balance sheet related risks, as the ratio on its own may not be enough to capture the trends developing in the banks' OBS positions. Some countries with historically high off to on balance sheet asset ratios do not necessarily have higher exposure to risk. On the other hand, those experiencing significant changes in the ratio (specifically increases) can be undergoing shifts in business strategies which expose them to new, untested risks.

Once all variables are added, we eliminate insignificant variables step-by-step, starting with the most insignificant ones first. Table 4 shows the results of testing

[5]These variables would imply different policy recommendations from the regulatory ones included in Barrell et al (2010). In particular provisioning against credit growth, as is often recommended in relation to Spanish banks, would need to be supported by a significant role for credit growth in causing crises

down process, starting from the general form and finishing with the final form of our model[6]. It can be seen, that throughout all stages of the elimination process the first five variables in the table (namely leverage and liquidity ratios, changes in house prices, the current account balance/GDP ratio and the difference of off/on balance sheet assets or activities ratio) remained highly significant with slight variation in their parameters. The opposite is true for all the remaining variables, which were highly insignificant (except for DCG which was significant at the 90% level almost until the last step).

Table 4: Estimation results

LEV_EXT(-1)	-0.392	-0.39	-0.373	-0.331	-0.359	-0.35	-0.321	-0.371
	(0.01)	(0.01)	(0.008)	(0.004)	(0.001)	(0.001)	(0.001)	(0)
NLIQ(-1)	-0.156	-0.157	-0.152	-0.154	-0.152	-0.139	-0.127	-0.123
	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)
RHPG(-3)	0.099	0.099	0.1	0.104	0.101	0.091	0.089	0.079
	(0.013)	(0.013)	(0.011)	(0.007)	(0.009)	(0.008)	(0.008)	(0.019)
CBR(-2)	-0.266	-0.265	-0.27	-0.259	-0.273	-0.28	-0.253	-0.256
	(0.009)	(0.009)	(0.007)	(0.007)	(0.004)	(0.002)	(0.003)	(0.002)
DOFFTOON(-2)	0.023	0.023	0.023	0.026	0.026	0.025	0.024	0.022
	(0.013)	(0.013)	(0.013)	(0)	(0)	(0)	(0)	(0.001)
DCG(-1)	-0.097	-0.096	-0.096	-0.095	-0.096	-0.094	-0.065	-
	(0.077)	(0.076)	(0.077)	(0.081)	(0.08)	(0.079)	(0.157)	
YG(-1)	0.192	0.193	0.193	0.191	0.182	0.157	-	-
	(0.214)	(0.211)	(0.212)	(0.217)	(0.243)	(0.288)		
BB(-1)	-0.048	-0.049	-0.054	-0.059	-0.046	-	-	-
	(0.589)	(0.582)	(0.541)	(0.496)	(0.584)			
M2RES(-1)	0	0	0	0	-	-	-	-
	(0.6)	(0.599)	(0.571)	(0.583)				
OBR(-2)	0.003	0.003	0.003	-	-	-	-	-
	(0.608)	(0.607)	(0.603)					
RIR(-1)	0.031	0.021	-	-	-	-	-	-
	(0.76)	(0.733)						
INFL(-1)	-0.02	-	-	-	-	-	-	-
	(0.9)							

Note: sample period 1980-2008; and hence estimation period 1983 to 2007 probabilities in parenthesis;
Unweighted capital adequacy ratio (LEV_EXT), narrow liquidity/assets ratio (NLIQ), change in real house prices (RHPG), current account/GDP ratio (CBR), change in off/on balance sheet assets ratio (DOFFTOON), real domestic credit growth (DCG), real GDP Growth (YG), fiscal surplus/GDP ratio (BB), M2/ Foreign Exchange Reserves ratio (M2RES), off/on balance sheet assets ratio(OBR), inflation (INFL), real interest rate (RIR).

These results are in line with the findings of Barrell et al (2010) and Barrell et al (2010a), showing that in OECD countries asset price booms, lower defences from less stringent bank regulation together with an accompanying current account imbalance are the most important factors driving the probability of a banking crisis. And although lax monetary policy and credit booms may at times contribute to banking crises, they are not the most powerful discriminators between times of crisis onset and other periods in OECD countries.

[6] We experimented with the lag length of OBR and DOFFTOON variables, by adding up to four lags of each variable separately and eliminating ones that were insignificant and/or have a wrong sign. The second lag for both the level and difference variables was found to be significant, generating the positive coefficient.

As it can be seen from Table 4, the change in of off/on balance sheet assets or activities ratio is significant in addition to capital adequacy (LEV), the liquid asset ratio (NLIQ), the growth rate of real house prices (RHPG) and the current account to GDP ratio (CBR). The variable proxying banks' OBS activities has a positive effect on the probability of a crisis[7], hence, expansion of OBS assets or activities relative to on balance sheet assets by the banks increases crisis probability.

We check for the in-sample performance of the final model and as shown in Table 5, the Type II error[8] is 26.5% and the Type I error (a false call rate when there is a crisis) is 20%, i.e. we only miss one in five crises. The overall successful call rate (both crisis and no crisis called correctly) is 74%, with 16 out of the 20 crisis episodes captured correctly at a cutoff point of 0.055[9]. Adding DOFFTOON improves the fit of the equation as compared to the version by Barrell et al (2010), as we are able to capture correctly both more crisis as well as non crisis periods (Appendix 3 lists the estimation results together with the in sample performance of the earlier model for comparison).

Table 5: In sample model performance

	Dep=0	Dep=1	Total
P(Dep=1)<=0.055	253	4	257
P(Dep=1)>0.055	91	16	107
Total	344	20	364
Correct	253	16	269
% Correct	73.6	80.0	73.9
% Incorrect	26.5	20.0	26.1

Looking in more detail at the in sample performance of the model, all the systemic banking crises are identified. Moreover, in the case of the four missed crises (Italy 1990, UK 1995, Germany and Netherlands 2008) none can be considered systemic. As for the so-called false alarms (Type II errors), more than half of them occur prior to and/or after the crises onset, indicating that our model, on the top of identifying crisis, is able to differentiate between periods of financial stability and instability very well.

Table 6 lists details of our in-sample performance analysis. The first column shows the total number of calls recorded by the model above the threshold value of 0.055. The next two columns depict the number of crises called when there is a crisis and the number of crises recorded when there are no crises. The fourth column shows number of crises recorded by the model in the years before and/or after the crisis occurrence. The fifth column is the difference between third and fourth columns and the last column includes information concerning the timing of false calls, with the corresponding crisis year reported in brackets.

[7]Table A2 in the appendix 2 show that these variables are not strongly correlated suggesting multicollinearity is not an issue. This is reinforced by the stable nature of parameters as variables are dropped from the equation

[8] Defined as false call rate when there is no crisis

[9] Calculated as the sample mean for onset of crises i.e. 20/364

To calculate the "true" number of false calls we first identify false calls occurring in the periods adjacent to the onset of crisis (column 4) and then subtract them from the initial number of false calls (result in column 5). This leaves us with 49 instead of 91 initial false calls. The effect of timing is most apparent in the UK, which incidentally has the largest number of crises recorded over our sample period. The UK appears to have the largest number of false calls, but once the timing is taken into account, only 1 "true" false call remains. Therefore, the build up of vulnerabilities in the economy prior to the crisis combined with the weakened banking system and current account after the crisis is the reason for a comparatively high number of false calls that our model has produced. Similar patterns are observed in France, Japan and Finland, which have the largest number of false calls after the UK. Here as well, once the timing of the crisis is accounted for, the type II drops by around 60% in France and by 40-55% in Japan and Finland.

Table 6: Break down of in sample predictions

	Total calls	Crisis called	False calls (as produced by model)	False calls prior/after crisis	False calls after correction for timing	Timing of false calls
Belgium	1	1	0	0	0	
Canada	9	1	8	1	7	next year (1983)
Denmark	6	1	5	0	5	
Finland	10	1	9	4	5	prior 1 year and following 3 years(1991)
France	18	2	16	7	7	prior 6 years and next year (1994)
				2		prior 2 years (2008)
Germany	1	0	1	0	1	
Italy	0	0	0	0	0	
Japan	11	1	10	4	6	prior 2 years and next 2 years (1991)
Netherlands	5	0	5	0	5	
Norway	3	1	2	2	0	prior 2 years(1990)
Sweden	8	1	7	3	4	next 3 years(1991)
Spain	4	0	4	0	4	
UK	21	4	17	4	1	prior 1 year and following 3 years (1984)
				5		prior 3 years and following 2 years (1991)
				7		prior 7 years (2007)
US	10	3	7	3	4	next 3 years(1988)
Total	107	16	91	42	49	

As a next step, we split a sample into three sub-periods; prior to 1990, from 1990 to 2000 and from 2000 till 2008 and investigate whether any of the above sub-periods are characterized by higher or lower number of false calls (we are concentrating only on the calls that are not adjacent to the occurrences of crises). We found that number of false calls in each sub-period is quite even on the aggregate level. While country by country breakdown shows different levels of concentrations of false calls. Canada has 6 out of 7 false calls recorded before 1993, (the period prior to the introduction of inflation targeting by the Bank of Canada). Finland and France have most of their false calls occurring in the early 80's, prior to the Saving and Loan crisis. In addition, for Finland we observe significant rises in house prices, possibly a by product of significant increases in debt financing over that period. For Spain, although there was no official record of systemic or non-systemic crises in 2007 or 2008, our model shows a substantial increase in vulnerabilities in the run up to and over the subprime crisis (probability charts for all countries can be seen in the appendix 5). Therefore, the vast majority of false calls reported by the model are associated with periods of

risk accumulation in the economies or with periods of weakened economic conditions in the aftermath of crises.

We ran a set of robustness tests, first by changing the time period of estimation, then by dropping one-by-one countries with the largest number of crises and finally using the *doftoon* variable without missing observations filled in (effectively estimating an unbalanced panel). The time period is reduced to 1980-2006 to eliminate possible biases from the inclusion of the sub-prime crisis period (2007, 2008) on the estimation results, since these episodes constitute 40% of all crisis observations in our sample. The UK and the US have the highest number of crises recorded over the period of our analysis (5 and 3 correspondingly), so we exclude them from the estimation one at a time to investigate whether either of them have a significant impact of the final results. And finally, we recalculate *dofftoon* variable so it takes account of missing observations in Canada, France Italy and Japan (gaps are illustrated in table 1). Our aim in running this unbalanced panel is to check whether adding spliced data could have had a significant effect on the estimated coefficients. These tests are reported in Table 7 and in no case is there significant change in the coefficients of our driving variables or their significance levels, indicating that we have a robust specification of the model.

Table 7: Robustness test results

	Full sample	Excluding subprime crisis period	Excluding UK	Excluding US	Allowing for missing observations for OBS
	-0.37	-0.57	-0.41	-0.45	-0.4
LEV_EXT(-1)	(0)	(0)	(0)	(0)	(0)
	-0.12	-0.1	-0.13	-0.11	-0.11
NLIQ(-1)	(0)	(0.02)	(0)	(0.01)	(0.01)
	0.08	0.09	0.11	0.1	0.08
RHPG(-3)	(0.02)	(0.03)	(0)	(0.01)	(0.02)
	-0.26	-0.46	-0.24	-0.2	-0.26
CBR(-2)	(0)	(0)	(0)	(0.02)	(0)
	0.02	0.02	0.02	0.02	0.02
DOFFTOON(-2)	(0)	(0)	(0)	(0)	(0)

Note: probabilities are reported in parenthesis

Having specified the model and checked its' robustness, we run scenarios to analyse the effect new variable is having on probabilities of crises and then look at possible actions that can be taken to mitigate an increased exposure to the risk. As a first step we adjust our proxy for OBS activity by the amount necessary to decrease the crisis probability to our threshold value (0.055) in each country every year. Table 8 illustrates the results of our exercise, with 0's indicating that probability of a crisis in a given year and for a country is already below 0.055 and no adjustment is necessary, while negative numbers illustrating a required reduction in the change of OBS activity[10]. Interpretation of the numbers is not straightforward as we are looking at the

[10] Years in the table refer to the date when probabilities are calculated, therefore as *dofftoon* variable is lagged twice, the actual adjustment required to it is referred to the period two years prior(for example, probability for year 1985 is calculated by taking into account *dofftoon* in 1983, correspondingly adjustment is referring to 1983 as well).

second derivative rather than directly at the movements in the ratios. But country by country and year by year comparisons still give us useful inside concerning the higher or lower risk exposures and increased vulnerability.

Based on the table 8, different groups of countries are immediately identifiable with several the most distinct ones: first where none or almost no adjustment is required to OBS activity (Italy, Germany, Belgium); second, which had banking crises historically and correspondingly showed the elevated levels of OBS exposures (Denmark, Finland, Sweden, Japan) and finally, countries where there is an increase in OBS vulnerabilities in the run up to subprime crises (France, Spain, the UK and the US). The last column of the table depicts average adjustment for each year necessary across all the countries. We have two periods clearly indicating need for lower OBS activity: the largest adjustment required for the period in the run up to current financial meltdown and the second one over 90's when again most of the countries in the sample experienced banking crises.

Table 8: Required adjustment in the change of off/on balance sheet activity in order to keep crisis probability at in sample mean level

	BG	CN	DK	FN	FR	GE	IT	JP	NL	NW	SD	SP	UK	US	mean
1985	0.00	0.00	**-0.53**	**-0.39**	**-0.30**	0.00	0.00	**-0.16**	0.00	0.00	0.00	0.00	**-0.18**	0.00	**-0.11**
1986	0.00	0.00	0.00	**-0.29**	**-0.03**	0.00	0.00	**-0.07**	0.00	0.00	0.00	0.00	**-0.49**	0.00	**-0.06**
1987	0.00	**-0.06**	**-1.32**	**-0.40**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**-0.23**	0.00	**-0.14**
1988	0.00	**-0.28**	0.00	0.00	**-0.12**	0.00	0.00	0.00	0.00	**-0.62**	0.00	0.00	**-0.38**	**-0.20**	**-0.11**
1989	0.00	**-0.48**	0.00	0.00	**-0.46**	0.00	0.00	**-0.08**	0.00	**-0.37**	0.00	0.00	**-1.01**	**-0.23**	**-0.19**
1990	0.00	**-0.57**	0.00	**-0.73**	**-0.52**	0.00	0.00	**-0.32**	0.00	**-1.21**	0.00	0.00	**-0.37**	**-0.11**	**-0.27**
1991	0.00	**-0.66**	0.00	**-0.99**	**-0.57**	0.00	0.00	**-0.07**	0.00	0.00	**-0.35**	0.00	**-1.90**	**-0.22**	**-0.34**
1992	0.00	**-0.25**	0.00	**-0.91**	**-0.54**	0.00	0.00	**-0.29**	0.00	0.00	**-0.40**	0.00	**-0.60**	0.00	**-0.21**
1993	0.00	0.00	0.00	**-0.30**	**-0.53**	0.00	0.00	**-0.08**	0.00	0.00	**-0.02**	0.00	**-0.05**	0.00	**-0.07**
1994	0.00	0.00	0.00	**-0.28**	**-0.43**	0.00	0.00	0.00	0.00	0.00	**-0.20**	0.00	0.00	0.00	**-0.07**
1995	0.00	0.00	0.00	0.00	**-0.41**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**-0.03**
1996	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1997	0.00	0.00	0.00	0.00	**-0.26**	0.00	0.00	**-0.14**	0.00	0.00	0.00	0.00	0.00	0.00	**-0.03**
1998	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1999	0.00	**-0.12**	0.00	0.00	0.00	0.00	0.00	**-1.07**	0.00	0.00	0.00	0.00	0.00	0.00	**-0.09**
2000	0.00	0.00	**-0.04**	0.00	0.00	0.00	0.00	0.00	**-0.04**	0.00	**-0.24**	0.00	**-0.25**	0.00	**-0.04**
2001	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**-0.07**	0.00	0.00	0.00	**-0.52**	**-0.05**	**-0.05**
2002	0.00	0.00	**-0.20**	0.00	**-0.25**	**-0.06**	0.00	0.00	**-0.69**	0.00	**-0.05**	0.00	**-0.65**	**-0.06**	**-0.14**
2003	0.00	0.00	0.00	0.00	**-0.09**	0.00	0.00	0.00	**-0.51**	0.00	**-0.01**	0.00	**-0.63**	**-0.03**	**-0.09**
2004	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**-0.04**	0.00	0.00	0.00	**-0.37**	**-0.14**	**-0.04**
2005	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**-0.10**	**-0.77**	0.00	**-0.06**
2006	0.00	0.00	**-0.10**	0.00	**-0.43**	0.00	0.00	0.00	0.00	0.00	0.00	**-0.58**	**-1.19**	0.00	**-0.16**
2007	0.00	0.00	0.00	0.00	**-0.32**	0.00	0.00	0.00	0.00	0.00	0.00	**-1.10**	**-0.89**	**-0.07**	**-0.17**
2008	**-0.84**	0.00	**-0.77**	0.00	**-2.27**	0.00	0.00	0.00	0.00	0.00	**-0.55**	**-1.26**	**-0.80**	**-0.22**	**-0.48**

Note: data in the table should be multiplied by 100, in order to be interpreted in percentage point terms

Once the necessity of adjustments to the banks' OBS positions in observed, the authorities can either directly target the required ratios of off/on balance sheet assets, implying direct monitoring of banks' activities at micro level, or increase capital and/or liquidity requirements for banks at macro level, thus counteracting and dampening amplified risk exposure from elevated levels of OBS assets. The first of these would require significantly better monitoring of OBS, and regulatory changes would be necessary to ensure this. We discuss these changes below.

We turn to the country-specific changes to capital and liquidity necessary to maintain a crisis probability at 1% level (implying that crisis occur once in a hundred years). For each country we identify years when the probabilities of crises exceed 0.01 and adjust first capital and liquidity requirements together and then separately (keeping other variables unchanged), so that probabilities are reduced to 1%. Then the average

adjustment for each country and each variable separately is calculated and mean values are reported, which can be considered as regulatory targets. We choose to focus on 1999-2007 because of the build up of OBS exposures in the period prior to financial meltdown and thus we can identify countries in the greatest need of adjustments to their banks' balance sheets during that time. Table 9 illustrates our findings. Columns 1 and 2 list the averages of actual data for the leverage and liquidity ratios for each country over the above period, while columns 3, 4 and 5 show the country-specific adjustments to leverage and liquidity together and separately. It can be seen from Table 9, that there is a considerable heterogeneity among countries in changes required to bring crises probabilities to 1% and the UK, France, Denmark and the US need considerably larger adjustments in both regulatory variables compared to other countries.

Table 9: Levels of leverage and liquidity as a percent of total assets required for reaching 0.01 probabilities

Column	1	2	3	4	5
Top Panel	Observed average over 1999-2007		Change in country specific levels of liquidity and leverage needed to reduce all prob. to 0.01 or below		
	lev	nliq	lev+liq	lev alone	nliq alone
Belgium	3.56	21.97	1.50	1.99	5.99
Canada	5.47	9.20	2.56	3.41	10.23
Denmark	6.04	4.79	3.74	4.99	14.98
Finland	9.39	7.91	0.32	0.42	1.27
France	4.50	13.72	4.17	5.56	16.70
Germany	4.18	16.01	1.40	1.87	5.62
Italy	6.99	17.08	1.16	1.55	4.64
Japan	4.40	26.82	0.00	0.00	0.00
Neths	3.65	6.76	3.65	4.87	14.62
Norway	6.17	4.50	0.47	0.62	1.86
Sweden	5.75	6.36	2.63	3.50	10.51
Spain	7.88	12.89	2.63	3.50	10.51
UK	6.17	5.23	6.54	8.72	26.19
US	9.46	6.79	3.67	4.89	14.69
Mean	5.97	11.43	2.46	3.28	9.84
SD	1.92	6.93	1.81	2.41	7.24

Policy Implications

The importance of liquidity and leverage in crisis determination models is hard to doubt, and strengthening defences against problems emerging within the financial sector is important. Our empirical work suggests current account imbalances are an indicator of impending problems, but these are hard to deal with in a macroprudential framework. However, there may be other policies that could be implemented. We divide these into three parts. First we should note that crises occurred in countries where capital appeared adequate, off balance sheet activity was not growing too rapidly and where housing market bubbles were absent. The most noticeable of these (our misses) are the Netherlands and Germany in 2008. Changes to on balance sheet product regulation, and the scope of the domestic regulator may be needed to deal

with these situations. As crisis are in part driven by housing market bubbles, the first best solution might be to find out what drives them and introduce regulations to constrain the bubbles. This may of course not be possible. The third area where policy may need to be strengthened is in the monitoring of off balance sheet activity. In particular the growth of the Over the Counter Market (OTC trades) is difficult to monitor, and changes in regulation that make these more transparent would be of value. Regulatory bodies can either determine the rules of operation of the market, as in privatised electricity and gas industries, or they can regulate products with a concern for consumer protection in the face of complex problems, as in the case of food and drugs, or they can both regulate the rules of play and the items allowed on the field, as in water and rail system regulation.

The current account and capital controls

The recent financial crisis has led to a discussion of the possibility of product regulation in financial markets after a long period where only the first regulatory style has been adopted. The international nature of the crisis and the role of current account imbalances might lead to calls for capital controls. Capital controls prevent markets working in the large as well as the small, and hence product and field regulation must avoid such controls if possible. There are two main functions of international capital markets, with the large and important one involving the redistribution of savings from surplus countries to deficit countries, and the small one involving asset swapping in order that risks are shared efficiently.

Long-term structural surpluses and deficits exist for many sustainable reasons, as well as for some unsustainable ones, and the project should discuss the origins and implications of both. Countries with populations that are older, or ageing more rapidly than others, may need to save more as a per cent of income, and if capital markets work well they will run current account surpluses. If they do not, the excess saving will be absorbed by increased capital at home, and the marginal return on capital in the potential surplus country, for instance Japan, will be below that in the potential deficit country. Equalising returns increases global output for a given level of the capital stock. The same may happen between two countries with different habits over working time. If one country, say the US, has institutions that induce its citizens to work seven years longer than those in another region, say the Euro Area (as is currently the case), then there are structural reasons for US deficits and European surpluses. US citizens need more capital to work with than do Europeans, as they input more labour, but they will want lower levels of financial wealth as a proportion of their incomes as they need to save less for retirement. The reverse is true of the Europeans, and they will own US assets in order to provide incomes for their longer retirements. In a growing world the existence of an equilibrium stock of assets as a percent of incomes goes with a need for net accumulation of those assets, and vice versa. Hence, if the US and the Euro Area have the same technology and skills, then in a growing world there are good structural reasons for permanent net capital flows from Europe to the US that will increase global output. If current accounts are to be taken into account by regulators when setting capital adequacy standards, then the distinction between structural and excess deficits would have to be drawn. This would be exceptionally difficult.

The risk sharing function of international capital markets has nothing to do with structural deficits and surpluses, but it does have a great deal to do with the recent

financial crisis. If individuals face different risks, then they may increase their expected welfare by sharing those risks. The same principal will be applicable to groups of countries. Risk sharing will only raise expected output and expected consumption if it also changes saving and investment behaviours. If it genuinely reduces risk premia in productive capital investment decisions, then output may be higher than it would otherwise have been and, if risk premia are made sustainably more equal across investment decisions in different countries, then output will be higher as a result of financial trade. The mathematics behind the Arrow Debreu theorems on risk sharing has fascinated economists with its beauty for some years, but it is not clear that beauty and significance have gone hand in hand. A desire to promote risk sharing has led to the construction of complex financial assets and the failure of such assets has been at the heart of the current financial crisis.

Regulation and protection

Financial regulation and financial protectionisms are potentially two names for potentially the same action. Global regulation may obviate the need for country or region-specific protection, but there may also be a case for region specific regulation, and we should investigate this. The Bank for International Standards (BIS) and the Basel Agreements are meant to prevent 'competition in laxity' and ensure a level playing field. However, this requires the cooperation of all major parties and a commitment to common goals. Financial regulations are changing in response to the crisis, and the core problems behind the current crisis will hopefully be addressed, with the scale and complexity of financial products almost certainly being restricted. Of course other problems may emerge and financial innovations may get round new regulations, as Goodhart (2008) discusses.

The IMF estimate that globally banks will have to acknowledge that they have lost $2.8 trillion by the end of 2010, with $1.3 trillion already declared by the middle of 2009 (IMF, 2009). As the capital base of the US banking system at the end of 2007 was around $1.5 trillion, the impact has been significant. The most important losses have been those in the US sub-prime mortgage market that resulted from low grade lending in an under-regulated market. This lending was promoted by the US administration[11] and the losses were building up before the crisis broke, and were the main reason for it. Some types of these low grade loans have default rates as high as 80 per cent, and overall default rates on all mortgages and mortgage-backed securities in US banks are likely to be around 12 per cent, whilst they are expected (by the IMF) to reach 4 per cent in the UK, despite the much more severe downturn in the economy, and less than 2 per cent in the Euro Area as a whole, although these losses may be heavily concentrated in Spain. Loss rates in the US would look worse if securitised mortgages had not been sold on to the UK and the Euro Area banking systems, where 40 per cent and 30 per cent respectively of all anticipated losses are likely to be on foreign assets, and these are mainly US paper. This difference is a

[11] In particular home ownership was promoted amongst low income families in 2002 which encouraged the sub-prime market to develop. Two speeches by President Bush in 2002 are particularly revealing. See President George W. Bush Radio Address American Dream Down Payment Fund 15 June 2002 and remarks by the President on home ownership at the Department of Housing and Urban Development Washington, D.C., 18 June 2002.

reflection of the peculiarly lax nature of US personal sector bankruptcy law[12] and new regulations have to reflect these differences, either through their removal by coordination of bankruptcy law, or by restricting trade in dubious financial instruments.

Under-regulated financial trade meant that low grade assets were bundled into structured vehicles and sold on to people who did not understand the risks involved. Many of those people were based in European regulated financial institutions, and hence the exchange of risks shifted the location of the crisis from being an entirely US problem to one shared by others. This exchange of risks left the US less exposed to its own problems than it otherwise would have been, and hence perhaps left US regulators and legislators with less incentive to limit structured vehicles and the risk amplifying originate and distribute models of asset creation. As a result financial asset trade probably resulted in the creation of risk as well as its sharing, and the welfare gains from risk sharing appear to have been overwhelmed by the costs of the induced risk creation.

Financial complexity can lead to the production of financial products that are harmful, and the case for regulating and restricting potentially damaging financial products is no different from that for goods. The US has an excellent drug administration system as does the European Union, but both evaluate products and decide on whether they can be used inside their domain. It would be wise to replicate this system in financial markets, especially as preferences may differ between regions. Given that Americans seem to have a preference for risky activities, and also because of their bankruptcy laws, they can produce financial products different from anything produced in Europe, so there is a case for specific financial product regulation. It would be wise to allow the use of complex products outside their domain of issue only once they had been fully stress tested in downturns, and even then it may be easier to allow European financial institutions (and others) to hold as many non-European non-financial corporate and government bonds and non-financial system equities as they wish, but to restrict them to these products, along with more complex, but tested products produced within the single market for financial services in Europe. All sensible risk sharing and savings relocations could take place, but toxicity would be contained within the domain of the home regulator. However, such action should be taken with care as it breaks with the traditional *caveat emptor* approach, and purchasers of approved assets may feel they have a right to compensation from the regulator if those assets turn bad. This moral hazard problem can either be dealt with by appropriate insurance or better still by pre-agreed 'haircuts' on the level of compensation

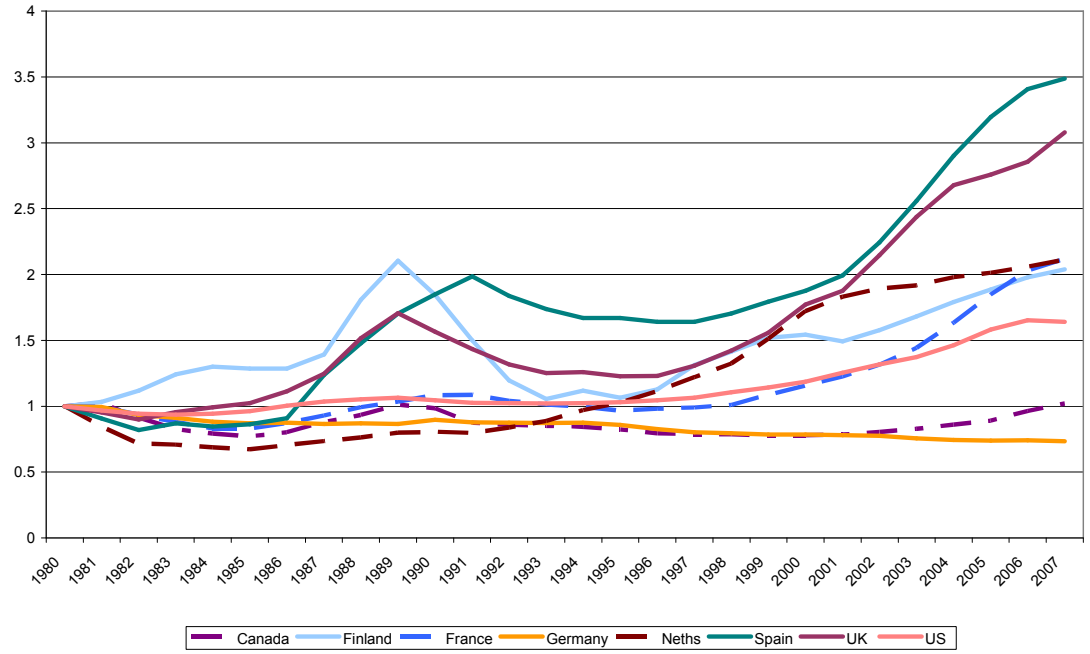
Housing Markets and regulation

In order to undertake macro-prudential regulation through direct housing market rules we need to understand why housing markets are prone to bubbles in some countries and not in others. Figure 1 plots real house prices in a number of countries, whilst

[12] Ellis (2008) discusses many of the relevant issues. The US housing boom was fed by the relaxation of lending standards and also by the growth of out of state second homes purchased through mortgage brokers who passed on all risks to others. US bankruptcy law varies from state to state, and in general mortgages are recourse. However, an out of state second home mortgage can be defaulted on with little cost, as recourse is not easy to obtain across state borders. Even where default is by a resident within the state, recourse is seldom pursued because of the costs of associated court cases.

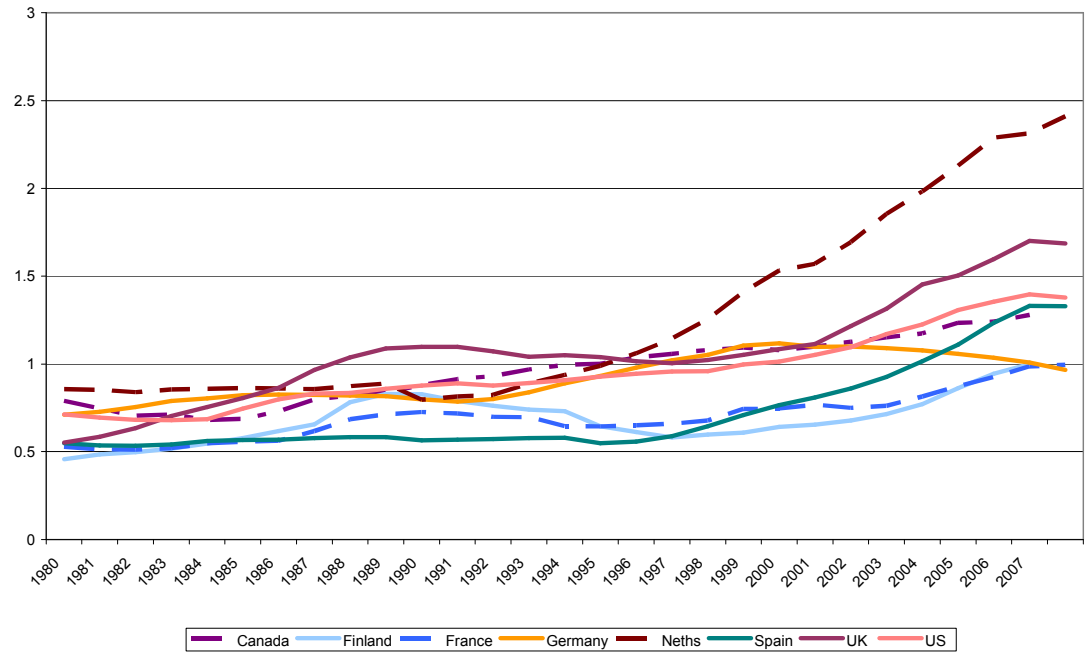
Figure 2 plots real lending to the personal sector as a proportion of real disposable incomes. It is widely believed that excessive lending leads to excessive house price growth, but it is not clear that this is the case, as Table 10 suggests.

Figure 1 Real House Prices (1980=1.0)



Source NiGEM database house prices divided by consumer expenditure deflator

Figure 2 Real personal sector borrowing as a proportion of real personal disposable income



Source NiGEM database house prices divided by consumer expenditure deflator

We have undertaken simple Granger causality tests of the relationship between real house price growth and real credit growth in a number of countries, and it appear that

in some cases house price growth 'causes' credit growth, and that in Germany and Sweden there is clear evidence that credit growth. The former has not however experienced a bubble, whilst the Swedish correlation reflects events in the 1980s and 1990s. There is also evidence that credit growth 'causes' house price growth, albeit with a two year or more lag in France and the US. There is at least as much evidence that changing standards by lenders change house prices, as increases in lending are more likely to be used for bringing consumption forward as for investing in housing. Lax lending standards are associated with high loan to value ratios.

Table 10 Granger Causality tests on growth in real house prices and personal sector real borrowing

	PERSONAL DEBT → PROPERTY PRICES: null hypothesis: no granger causality F-stat (probability)				PROPERTY PRICES → PERSONAL DEBT: null hypothesis: no granger causality F-stat (probability)			
	1 LAG	2 LAGS	3 LAGS	4 LAGS	1 LAG	2 LAG	3 LAGS	4 LAGS
BELGIUM	0 (0.99)	0.73 (0.49)	0.68 (0.57)	0.87 (0.49)	0.07 (0.8)	2.15 (0.13)	1.29 (0.3)	1.02 (0.41)
CANADA	1.61 (0.21)	1.65 (0.21)	1.39 (0.27)	0.79 (0.54)	**4.35 (0.04)**	3.32 (0.05)	2.54 (0.08)	**3.88 (0.01)**
DENMARK	**6.97 (0.01)**	3.4 (0.05)	2.3 (0.1)	2 (0.13)	0.19 (0.67)	0.17 (0.84)	1.19 (0.33)	0.57 (0.69)
FINLAND	1.03 (0.32)	0.21 (0.81)	0.65 (0.59)	1.08 (0.4)	0.2 (0.66)	1.87 (0.18)	2.53 (0.09)	**3.29 (0.04)**
FRANCE	2.55 (0.12)	1.81 (0.18)	**3.99 (0.02)**	**3.04 (0.04)**	1.08 (0.31)	1.81 (0.18)	1.3 (0.29)	0.47 (0.76)
GERMANY	**8.53 (0.01)**	**8.79 (0)**	**4.59 (0.01)**	**3.24 (0.03)**	0.4 (0.53)	0.16 (0.85)	0.08 (0.97)	0.66 (0.62)
ITALY	0 (0.97)	1.38 (0.27)	0.88 (0.46)	1.02 (0.42)	**11.51 (0)**	**7.43 (0)**	1.79 (0.18)	0.89 (0.48)
JAPAN	3.7 (0.06)	2.89 (0.07)	0.93 (0.44)	1.07 (0.39)	0.71 (0.41)	**5.12 (0.01)**	1 (0.41)	**3.03 (0.04)**
NETHERLANDS	0.3 (0.59)	0.33 (0.72)	0.53 (0.67)	0.56 (0.7)	0.28 (0.6)	0.62 (0.55)	1.6 (0.21)	1.45 (0.25)
SWEDEN	**14.38 (0)**	**8.5 (0)**	**5.35 (0)**	**4.03 (0.01)**	0.48 (0.49)	0.51 (0.6)	0.4 (0.75)	0.12 (0.97)
SPAIN	0.31 (0.58)	2.2 (0.13)	1.56 (0.22)	1.31 (0.29)	1.49 (0.23)	2.36 (0.11)	1.41 (0.26)	0.99 (0.43)
UK	0.32 (0.58)	0.76 (0.47)	0.37 (0.78)	0.38 (0.82)	0.07 (0.8)	0.28 (0.76)	0.5 (0.68)	0.77 (0.55)
USA	1.72 (0.2)	2.96 (0.07)	**4.26 (0.02)**	2.89 (0.05)	0 (0.99)	1.14 (0.33)	1.66 (0.2)	1.32 (0.3)

House price bubbles may be related to changes in lending standards, and hence it may be wise to introduce quantitative controls on the loan to value ratio (LTV). These may be hard to enforce unless one can deal with second mortgage markets by removing recourse from second loans. Upper limits can be made self reinforcing, as in Germany

where mortgages cannot be securitized (a very mature market) if they exceed an LTV of 90 per cent. This may be one of the reasons why in 2006 the average LTV in Germany was 72 percent as against 80 percent in the UK and typically 78 percent in the US. The former did not have a housing bubble whilst the latter two did. However, it is hard to find a role for LTV ratios in econometric models of house prices because of the paucity of data, and hence relying on this alone for regulation may not be good evidence based policy analysis.

Creating markets and changing banks.
Off balance sheet activity can be productive, and it can spread risks and fill holes in the market. These should increase welfare and increase output. However, it was clear in the recent crisis that structures became too complex and risks too opaque, and regulators found it difficult to set up defences against the systemic risks involved. This was in part because there was no register of such activities, and especially no clear market in OTC trades. There are a number of options that have to be considered as regulatory responses to the problems we have seen. The most obvious involve change to the (mainly US) model of separating the origination and the distribution of assets. If the originator of a loan has no stake in its risks once it is sold on then there is perhaps a lack of an incentive to properly evaluate the risk. Residual obligations can easily be written into change of ownership contracts, and this should be required. Recording and understanding contracts is also essential to regulating markets. Creating clearing houses for off balance sheet activities and in particular for OTCs would be a very effective way of ensuring regulators could respond, and as it involves transactions costs it would limit the scale of such activities.

Other proposals to reduce the scale of OBS activity involve taxes on credit and taxes on transactions. These are two different issues, and they are designed to address two different problems. Taxes on credit would reduce level of borrowing by individuals, but not necessarily affect the cyclicity of asset prices, and that would be essential. Hence although there is no reason why taxes on credit should not be used to raise revenue it is not clear that they will reduce the risks of crises. The same might be said of transactions taxes and bank taxes designed to contribute to a fund to cover future costs. Indeed, there is evidence that such schemes increase the risk of crises, as they are similar to deposit insurance, and its impact on crisis probabilities is clear in eth literature. Perhaps the only sound reason for taxing transactions 9aprt from revenue) is to make sure that their is a proper record, and this could be achieved by requiring recourse loans were all registered (if you do not register, you cannot enforce the loan). Clearing houses and registers serve the same purpose.

Conclusions

We have used the Boyd and Gertler (1994) method to estimate the off balance sheet exposures of the banking systems in our econometric model. We checked for the significance of both the ratio and the change in the ratio of off/on balance sheet assets and found that along with four explanatory variables by Barrell et al (2010) changes in the of off/on balance sheet assets ratio has a positive and significant effect on the probability of a banking crisis. The inclusion of a proxy variable for banks' OBS activity in the estimation improved in sample performance of the model, such as more crisis periods were captured and the number of false calls have been reduced. 80% of crises were captured and once the timing of the false calls was accounted for the

number of false calls dropped from 26.5% to 14%. We ran several robustness tests as well and conclude that the model is well specified as it passes the tests well. Scenario analysis looking at adjustments in changes in OBS activities in the run up to subprime crises aimed at bringing crisis probabilities to in sample mean reveal need of altering OBS positions in the UK, France, Denmark and the US. At the same time, if crises probabilities to be kept at 1% both regulatory variables should be increased, and liquidity requirements more than capital adequacy.

The manufacture and trade in OBS assets has been a major factor behind the recent and other crises. Reducing the scale and complexity of OBS activity may be essential, and the re are several ways to do this. Registers, clearing houses and taxes may make OBS activity more transparent and easier to provision against. Financial protection before 2008 would also almost certainly have led to a reduction in the US current account deficit, as the costs of risky loans in the US would have been higher than they were and hence fewer of them would have been issued. The US housing bubble would have had less fuel to inflate it, and hence house prices would have risen less, and housing construction would have grown less. US consumers do treat their housing wealth as wealth, whatever economic theorists think they should do, and hence consumption would have been less buoyant. Weaker consumption and housing investment would have meant domestic demand would have been lower in the US and hence the current account deficit would have been smaller. If the excess deficit was a cause of crisis, its reduction through financial regulation would have reduced the risks of a crisis.

Our finding can be considered as a step towards quantifying the effect OBS activity has on the occurrence of a crisis. Further investigation in this area can be conducted once more detailed data is available, which will allow to adjust banks liquidity and leverage ratios for the size of the OBS exposures directly and test for its impact on the crisis probability. Without more detailed data we would suggest more direct regulation (to produce that data) would be wise

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Appendix 1

Data Issues: Bankscope

1. In order to obtain country-level measures, the user has to aggregate the OBS series for individual banks within a country. This requires a judgment on the shareholder criteria used for the aggregation: for example, we opted to include all banks in an economy where at least 50% of the shares were owned domestically. This excluded banks with majority foreign ownership but which may have held significant amounts of OBS exposures within the domestic system.

2. The aggregated data for off balance sheet for each country showed major time series problems:

    - Bankscope only allowed us to access data back to 2001 which meant the OBS series were shorter than the remaining sample period (1980 – 2007). This meant we had to make the crude assumption that OBS activity prior to 2001 had remained stable in each country in order to fill the missing observations.[13]

    - Even when Bankscope covered the years, many individual observations of OBS within each series were missing. Due to points (iii) and (iv) below, it was impossible to replace such missing observations with reliable alternative data points.

    - Bankscope's OBS assets series prior to 2004 are particularly patchy in their coverage with countries such as Finland having far fewer observations than others (such as Germany, Denmark and the USA).

    - We construct the off-balance sheet exposures for a banking system by aggregating the figures for all banks that comprise the top 80% of total banking system assets. The problem with Bankscope data is that the banks that comprise the top 80% with OBS data vary vastly from year to year. For example, in France in 2004, Credit Agricole SA was the largest bank in terms of assets, yet this bank does not contribute to the top 80% of assets in 2002; the bank only starts reporting in 2004. Thereon, Credit Agricole forms a large part of the French off-balance sheet exposures. Such anomalies make the Bankscope data extremely volatile at best and unreliable at worst.

Data Issues: OECD

1. The UK does not report data to the OECD prior to 1984, although from there on, figures are available till 2007. Because the FSA were able to provide us with consistent series for the entire sample period, we opted to use their data for the

[13] This does not of course nullify the major benefits of Bankscope for undertaking cross sectional and panel research for individual banks.

UK. The FSA data covered all large UK commercial banks and were compatible with the OECD figures we could access.

2. The OECD data for Japan are missing from 2004 onwards. It is possible to substitute the missing observations with data from the Japanese Banker's Association but there remain difficulties with obtaining consistent estimates of non interest income from the two sources.

3. Belgium, Canada, France, Italy and Japan do not report some series around the beginning of our sample period. For these countries, we were able to obtain missing observations by splicing from old copies of OECD Bank Profitability Statistical Supplements. However, we are unable to confirm whether the aggregation methods of the OECD are consistent across their data sources.

Missing observations for 1980 were constructed by applying average growth for 3 preceding years to the data in 1981.

APPENDIX 2: CORRELATIONS

As Table A2 illustrates correlations between the independent variables are low, thus reducing concern about multicollinearity. More systematically, as in Barrell et al (2010), 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 sub-table of contemporaneous variables, the standard normal deviate is -1.44 and in the case of the chosen lags it is -1.41 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	CBR
NLIQ	-0.14			
RHPG	0.17	-0.13		
CBR	-0.22	-0.06	0.08	
DOFFTOON2	-0.02	-0.04	0.03	0.00

Correlations of chosen lags

	LEV(-1)	NLIQ(-1)	RHPG(-3)	CBR(-2)
NLIQ(-1)	-0.14			
RHPG(-3)	0.15	-0.20		
CBR(-2)	-0.22	-0.07	-0.03	
DOFFTOON2(-2)	-0.02	-0.05	-0.04	0.01

APPENDIX 3: Comparison with estimation results from Barrell et al (2010)

Table A3: Logit estimation results over 1980-2008

Variable	Coefficient	z-Statistic
LEV(-1)	-0.342	-4.1
NLIQ(-1)	-0.113	-3.3
RHPG(-3)	0.079	2.4
CBR(-2)	-0.236	-2.8

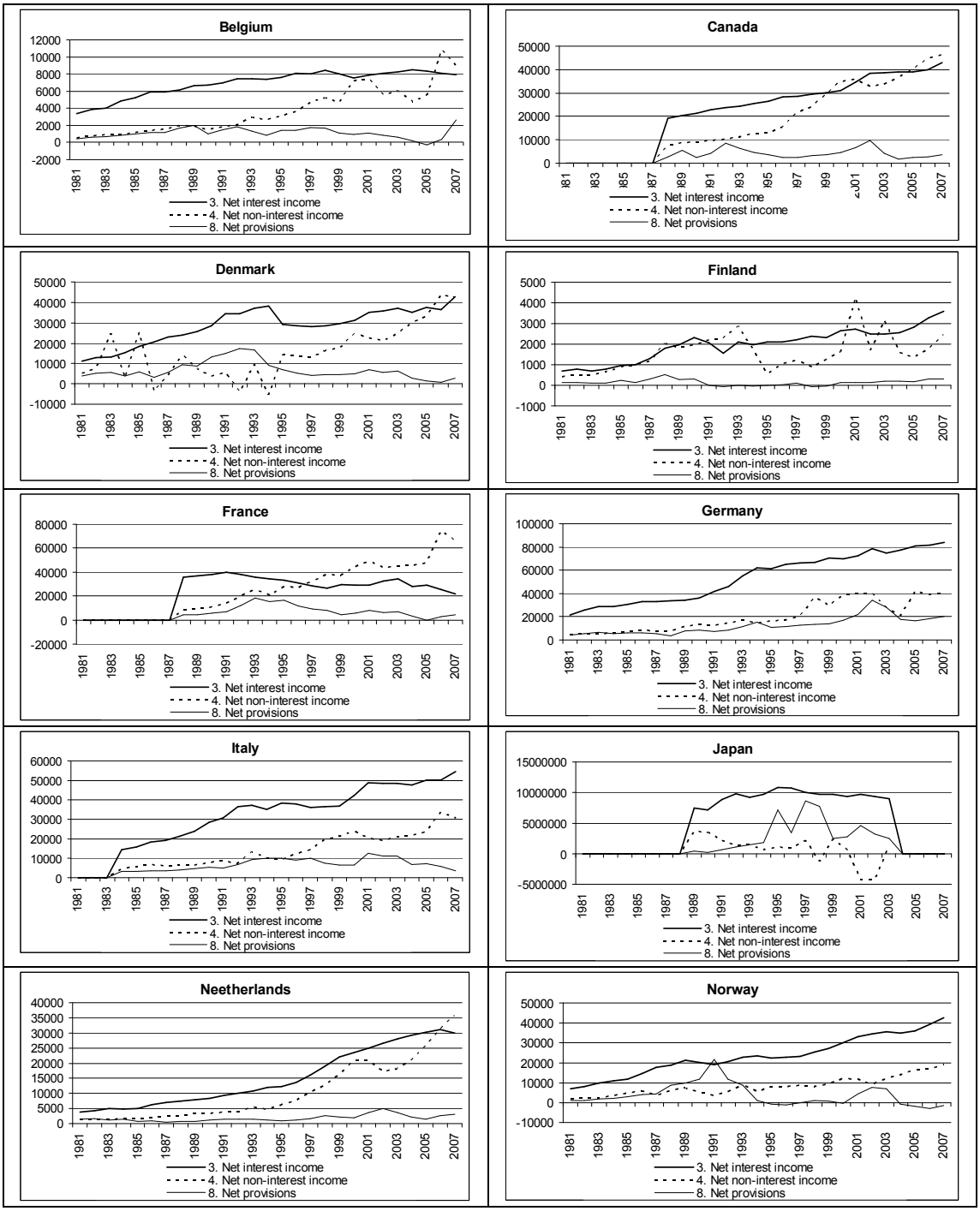
Table B3: In sample model performance based on correct calls

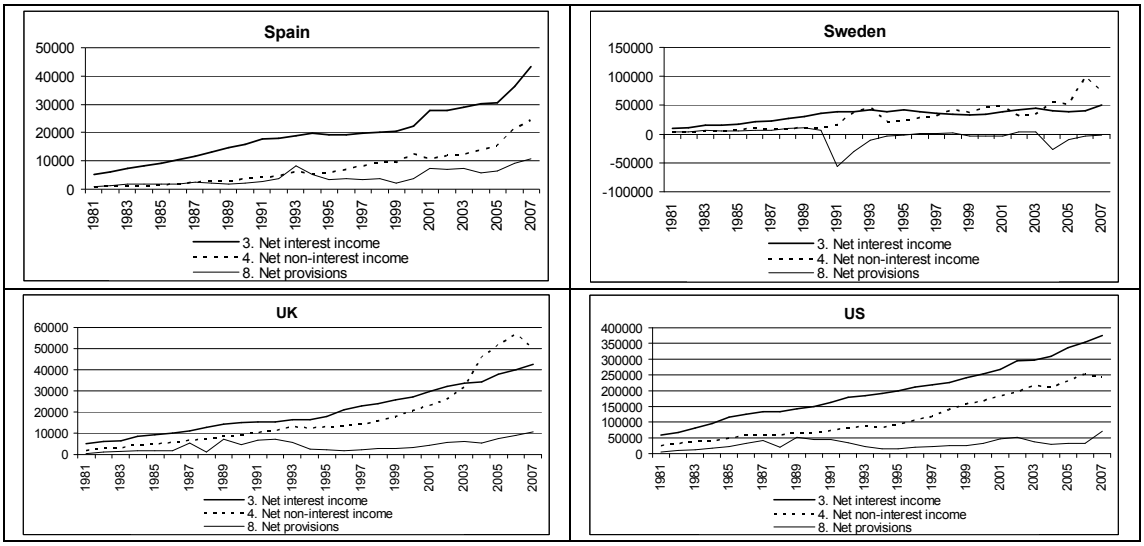
	Dep=0	Dep=1	Total
P(Dep=1)<=C	247	5	252
P(Dep=1)>C	97	15	112
Total	344	20	364
Correct	247	15	262
% Correct	71.80	75.00	71.98
% Incorrect	28.20	25.00	28.02

Note: threshold value is 0.0555

APPENDIX 4: Breakdown of off balance sheet activity

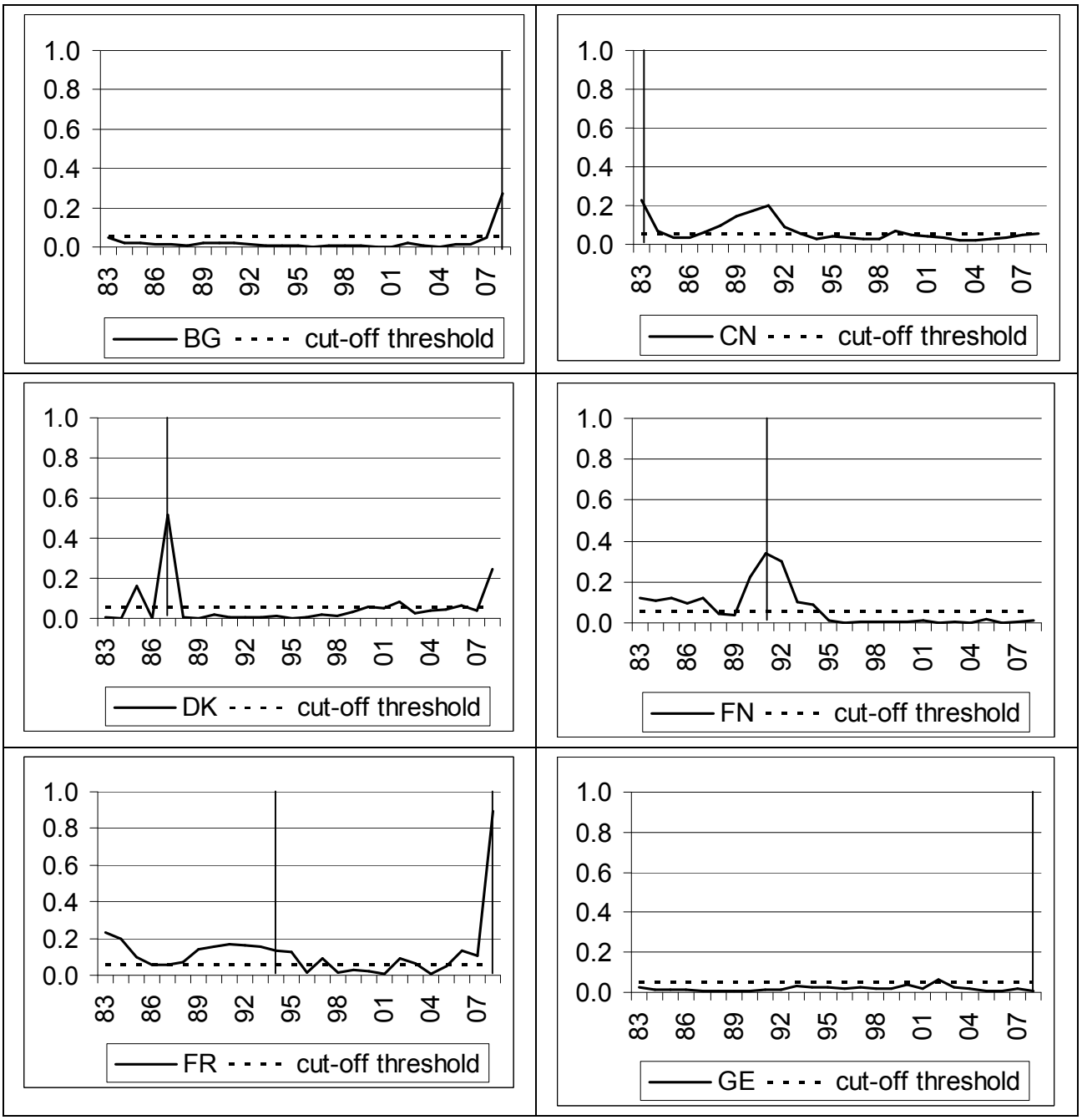
Charts below illustrate developments in net non-interest income, net interest income and net provision of banks in our sample countries over 1981-2007. The data source is Income Statement and Balance Sheet from OECD and statistics are reported at current prices in millions of national currency and in millions of Euros for OECD countries which are members of the Euro zone.

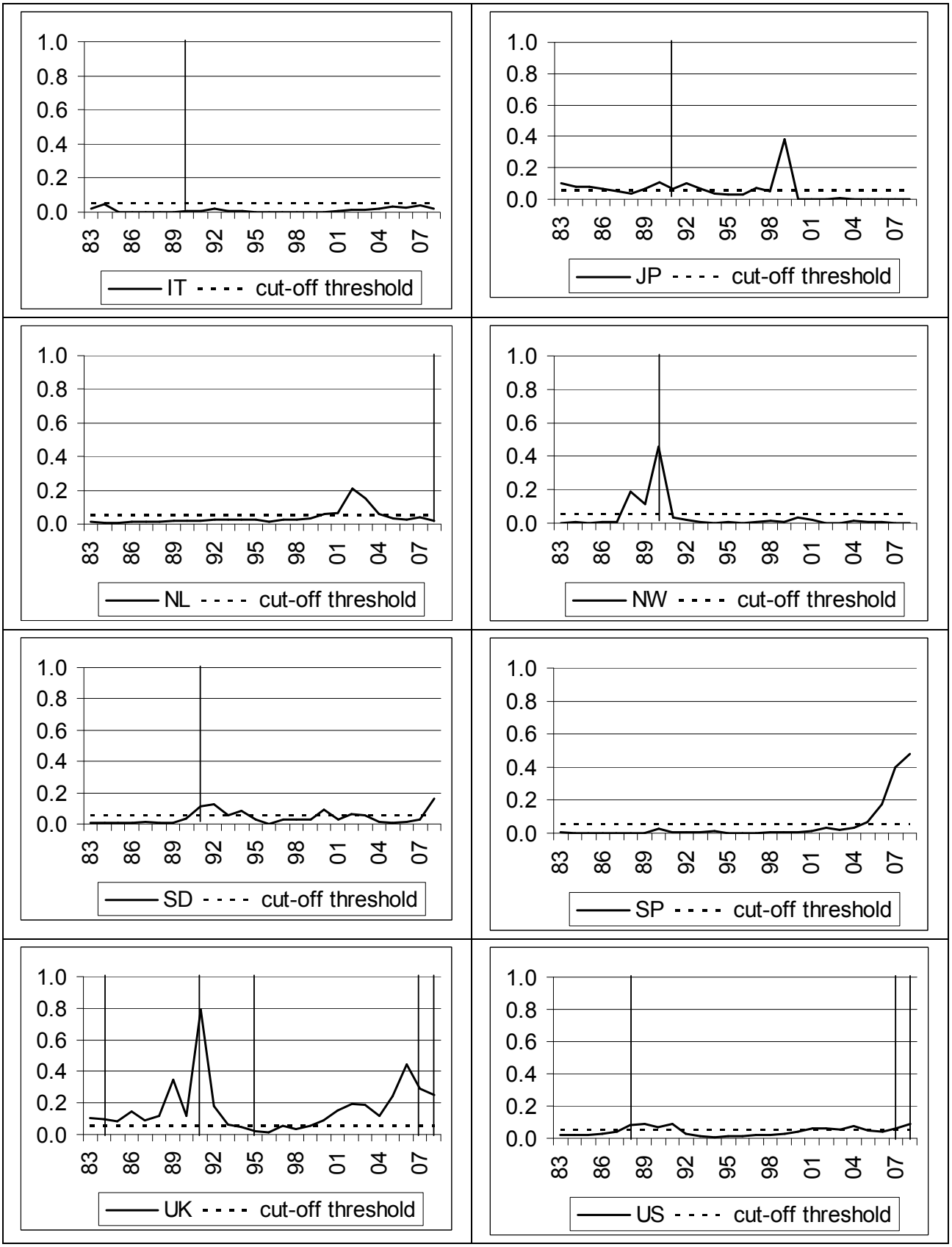



Spain
50000
40000
30000
20000
10000
0
1981 1983 1985 1987 1989 1991 1993 1995 1997 1999 2001 2003 2005 2007
3. Net interest income
4. Net non-interest income
8. Net provisions
Sweden
150000
100000
50000
0
-50000
-100000
1981 1983 1985 1987 1989 1991 1993 1995 1997 1999 2001 2003 2005 2007
3. Net interest income
4. Net non-interest income
8. Net provisions
UK
60000
50000
40000
30000
20000
10000
0
1981 1983 1985 1987 1989 1991 1993 1995 1997 1999 2001 2003 2005 2007
3. Net interest income
4. Net non-interest income
8. Net provisions
US
400000
350000
300000
250000
200000
150000
100000
50000
0
1981 1983 1985 1987 1989 1991 1993 1995 1997 1999 2001 2003 2005 2007
3. Net interest income
4. Net non-interest income
8. Net provisions

APPENDIX 5: In sample probabilities

Charts below illustrate in sample probabilities based on final estimation results for all countries in our sample (solid line depicts probabilities, dashed line indicates threshold value of 0.055).




1.0
0.8
0.6
0.4
0.2
0.0
83
86
89
92
95
98
01
04
07
IT cut-off threshold
JP cut-off threshold
NL cut-off threshold
NW cut-off threshold
SD cut-off threshold
SP cut-off threshold
UK cut-off threshold
US cut-off threshold

APPENDIX 6: Crisis onset dates

Table below lists banking crisis onset dates based on the definitions by World Bank (2003), Laeven and Valencia (2007) and Borio and Drehmann (2009)

Crisis	Date
Belgium	2008
Canada	1983
Denmark	1987
Finland	**1991**
France	1994, 2008
Germany	2008
Italy	1990
Japan	**1991**
Netherlands	2008
Norway	**1990**
Sweden	**1991**
UK	1984, 1991, 1995, **2007,** **2008**
US	**1988,** **2007,** **2008**

Note: bold indicates systemic banking crisis