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HOW IDIOSYNCRATIC ARE BANKING CRISES IN OECD COUNTRIES?

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Abstract: Low levels of bank capital and liquidity in combination with ongoing crises in other countries are shown to increase the probability of banking crises in OECD countries. Hence global coordination of regulatory reform is vital for reducing crisis risks.

Keywords: Banking crises, bank regulation

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1. Introduction

A particular feature of the recent subprime crisis was its contemporaneous nature as problems arose simultaneously in a number of countries. Although similar patterns were also observed in past crises, the empirical literature shows a limited treatment of cross country patterns of banking crises.[2] We test for cross-country simultaneity of banking crises within the OECD using the logit methodology.

2. Background

Early theoretical models of bank failures and banking crises such as Diamond and Dybvig (1983) assumed bank failures were a form of "sunspot", arising from random shifts in depositor perceptions of the likelihood of a run. 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)).

There are reasons to expect that a crisis in one country might also link to an increased probability of a crisis elsewhere, although this does not necessarily imply causality. Indeed, the transmission mechanism for such simultaneous crises could be common shocks to each country arising from elsewhere. These might include the development of new, unsound, financial instruments adversely affecting banking systems in several countries, tighter monetary policy in a dominant third country or a global recessions impinging on world trade and hence on solvency of corporate clients.

Channels of causality can also be envisaged. One is that a recession caused by a banking crisis in one country generates recessions and banking crises elsewhere. Causality could also arise from the behavior of investors associated with asset market exposures, where shocks to global asset markets can cause banks not only to reduce their exposure to these assets but also to other assets which are seen as having similar characteristics, generating solvency problems as prices fall. Or causality could be due to information where revelation of liquidity or solvency problems in one country's banks induces runs against other countries' banks that appear similar. Bank behaviour per se can also be at the root of simultaneous crises given international interbank exposures, which can lead to cross border systemic liquidity problems if one bank defaults, since counterparties may then be unable to service their own obligations.

Despite these points, there is little empirical work assessing whether banking crises in OECD countries are systematic at an international level, in other words whether banking crises in one country tend to increase the probability of a crisis in other countries. For example, most banking crisis prediction models (as surveyed in Davis and Karim (2008)) employ purely domestic macroeconomic variables, albeit often capturing cross border impacts (e.g. terms of trade, exchange rates). One exception is Santor (2003) who finds banking crises are more likely following the occurrence of crises in countries in the same income group.

[2] There is, however, a great deal of work on cross border contagion in asset prices and currency crises, see Edwards and Rigobon (2002)

Empirical work on investor-driven banking crises is also generally at a national level, such as that on abnormal bank stock price behavior alongside "bad news" of banks' performance, and depositors' behavior in response to bad news (Calomiris and Mason 2001). One of the few cross border studies focused on banking crises is Jayanti and Whyte (1996) who found significant increases in UK and Canadian banks' CD rates after the 1984 Continental Illinois failure.

Models of banking crises such as Freixas et al. (2000) typically focus on banking links and suggest a potential domino effect if one bank is unable to meet its counterparty obligations, which could be cross border. However, empirical counterparts to such research are usually at a country level (e.g. Furfine 2003) although Gersl (2007) uses BIS data to study cross border effects. However, using direct interbank exposures of banks or sectors ignores other potential causes of cross-border crisis simultaneity.

To advance understanding of banking crisis incidence, we created a variable showing the weighted incidence of ongoing crises elsewhere (WYCRISC) using 2005 GDP weights. Unlike the studies cited above, this variable is not restricted to one type of cross-border transmission.

3. Methodology and data

We utilise the multinomial logit, the workhorse approach to predicting crises (Demirguc Kunt and Detragiache (2005), Davis and Karim (2008)). There are alternative approaches but these are less tractable when looking at simultaneous crises. The logit estimates the probability a banking crisis will occur in a given country with a vector of explanatory variables X_{it}. The banking crisis dependent 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:

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

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.

We start with a general model and utilise traditional variables, namely credit growth (DCG), M2/FX reserves (M2RES), fiscal balances (BB), GDP growth (YG), real interest rates (RIR) and inflation (INFL), as in Demirguc Kunt and Detragiache (2005) as well as banks' unweighted capital adequacy (LEV), the banks' broad liquidity/assets ratio (LIQ) and the change in real house prices (RHPG) as in Barrell et al (2010). The latter paper estimated determinants of banking crises in 14 OECD countries over 1980-2006, and found LEV, LIQ and RHPG dominate traditional crisis indicators. Bank concentration and structure-of-supervision variables (Beck et al 2006) were not discriminators for OECD crises. This analysis forms the basis of our work here. Our initial estimation

dataset includes 12 systemic and non systemic crises[3] drawn from existing datasets, which are derived consistently according to relevant criteria.[4] We use narrow liquidity (NLIQ) comprising cash, central bank and government-issued assets instead of the broader LIQ measure including private sector securities, because the latter were unreliable as a source of bank liquidity in 2007-9.

4. Results

We estimated our general model over 1980-2006 and assessed whether the errors are normally distributed before introducing a contemporaneous cross country variable. Non-normality could signal an omitted common factor or crisis driver that could in turn be correlated with a contemporaneous variable. We would then have to utilise either the Pesaran (2004a) Common Correlated Effects approach or the simultaneous logit approach. Both of these would have required country-by country regressions, difficult in this case owing to the shortage of crises.

We used Pesaran's (2004b) test for cross section dependence to investigate cross equation correlations (ρ_{ij}) between errors and test for normality. He shows that the correlation coefficients are distributed as a standard normal variate CD where N is the cross section dimension and T is the time dimension

$$CD = (2T/(N(N-1))^{**}(1/2)*(\sum_{i=1,N}\sum_{j=i+1,\,N-1}\rho_{ij}) \qquad (3)$$

The test statistic for the general equation before the introduction of the contemporaneous cross country variable WYCRISC is 1.03, below the critical value for non normality of 1.96. Hence we can add contemporaneous variables without inducing bias on their parameters.

[3] Our core dataset includes 12 systemic and borderline systemic crises in 14 OECD countries between 1980 and 2006, and we also look at the group of crises in 2007 and 2008. We take information concerning systemic banking crises from the IMF Financial Crisis Episodes database (Laeven and Valencia 2007) which covers the period of 1970–2007, while we collect borderline-systemic crises from the World Bank database of banking crises (Caprio and Klingebiel 2003) over the period of 1974– 2002. Systemic crisis episodes cover Finland (1991), Japan (1991), Norway (1990), Sweden (1991), UK (2007) and the US (1988, 2007) while borderline-systemic crises are Canada (1983), Denmark (1987), France (1994), Italy (1990) and the UK (1984, 1991,1995). Borio and Drehmann consider there were additional crises in the UK, the US, Germany, the Netherlands, France and Belgium in 2008.

[4] The IMF criteria are that in a systemic banking crisis, a country's corporate and financial sectors experience a large number of defaults and financial institutions and corporations face great difficulties repaying contracts on time. As a result, non-performing loans increase sharply and all or most of the aggregate banking system capital is exhausted. As a cross-check on the timing of each crisis, they examine whether the crisis year coincides with deposit runs, the introduction of a deposit freeze or blanket guarantee, or extensive liquidity support or bank interventions. Or alternatively they require that it becomes apparent that the banking system has a large proportion of nonperforming loans and that most of its capital has been exhausted. The selection criteria for the wider range of borderline-systemic crises from the World Bank are to include failures of individual banks or groups of banks considered to pose systemic risks and necessitating government intervention in the institutions concerned. These crises do not involve the complete exhaustion of the banking system's asset base, but involve large scale erosion of that base. Finally, Borio and Drehmann looking at 2008 events use the criterion of countries where the government had to inject capital in more than one large bank and or more than one large bank failed.

We obtain a final specification by sequential elimination of the least significant variable at each stage, with a goal of ensuring 5% significance level of the retained regressors. The lag length for all variables, except for WYCRISC, was chosen to capture developments in the economy prior to the crisis. WYCRISC is contemporaneous as it is designed to capture ongoing crises in other countries.

Table 1 shows the traditional variables are dominated by the regressors LEV, NLIQ and the variable for simultaneous crises, WYCRISC. Higher liquidity (NLIQ) and capital adequacy (LEV) ratios reduce crisis probabilities. Banking crises in other countries increase the chances of a crisis in the domestic economy. We tested for the joint elimination of insignificant variables: the F statistic is insignificant with a p-value of 0.26.

Table 1: Sequential elimination of variables

NLIQ(-1)	-0.174	-0.138	-0.14	-0.153	-0.138	-0.145	-0.155	-0.156
	(-3.81)	(-3.058)	(-3.036)	(-3.289)	(-2.969)	(-2.854)	(-2.796)	(-2.749)
LEV(-1)	-0.398	-0.479	-0.419	-0.502	-0.463	-0.473	-0.462	-0.457
	(-3.795)	(-4.034)	(-3.473)	(-3.6)	(-3.247)	(-3.266)	(-3.122)	(-2.986)
WYCRISC	3.62	2.582	2.831	2.164	2.295	2.161	2.185	2.256
	(3.112)	(2.075)	(2.223)	(1.584)	(1.665)	(1.52)	(1.534)	(1.424)
RHPG(-3)	-	0.08	0.083	0.078	0.078	0.08	0.09	0.088
		(1.774)	(1.938)	(1.817)	(1.849)	(1.885)	(1.906)	(1.809)
DCG(-1)	-	-	-0.092	-0.09	-0.086	-0.099	-0.101	-0.1
			(-1.797)	(-1.788)	(-1.695)	(-1.612)	(-1.629)	(-1.581)
RIR(-1)	-	-	-	0.094	0.086	0.093	0.0815	0.0689
				(1.303)	(1.187)	(1.248)	(1.029)	(0.477)
M2RES(-1)	-	-	-	-	-0.0001	-0.0001	-0.0001	-0.0001
					(-0.822)	(-0.86)	(-0.934)	(-0.931)
YG(-1)	-	-	-	-	-	0.065	0.0918	0.091
						(0.373)	(0.498)	(0.494)
BB(-1)	-	-	-	-	-	-	-0.0438	-0.046
							(-0.451)	(-0.463)
INFL(-1)	-	-	-	-	-	-	-	0.019
								(0.104)

Note: estimation period 1980-2006; z-stat in parenthesis; NLIQ- narrow liquidity ratio, LEV- unweighted capital adequacy ratio, WYCRISC – GDP-weighted average of crises; 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.

Table 2 shows that using the sample average cutoff of 3.2%, 75% (9 out of 12) in-sample crisis observations are called and 64% of no-crisis observations are captured correctly.[5] Eliminating crises in the largest countries or European countries experiencing systemic banking crises, does not affect the results. Equally, extending the estimation period to include 2007, when there were crises in the UK and US, leaves the parameters largely unchanged. The simultaneity variable becomes less significant, although it still retains a 5% significance level.

[5] Demirguc-Kunt and Detragiache (2005) for their most preferred equation had 61% of in-sample crisis observations and 69% of no-crisis observations correct. Hence our work stands up well in comparison.

Table 2: Robustness analysis – country elimination and changing the estimation period

	Final panel	Final panel extended one year	UK not included	US not included	Japan not included	US and Japan not included	Norway not included	Finland not included	Sweden not included
NLIQ(-1)	-0.174	-0.181	-0.163	-0.188	-0.16	-0.173	-0.185	-0.167	-0.167
	(-3.81)	(-4.194)	(-3.305)	(-3.828)	(-3.595)	(-3.616)	(-3.754)	(-3.574)	(-3.679)
LEV(-1)	-0.398	-0.324	-0.429	-0.405	-0.399	-0.406	-0.366	-0.377	-0.382
	(-3.795)	(-3.502)	(-3.374)	(-3.594)	(-3.842)	(-3.629)	(-3.343)	(-3.376)	(-3.597)
WYCRISC	3.62	2.703	3.391	3.998	3.337	3.712	3.355	3.108	3.0002
	(3.112)	(2.506)	(2.647)	(3.3)	(2.713)	(2.911)	(2.757)	(2.533)	(2.456)
% of non-crises called correctly	63.9	59.3							
% of crises called correctly	75.0	71.4							

Note: Cut off value for the extended panel is 3.5% as the number of crisis and non-crisis observations increases in the extended sample; z-tat in parenthesis

We ran additional robustness tests to check the sensitivity of our results, first towards the change in crisis dates[6], secondly to crises duration and consequent endogeneity between the crisis itself and the explanatory variables in the post-crisis period and finally towards exclusion of borderline-systemic crises episodes, as defined in footnote 3. Table 3 illustrates that our final specification remains robust to all the above changes.

Table 3: Additional robustness analysis – changing crisis dates, removing post crisis observations and elimination of borderline-systemic crises

	Final panel	Japanese crisis at 1992	US crisis at 1984	Elimination of post crisis observations	Only systemic crises included
NLIQ(-1)	-0.174	-0.169	-0.17	-0.167	-0.257
	(-3.81)	(-3.755)	(-3.774)	(-3.797)	(-3.125)
LEV(-1)	-0.398	-0.371	-0.411	-0.383	-0.622
	(-3.795)	(-3.643)	(-3.892)	(-3.738)	(-3.297)
WYCRISC	3.62	2.925	3.708	3.572	5.938
	(3.112)	(2.479)	(3.201)	(3.085)	(3.259)

Note: z-stat in parenthesis, estimation period 1980-2006

Our final preferred specification is given by equation (4) with the corresponding z-statistics:

$$\log\left[\frac{p(crisis)}{1-p(crisis)}\right] = -0.398\ LEV(-1) - 0.174\ NLIQ(-1) + 3.62\ WYCRISC \qquad (4)$$

$$(-3.80) \qquad (-3.81) \qquad (3.11)$$

Table 4 shows the increment in the probability of a crisis in one country induced by a crisis in another country for 2006. Effects feed through WYCRISC, with a greater effect the larger the weight the country takes in the average. The systemically important

[6] Alternative crisis dates for the US and Japan are based on Reinhart and Rogoff (2008)

countries (see "average change") are the US followed by Japan and Germany, UK and France. The potential importance of a crisis event in the US is noticeable, as its average induced probability is much greater than its size would suggest[7]. The remaining large countries are less influential. The Scandinavian economies and the Netherlands are quite vulnerable to events elsewhere, and the UK is also shown to be particularly vulnerable. The table implies small countries have an incentive to induce large countries to improve their regulatory framework, and large countries have an incentive to co-operate - although the US as a dominant player may require side payments.

Table 4: Induced changes in crisis probabilities in other countries in 2006

Columns are for countries with a crisis and rows are for countries affected by spillover

Country j	Country i: US	UK	SP	SD	NW	NL	JP	IT	GE	FR	FN	DK	CN	BG
BG	5.42	0.40	0.23	0.06	0.04	0.11	0.91	0.33	0.54	0.38	0.03	0.03	0.22	0.00
CN	9.25	0.71	0.42	0.10	0.07	0.19	1.61	0.59	0.95	0.68	0.05	0.06	0.00	0.11
DK	18.39	1.57	0.92	0.22	0.16	0.43	3.52	1.31	2.11	1.51	0.12	0.00	0.88	0.25
FN	3.53	0.26	0.15	0.04	0.03	0.07	0.58	0.21	0.34	0.25	0.00	0.02	0.14	0.04
FR	8.35	0.63	0.37	0.09	0.06	0.17	1.44	0.53	0.85	0.00	0.05	0.05	0.35	0.10
GE	4.98	0.37	0.21	0.05	0.04	0.10	0.83	0.30	0.00	0.35	0.03	0.03	0.20	0.06
IT	1.80	0.13	0.07	0.02	0.01	0.03	0.29	0.00	0.17	0.12	0.01	0.01	0.07	0.02
JP	0.13	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.01	0.00
NL	26.86	2.61	1.54	0.37	0.27	0.00	5.75	2.18	3.48	2.51	0.20	0.22	1.47	0.42
NW	15.54	1.28	0.75	0.18	0.00	0.35	2.88	1.07	1.72	1.23	0.10	0.11	0.72	0.20
SD	12.04	0.95	0.56	0.00	0.10	0.26	2.15	0.79	1.28	0.92	0.07	0.08	0.53	0.15
SP	3.59	0.26	0.00	0.04	0.03	0.07	0.59	0.22	0.35	0.25	0.02	0.02	0.14	0.04
UK	13.19	0.00	0.62	0.15	0.11	0.29	2.38	0.88	1.42	1.02	0.08	0.09	0.59	0.17
US	0.00	0.14	0.08	0.02	0.01	0.04	0.31	0.11	0.19	0.13	0.01	0.01	0.08	0.02
Avge	**8.79**	**0.67**	**0.42**	**0.09**	**0.07**	**0.15**	**1.66**	**0.61**	**0.96**	**0.67**	**0.05**	**0.05**	**0.39**	**0.11**

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

Predictions of banking stress for 2007 are reported in Table 5 and are compared to the crisis definition from Borio and Drehmann (2009), i.e. "countries where the government had to inject capital in more than one large bank and/ or more than one large bank failed". By end-January 2009 this definition included Belgium, France, Germany, the UK, the US and the Netherlands.

We show in Table 5 that 5 out of 6 countries that had a crisis in 2008 were already showing stress (with the probability exceeding the sample average) in 2007. Our model suggests that there was a noticeable risk of a crisis in six more counties including Spain, where developments in 2010 suggest that there may be one under way.

There is a marked nonlinearity in the model which is revealed in Tables 4 and 5, which depends both on the size and the number of countries having crises. In particular a crisis in the US produces a fourfold increase in the probability of crises in the UK, France, Germany, Belgium and the Netherlands.[8]

[7] The increment to the 2006 probability is independent of the crisis event in the US in the next year.

[8] Note that Table 4 is derived using 2006 data and Table 5 has projections for 2007, so the comparison is not exact.

Table 5: Banking stress indicators for 2007 (percentage probability of crisis)

	2007	Borio-Drehmann
Belgium	**10.47**	**X**
Canada	**14.53**	
Denmark	**31.88**	
Finland	**5.99**	
France	**18.69**	**X**
Germany	**9.45**	**X**
Italy	3.12	
Japan	0.34	
Netherlands	**47.3**	**X**
Norway	**33.24**	
Sweden	**20.18**	
Spain	**9.97**	
UK	**18.89**	**X**
US	0.73	**X**

Bold figures are predictions above the sample mean

Conclusions

The risk of a financial crisis is increased markedly when other OECD countries have a crisis at the same time. Since the probability of such crises is in turn increased by low capital adequacy as well as liquidity, the results provide support not only for tighter national bank regulation but also for international agreements on harmonization of regulation at a suitably stringent level, and in particular for tighter and more effective regulation in the US.

References

Barrell R., Davis E. P., Karim D., and Liadze, I., (2010), "Bank regulation, property prices and early warning systems for banking crises in OECD countries", Journal of Banking and Finance, 34, 2255-2264

Beck T., Demirguc Kunt A., and Levine R., (2006), "Bank concentration, competition and crises, first results", Journal of Banking and Finance, 30, 1581-1603

Borio C., and Drehmann M., (2009) "Assessing the risk of banking crises - revisited", BIS Quarterly Review, March, pp 29-46.

Calomiris, Charles W.,. and Mason, Joseph R., (2001). "Causes of U.S. Bank Distress During the Depression". Federal Reserve Bank of Chicago, Proceedings, May 2001, 530-554

Caprio, G and Klingebiel D., (2003). "Episodes of Systemic and Borderline Financial Crises" World Bank Research Dataset.

Davis, E. P., and Karim, D., (2008). "Comparing Early Warning Systems for Banking Crises", Journal of Financial Stability, Volume 4, Issue 2, pp 89 – 120.

Demirgüç-Kunt, A., and Detragiache, E., (2005). "Cross-Country Empirical Studies of Systemic Bank Distress: A Survey." National Institute Economic Review, 192, 68-83

Diamond D., and Dybvig P., (1983), "Bank runs, deposit insurance, and liquidity", Journal of Political Economy, 91, 401–19

Edwards, S., and Rigobon, R., (2002) "Currency crises and contagion: an introduction," Journal of Development Economics, 69, 307-313

Freixas, X., Parigi, B.,. and Rochet, J-C., (2000). "Systemic Risk, Interbank Relations and Liquidity Provision by the Central Bank". Journal of Money, Credit and Banking, 32, 611 - 38.

Furfine, C. H., (2003): "Interbank Exposures: Quantifying the Risk of Contagion", Journal of. Money, Credit and Banking, 35, 111–28

Gersl A., (2007), "Foreign Banks, Foreign Lending and Cross--Border Contagion: Evidence from the BIS Data", Czech Journal of Economics and Finance, 57, 27-40

Gorton G., (1988), "Banking panics and business cycles", Oxford Economic Papers, 40, 751-781

Jayanti, S. and Whyte, A. (1996). "Global Contagion Effects of the Continental Illinois Failure," Journal of International Financial Markets, Institutions and Money, 6, 87-99.

Laeven L., and Valencia F., (2007), "Systemic Banking Crises: A New Database", IMF Working Paper 08/224

Pesaran M. H., (2004a), "Estimation and inference in large heterogeneous panels with a multifactor error structure", CESIFO Working paper 1331

Pesaran, M.H., (2004b) "General diagnostic tests for cross section dependence in panels", CESifo Working Papers 1229

Reinhart, M.C., Rogoff, S.K., (2008) “Is the 2007 US sub-prime financial crisis so different? An international historical comparison”, American Economic Review 982, 339–344.

Santor, E., (2003). "Banking Crises and Contagion: Empirical Evidence," Bank of Canada Working Paper 03-1.