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International Capital Mobility and Financial Fragility - Part 1. Drivers of Systemic Banking Crises: The Role of Bank-Balance-Sheet Contagion and Financial Account Structure

Rudiger Ahrend,

Antoine Goujard

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INTERNATIONAL CAPITAL MOBILITY AND FINANCIAL FRAGILITY
PART 1: DRIVERS OF SYSTEMIC BANKING CRISES: THE ROLE OF BANK-BALANCE-SHEET CONTAGION AND FINANCIAL ACCOUNT STRUCTURE

ECONOMICS DEPARTMENT WORKING PAPERS No. 902

by Rudiger Ahrend and Antoine Goujard

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ABSTRACT/RÉSUMÉ

International Capital Mobility and Financial Fragility
Part 1: Drivers of Systemic Banking Crises: the Role of Bank-Balance-Sheet Contagion and Financial Account Structure

This paper examines whether the composition of a country's external liabilities and assets has an incidence on its risk of suffering financial turmoil. Particular emphasis is put on the role of international financial integration, using newly-constructed measures of contagion shocks. These new measures capture well the contagion observed *e.g.* in the wake of the Mexican and Asian crises, and confirm that contagion shocks observed in 2009/10 dwarfed those observed during previous financial crises.

Using a panel of 184 developed and emerging economies from 1970 to 2009, the empirical analysis finds that the structure of the financial account has an important influence on financial stability. A key result is that a bias in external liabilities towards debt strongly increases the risk of a systemic banking crisis. Moreover, certain forms of international financial integration are found to amplify contagion shocks and increase crisis risk, such as integration through international bank lending, and in particular through short-term bank debt.

JEL classification codes: E44; F34; F36; G01; G32
Keywords: banking crises; contagion, financial stability; banking system; financial spillovers; balance sheet; financial account; external debt.

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Flux de capitaux internationaux et fragilité financière
Partie 1 : Les déterminants des crises bancaires : le rôle de la contagion par le système bancaire et de la structure du compte financier

L'article étudie les effets de la structure des engagements et créances externes d'un pays sur sa stabilité financière. Une attention particulière est portée au rôle de l'intégration financière internationale. L'article propose de nouvelles mesures de la propagation des chocs par le système bancaire. Ces mesures capturent bien les chocs de contagion observés lors des crises mexicaine et asiatique. De plus, elles soulignent que les chocs de contagion liés à la crise financière de 2009/2010 sont d'un ordre de magnitude différent de ceux observés historiquement lors des crises financières.

L'analyse empirique menée sur un panel de 184 pays développés et émergents de 1970 à 2009 confirme l'importance de la structure du compte financier pour la stabilité financière. En particulier, un biais de la structure de financement vers la dette augmente fortement la probabilité de crise bancaire. De plus, certaines formes d'intégration financière comme les besoins de financement externes des banques, en particulier à court-terme, amplifient les chocs de contagion et augmentent les risques de crises.

Codes JEL : E44 ; F34 ; F36 ; G01 ; G32
Mots Clés : crises bancaires ; contagion ; stabilité financière ; système bancaire ; interdépendances financières ; compte financier ; dette externe

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INTERNATIONAL CAPITAL MOBILITY AND FINANCIAL FRAGILITY PART 1: DRIVERS OF SYSTEMIC BANKING CRISES: THE ROLE OF BANK-BALANCE-SHEET CONTAGION AND FINANCIAL ACCOUNT STRUCTURE

by

Rudiger Ahrend and Antoine Goujard[1]

Introduction and main findings

1. The large swings of financial flows during the financial crisis of 2007-9 have put the link between global financial integration, financial contagion and financial stability to the forefront. While there is no clear consensus in the literature regarding the main causal factors of financial crises, or their main propagation mechanisms, one channel that has received increasing interest is the external financial account. Excessive non-contingent liabilities (such as debt), overly large *short*-term debt, as well as currency mismatches may increase the riskiness of countries' external balance sheets. Certain forms of international financial integration, especially via leveraged financial institutions such as banks, or through synchronised and abruptly changing financial market perceptions may propagate financial shocks across countries. Taking a balance-sheet approach, this paper first examines whether the structure of external financial account positions affects financial stability, before turning to the role of banking integration in generating and spreading financial instability. The analysis covers a panel of one hundred eighty four developed and emerging economies from 1970 to 2009.

2. As regards the links between external financial structure and financial vulnerability, several factors are found to increase the likelihood of systemic banking crises, including:[2]

- A skew in external liabilities towards debt.
- A bias in a country's borrowing from external banks towards shorter maturities.
- An aggregate currency mismatch (*i.e.* large foreign-currency denominated liabilities compared with foreign-currency denominated assets).

1. The authors are indebted to Romain Duval, Jørgen Elmeskov, Issam Hallak, Jean-Luc Schneider and Cyrille Schwellnus, as well as delegates to the Working Party No. 1 on Macroeconomic and Structural Policy Analysis, and to colleagues in the OECD economics department for useful comments. The authors would like to thank Celia Rutkoski and Diane Scott for first rate editorial support, and Olga Tschekassin and Vera Zipperer for excellent research assistance. The authors are also very grateful to the Bank of International Settlements, and in particular Swapan-Kumar Pradhan, for providing bilateral Locational Banking Statistics. Nancy B. Brune generously provided her data on financial account openness. All remaining errors are those of the authors. The view expressed here are those of the authors, and do not necessarily reflect those of the OECD or its member countries.

2. In part, these findings confirm earlier work carried out at the OECD and elsewhere.

- Past banking crises, possibly by creating long-lasting financial vulnerabilities or negative reputation effects.
- Very large external liabilities, with very large external assets decreasing financial-crisis risk.

Larger reserve holdings reduce the crisis probability, but with decreasing marginal effectiveness.

3. International financial integration through bank flows is found to increase direct and indirect contagion risk:

- Greater indebtedness towards banks located in foreign countries that experience negative shocks to their perceived creditworthiness increases a country's risk of suffering a banking crisis.
- In addition, there are powerful contagion effects through borrowing from foreign banks that suffer from deteriorating credit quality in third countries.
- Borrowing short-term from external banks increases contagion-risk roughly twice as much as general bank lending from abroad.

4. The remainder of this paper is divided in four sections: Section 1 briefly reviews the literature. Section 2 describes developments in the structure of the financial account around banking crises. Section 3 presents the empirical analysis on the financial account drivers of banking crises. Section 4 examines possible links between some forms of financial integration and contagion.

1. Literature review

5. A large body of both theoretical and empirical work, reviewed *e.g.* in Demirgüç-Kunt and Detragiache (2005), has focused on understanding the determinants of financial crises. It highlights two broad types of determinants, namely direct measures of some form of financial account positions and other drivers. The latter can then affect the risk of financial instability directly, indirectly via their impact on the structure of the financial account, or both. The literature review below deals first with these "other" factors, before turning to direct financial account measures.

6. Mendoza and Terrones (2008) and Schularick and Taylor (2011) stress the role of excessive credit growth in generating financial instability at the country level. Credit can induce financial fragility in the presence of collateral constraints, as increased leverage raises the risk that declining asset prices trigger increases in default rates of private households and firms which, in turn, then directly affect the banking and insurance sectors.[3] Financial integration can also increase financial risk. While financial openness should result in a more efficient allocation of capital,[4] it may expose countries to increased contagion risks through debt (Bolton and Jeanne, 2011), as well as to boom-bust cycles through asset-price bubbles and surges and sudden stops in capital flows (OECD, 2011; Furceri *et al.*, 2011). In contrast, stronger macro-prudential policies may decrease the risk of systemic banking crises. For example, tighter prudential regulation and supervision of the banking sector may lower the risk of financial instability (Ahrend *et al.*, 2011). Moreover, capital controls that carefully distinguish between different forms of capital flows may skew the composition of external liabilities towards safer forms of finance and thereby make emerging economies more robust to external shocks (Henry, 2007; Jeanne and Korinek, 2010; Korinek, 2011).

7. On the liability side of the financial account, excessive reliance on debt instruments instead of state-contingent assets (as *e.g.* equity) is often seen as a fundamental factor behind financial crises in

3. For the distributional consequences of financial crises in the presence of collateral constraints see also Ahrend *et al.* (2011).

4. See Henry, 2007, for a review of the empirical evidence.

general (Rogoff, 1999) and the propagation of the 2007-09 financial crisis in particular (Rogoff, 2011). Debt contracts require regular payments regardless of the borrowers' situation and are therefore more prone to cause financial distress (Henry, 2007). Debt inflows are also less stable than FDI inflows (Kose *et al.*, 2006, Duttagupta *et al.*, 2011). However, Tornell and Westermann (2005) point out that in many emerging economies most of the bank lending to the non-tradable sector finances relatively small projects and can hence not be replaced by FDI or equity inflows: to the degree that such domestic debt needs external financing, international debt would hence be necessary for realising the growth potential of these economies. This notwithstanding, there is compelling theoretical and anecdotal evidence on the risks to macroeconomic financial stability connected with external debt finance. In contrast, as underlined by Faria *et al.* (2007), there is no or little solid empirical evidence on the issue.

8. The maturity of debt is often thought of as another important determinant of financial crises (see Jeanne and Zettelmeyer, 2002, for a review). At the macroeconomic level, Rodrik and Velasco (1999) and Radelet and Sachs (1998) find that higher short-term debt is correlated with a higher probability of large capital-account reversals. Such a correlation, however, could also reflect that a deteriorating financial situation may force countries to borrow increasingly short term, implying that short-term debt would be a coincident indicator rather than a cause of pending financial instability. A larger share of short-term debt may also be associated with a bank funding structure that increases vulnerability to "Northern-Rock type" wholesale funding runs.[5] However, the higher liquidity risk associated with short-term bank debt should be weighed against its lower costs and other advantages of short-term debt. For example, Huberman and Repullo (2011) show theoretically that short-term debt could be socially optimal to avoid moral hazard and excessive risk taking by debtors. The need to roll over the debt would act as a disciplinary device that restrains borrowers from unduly increasing their exposure to risk at the potential expense of their creditors. However, Bleakley and Cowan (2010) fail to find any empirical evidence of a relationship between firms' short-term debt exposure and their probability to default during sudden stops.

9. The currency composition of a country's external position is an important determinant of the capital gains and losses that result from exchange rate movements (Lane and Shambaugh, 2010). Unless countries, local firms and banks are properly insured, such shocks may have destabilising consequences for them (see Eichengreen *et al.*, 2007, who also survey the literature on currency mismatches). Different types of financial vulnerabilities are highly interdependent. For example, the share of debt in external liabilities and currency mismatch measures are often strongly correlated as FDI and equity inflows are mostly denominated in domestic currency whereas debt instruments may carry exposure to foreign currency.[6]

2. Descriptive analysis: the evolution of external debt and other financial variables around banking crises

10. This section aims to establish tentative stylised facts for the behaviour of certain key aggregate economic variables prior to, and in the aftermath of systemic banking crises. As the paper is interested in the international dimension it abstracts from non-systemic bank failures and focuses on systemic banking crises that are typically related to currency and/or debt crises.[7] Data for episodes of systemic banking crisis

5. During such a wholesale funding run, providers of short-term financing stop rolling over their credits because they expect the bank to fail. Similar to classical bank runs (Diamond and Dybvig, 1983), such sudden refusals of financing can result in a failure of the attacked bank, with expectations of failure becoming self-fulfilling.

6. The data of Lane and Shambaugh (2010) assume that all FDI and equity inflows are denominated in domestic currency, while the corresponding outflows are denominated in the host country's currency.

7. Kaminsky and Reinhart (1999) and Reinhart and Rogoff (2009) document that systemic banking crises often precede currency and debt crises. However, Falcetti and Tudela (2008) argue against a causal interpretation of this time pattern.

are taken from Laeven and Valencia (2008, 2010), resulting in a sample of 144 crisis episodes between 1970 and 2009. The onset of a systemic banking crisis is identified based on both significant signs of financial distress in the banking system (as indicated by significant bank runs, losses, and bank liquidations) and policy interventions in response to such distress.

11. An initial analysis of the relationship between banking crises and selected financial variables is reported in Figure 1, which show how a given variable behaved for countries that experienced a banking crisis relative to countries that did not.[8] More precisely, the figures present difference-in-differences estimates of the association between the financial variables and crisis episodes, from 10 years before to 10 years after the onset of the crisis. These specifications control linearly for country and year fixed effects:

$$y_{ict} = \sum_{k=-10}^{9} \alpha_k 1_{t=c+k} + \alpha_{10} 1_{t \geq c+10} + \gamma_i + \delta_t + \varepsilon_{ict} \ , \qquad (1)$$

where c is the starting year of a crisis episode, i indexes the countries, and t the years of observation. The omitted category is the period more than 10 years before the onset of a crisis, so all estimates are relative to those earlier years of data. On the solid lines, each point corresponds to the estimate of α_k, the difference between the level of the dependent variable, y_{ict}, in pre- or post-crisis year k relative to tranquil times. The last point estimate, 10 years after the onset of a crisis, is interpreted as capturing the long-run association between the crisis episode and the evolution of the dependent variable, α_{10}. Dashed lines represent the 90% confidence interval adjusted for heteroskedasticity and within-country autocorrelation.

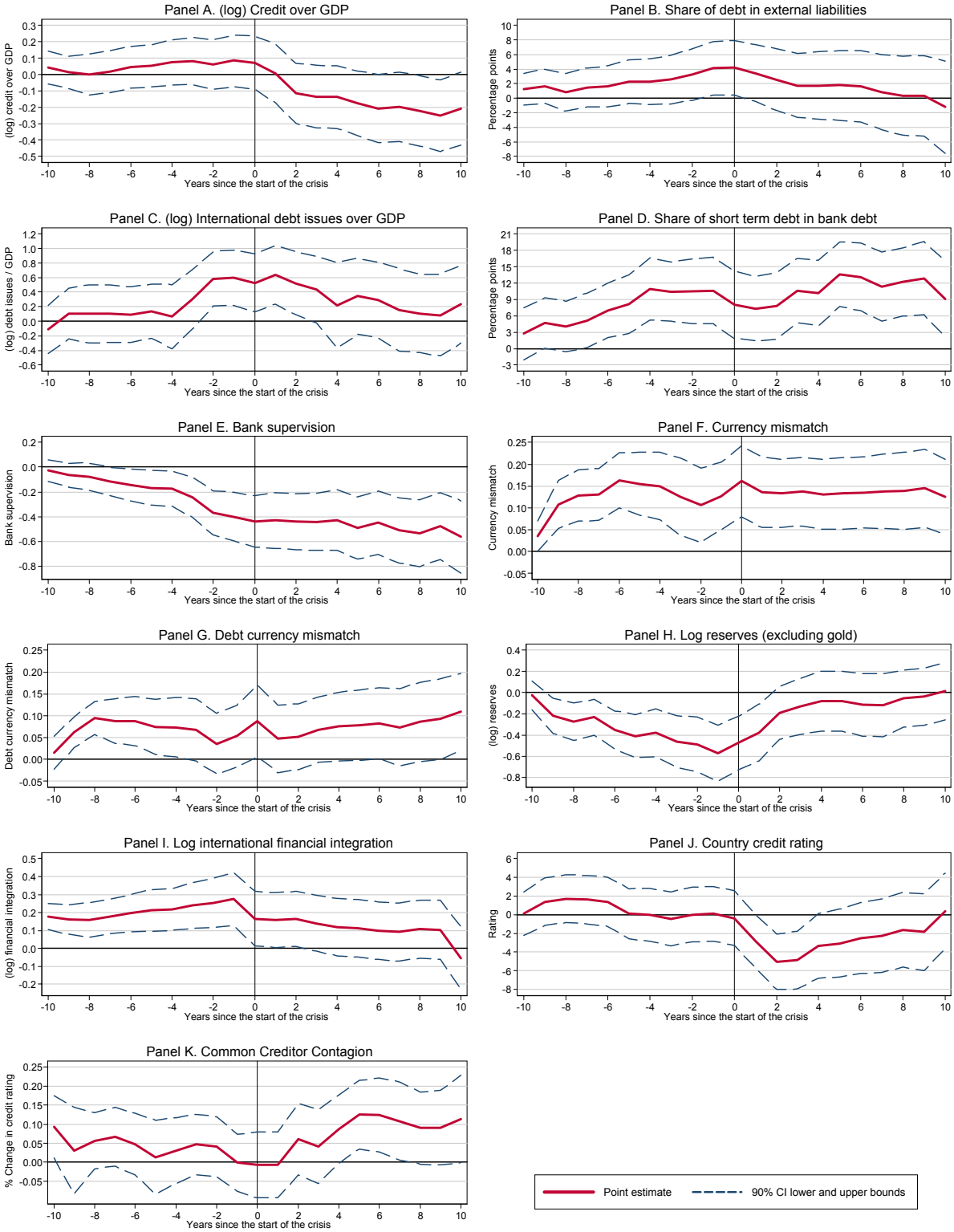
12. Figure 1 reports the development of selected financial variables and characteristics of external liabilities before and after systemic banking crises, compared to countries that did not experience a crisis. The definition and construction of each variable is detailed in Table A1 in the Appendix. The evolution of the ratio of credit to GDP increases somewhat prior to crises and declines steadily afterwards, and this relative decline is still present even after 10 years (Panel A). The dynamics of the share of debt in external liabilities is hump shaped around banking crises (Panel B), *i.e.* the share of debt increases in the run-up to the crisis, but decreases afterwards.[9] This pre-crisis increase in the debt share coincides with a large increase in newly issued international debt (Panel C) at increasingly short maturities (Panel D): cross-border bank debt with residual maturity of less than one year as a share of total cross-border bank debt increases by nearly 10 percentage points in the pre-crisis period and remains at this level afterwards. This change in the structure of the liability side of the financial account is concomitant with some easing of banking supervision during the pre-crisis period, and this relative decline persists during the decade after the crisis (Panel E).[10]

8. As it cannot be excluded that such figures are driven by unobserved country-specific time trends, some caution is needed in giving them a causal interpretation.

9. For evidence on such developments in the Euro area see, *e.g.* Barnes (2010).

10. The employed index by Abiad *et al.* (2010) basically summarises the independence, strength, and coverage of the mandate of the banking supervisor.

Figure 1. Systemic banking crises and financial variables



Note: The solid lines show the association between banking crisis and the dependent variables. The last point, 10 years after the onset of a crisis, is interpreted as the estimate of the long-run impact of the crisis. The dashed lines represent the 90% confidence interval adjusted for heteroskedasticity and within-country autocorrelation. The panel dataset of crisis-country pairs is unbalanced. Countries with no banking crisis are included in the control group.

Source: OECD calculations.

13. Exposure to exchange rate shocks is measured by the currency mismatch, which is the mismatch between foreign currency-denominated assets and liabilities (using different indices constructed by Lane and Shambaugh, 2010, which vary between -1 and 1 from lowest to highest exposure to currency risk).[11] The currency mismatch based on all assets and liabilities increases significantly before banking crises (Panel F). A currency mismatch only based on fixed-income assets and liabilities (in particular excluding countries' foreign reserves) presents a similar but less significant pattern than the overall currency mismatch (Panel G). Consistent with these findings, there is a large drop in foreign currency reserves prior to banking crises (Panel H). *De-facto* financial integration with the rest of the world, measured as the sum of countries' external assets and liabilities divided by nominal GDP, typically increases prior to, and declines in the aftermath of banking crises (Panel I). Countries' perceived creditworthiness declines, albeit mainly during and in the aftermath of the crises, and it takes on average a decade to regain pre-crisis credentials (Panel J). Finally, countries that experience a systemic banking crisis see the quality of the credit portfolio of their foreign creditor banks (excluding exposure to the crisis country) improve in the wake of the crisis. This likely reflects a rebalancing of debt portfolios that were exposed to the crisis country towards less risky borrowers (Panel K).

3. Empirical analysis of the financial account drivers of systemic banking crises

3.1. Methodology

14. The empirical strategy pursued to assess how the structure of foreign assets and liabilities and a set of other determinants of financial stability affect the probability of a systemic banking crisis is the following: A baseline equation assumes that, conditional on the absence of crisis at time t-1, the likelihood of a banking crisis at time t is determined by a linear probability model:[12]

$$c_{it} = F_{it-1}\alpha + X_{it-1}\beta + \gamma_i + \delta_t + \varepsilon_{it} \ , \qquad (2)$$

where c_{it} is a dummy variable taking value one at the beginning of a systemic banking crisis, F_{it-1} is a row vector containing the relevant financial account characteristics, and X_{it-1} is a row vector of additional explanatory variables identified by the literature as key determinants of financial stability. γ_i and δ_t capture unobserved country and time specific shocks. ε_{it} are idiosyncratic disturbances. While the functional form of the linear probability model is open to criticism,[13] it is convenient for panel data sets because it leads to estimators of crisis incidence that are free of country-specific heterogeneity, do not require specification of initial conditions in the dynamic model, and provide the best linear approximations (in the mean-square-error sense) of the average marginal effects (Angrist, 2001). All explanatory variables are lagged in order

11. This measure captures the sensitivity of a country's external balance sheet to a uniform movement of its domestic currency against all foreign currencies. A potential caveat of this measure is that it does not take into account possible hedges against foreign currency exposure or naked currency exposure through derivatives (see also Rancière *et al.*, 2010). The analyses in Section 3 deals with this problem by adding control covariates.

12. Systemic banking crisis episodes are defined according to Laeven and Valencia (2010). They define the end of a systemic banking crisis as the year before two consecutive years of real GDP and real credit growth. When the first two years of the crisis record real GDP and real credit growth, the first year of the crisis is also the end year. Thus, observations corresponding to an ongoing banking crisis and the two subsequent years are not included in the regressions.

13. The main criticism of the linear probability model concerns its use for predictions which is not the purpose of this paper. The estimated average marginal effects of fixed-effects conditional logit models are close to those of fixed-effects linear models (results not reported). Joyce (2010) and Caballero (2011) extensively apply fixed-effects logit models to the analysis of banking crises. However, these models require the regressors to be strictly exogenous.

to measure them prior to the crisis period and to mitigate concerns of endogeneity. First-difference and instrumental-variables specifications are also introduced to tackle the endogeneity issue more directly.[14] In particular, the preferred empirical strategy relies on a dynamic framework rather than a fixed-effects specification. Following Chay and Hyslop (1998) and Hyslop (1999), the preferred specification is a flexible linear first-difference equation:[15]

$$\Delta c_{it} = \Delta F_{it-1}\alpha + \Delta X_{it-1}\beta + \Delta\delta_t + \Delta\varepsilon_{it} \tag{3}$$

15. Specification (3) is less restrictive than a country fixed-effects model as it requires only:

$$E(\Delta\varepsilon_{it}.(\Delta F_{it-1}, \Delta X_{it-1}, \Delta\delta_t)^T) = 0 \tag{4}$$

corresponding to the assumption that banking crises are unpredictable. However, as argued by Griliches and Hausman (1986), specification (3) may lead to more severe attenuation bias than fixed effect models in the presence of measurement error. This is an important identification issue as systemic banking crises are rare events, and the dependent variable has a limited variance. Hence, the empirical section reports the results of pooled, fixed-effects, first-difference and first-difference instrumental variable specifications.[16]

16. One issue to be addressed in the empirical analysis is so-called state and duration dependence. Indeed, after a systemic banking crisis, some explanatory variables are likely to be affected by the crisis itself as shown above (Figure 1). Furthermore, the probability that a crisis occurs in a country that already suffered financial turmoil in the past is typically higher than for a country where no crisis occurred recently, which could confound the effects of explanatory variables if not accounted for (Demirgüç-Kunt and Detragiache, 1998, Bussière and Fratzscher, 2002). The empirical specifications control for these state and duration dependence effects by interacting a quadratic function of the time elapsed since the last systemic banking crisis with dummy variables for the number of previous crises.[17]

---

14. As most explanatory variables and financial factors are affected by systemic banking crises, they may be only predetermined or weakly exogenous. Assuming that the explanatory variables are strictly exogenous would imply, for example, the too-strong statement that the country-specific idiosyncratic shocks that coincide with systemic banking crises are unrelated to future financial account developments. However, the descriptive findings of Section 1 show that observable characteristics of the financial account respond to banking crises, implying that the idiosyncratic error terms could be partly determined by the systemic banking crises. Moreover, the political economy literature argues that financial and political crises imply more structural reforms, and these may also impact future financial stability (see *e.g.* Duval, 2008). This bias should vanish if the number of time periods is large; however, for some variables the number of time periods is small (15 years in the case of the currency mismatch) and the feedback effects of the crises on the financial variables are likely to be particularly large.

15. See Card (1990) for an early application and De Ree and Nillesen (2009) for an application in a panel of countries. Falcetti and Tudela (2008) investigate the probability of banking crises in a related non-linear dynamic framework including a lagged dependent variable. However, their implicit assumption is that the start of a systemic banking crisis and its continuation are the results of the same stochastic process.

16. The empirical relevance of the first-difference and fixed-effect specifications is assessed using the heteroskedacity- and autocorrelation-robust Hausman tests suggested by Wooldridge (2002). The tests were implemented using a country block bootstrap process (Cameron and Trivedi, 2009).

17. The final model can be thought of as a flexible, discrete-time hazard model that allows for time-varying covariates, duration and state dependence, and correlated unobserved heterogeneity. Allison (1982) shows that estimates from models of this type converge to those obtained from continuous time-duration models.

17. The explanatory variables in X_{it-1} are those typically suggested in the literature and are grouped into three main categories:[18]

- Macroeconomic and related country-specific characteristics, which include (log) per capita GDP and (log) population.

- International trade variables, including (log) openness to international trade measured as the sum of imports and exports as a share of nominal GDP, and real GDP growth in a country's trading partners to measure export prospects.

- The country's financial sector and international financial exposure. This is measured *e.g.* by the development of the domestic banking sector, the size of credit to the non-financial sector, the strength of banking sector supervision, and a variable that captures financial contagion through bank balance sheets (see below). Bank-driven contagion should have a larger effect on the likelihood of systemic banking crises in countries where the size of external bank debt is larger. Hence the empirical specifications also include an interaction term between the external bank debt-to-GDP ratio and the contagion variable.

- Some other variables suggested by the literature were also tentatively tested for, such as the public deficit, the current account balance, the *de facto* exchange rate regime, or the *de facto* concentration of the banking sector. However, results were non-significant or unstable and are therefore not reported.

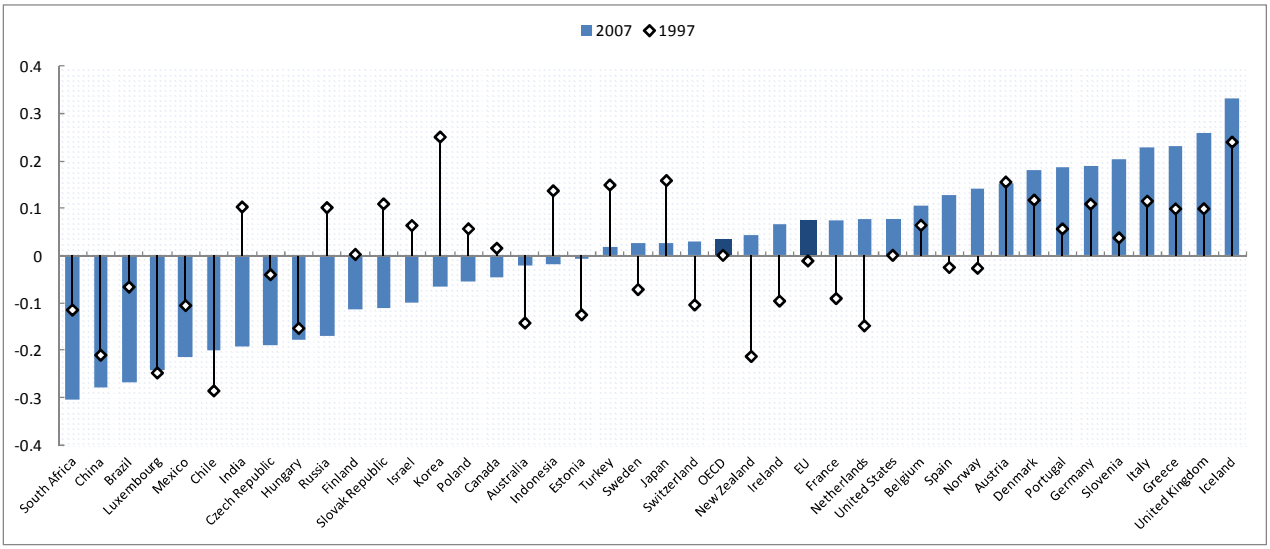
18. Country specific balance-sheet characteristics of the financial account are introduced through the vector F_{it-1}. These include the share of debt in external liabilities, measures of overall and short-term bank debt as a share of external liabilities, short-term bank debt as a share of total bank debt to measure maturity-related risk, and measures of the currency mismatch. It is well known that – everything else equal – increased external liabilities eventually raise the risk of financial crisis (Joyce, 2010). The more interesting question is therefore whether the structure of external liabilities, and more broadly of the financial account, is related to financial-crisis risk. This paper focuses therefore on relative measures of financial account characteristics, using the total size of external assets and of external liabilities (both as a share of GDP) as control variables.

19. To give an example, Figure 2 shows the share of (gross) external debt in total external liabilities for OECD countries and the BRIICS which – when excepting the most highly rated sovereigns - can be interpreted as a measure of excessive exposure to non-contingent external liabilities. Two stylised facts emerge: first, most of the countries that suffered from violent financial turmoil in recent years had a relatively high share of external debt prior to the 2007-09 financial crisis. Second, over the decade that preceded this crisis, many advanced economies increased their share of external debt, whereas emerging economies generally reduced it to comparatively low levels. This amongst other factors might explain why emerging markets fared not only much better during the recent crisis than during the financial crises of the 1990s, but were also often less affected than developed countries.

18. This classification is based partly on Milesi-Ferreti and Tille (2011). The definition and construction of each variable is detailed in Table A1 of the Appendix.

Figure 2. Share of external debt in total external liabilities

Deviation from sample average



Source: OECD calculations based on Lane and Milesi-Ferreti (2007).

3.2. Main empirical results -- debt as a share of external liabilities

20. This and the following sections report the results for a series of specifications based on Equations (2) and (3) along with variants designed to test for their robustness. Tables 1 to 7 display the results of the banking crises models for the different financial-account-structure variables. Each table reports the estimates by pooled OLS, fixed-effects, fixed-effects controlling for duration and state dependence, first-difference, first-difference controlling for duration and state dependence, and first-difference instrumental variables. All specifications include year fixed effects, and robust standard errors clustered at the country level are used to calculate the test statistics.

21. Table 1 displays the estimates of the impact of a country's structure of foreign liabilities on the likelihood of banking crises, using the baseline specification.[19] The baseline control variables are reported in Table 1. As they are not the focus of the analysis they are not reported subsequently to increase the

19. The baseline specification controls – in addition to the financial account structure variable of interest - for credit levels (as a share of GDP), credit growth, GDP per capita, population size, and *de facto* trade openness. In addition, total liabilities, total assets (excluding reserves) and foreign currency reserves (all as a share of GDP), a quadratic function of each of these variables, and the previously mentioned controls for state and duration dependence are included. These controls were chosen so as to replicate the main results of the literature, maximise the sample size, and avoid confounding the composition of the balance sheet and its size.

readability of tables, even though these baseline variables are included in all regressions unless specifically stated otherwise. The share of debt in external liabilities comes out as a strong predictor of banking crises (Table 1). Point estimates for the period 1970-2009 suggest that an increase in the share of debt in external liabilities by 11 percentage points, corresponding in 2007 to a move from the French share of external debt (the OECD median) to the Portuguese position (the OECD third quartile), would on average increase the likelihood of banking crises by 1.2 percentage points (Column 5).[20] This effect is large as it implies an increase in crisis risk by 37%.[21] Addressing possible endogeneity concerns by instrumenting the share of debt in external liabilities based on lagged capital controls on inflows[22] (Brune, 2006, Brune and Guissinguer, 2007) does not qualitatively affect these results.[23] Since the instruments used are likely to capture mainly private lending to a country, which should be more prone to causing financial instability than official lending, the coefficient in this specification should *a priori* be higher than in the non-instrumented regressions, which indeed is the case.[24]

20. This is also broadly in line with recent estimates of Joyce (2010) based on a sample of 20 emerging countries.

21. The reported increase in the probability of a banking crisis is specific to the median country. For countries with a higher general risk of financial crisis, the increase in the likelihood of a financial crisis would be smaller. However, this effect is counteracted as countries that are generally more at risk of having a banking crisis are likely to be more exposed to increases in risk factors than the estimate for an average country would suggest. It is impossible to predict the direction of the net result from these countervailing effects.

22. Instruments are openness to inflows from credit operations, capital and money market securities, and FDI. These three capital controls' dummies are apparently relevant for capital inflows' composition. In the unreported first stage regression, the three variables are included in level in year t-2 and have the expected signs. The variables are taken from Brune (2006) and are coded as dummy variables. They are the only available capital control indicators that distinguish between different types of controls on inflows and outflows for a large number of countries and a long time period (Eichengreen and Luengnaruemitchai, 2008, Schindler, 2009). The openness indicators are available for 187 countries over the period 1965-2007.

23. Given the relatively small number of countries in the sample and the presence of arbitrary heteroskedasticity and within-country autocorrelation, the two-step GMM estimator with a fully flexible variance covariance matrix is likely to perform poorly. Therefore, the reported estimates are 2SLS estimates.

24. However, the standard-error of the point estimate is large and uninformative about the magnitude of the impact of the debt bias. The Hansen J statistics for over-identification fails to reject the null hypothesis that the instruments are jointly valid with a p-value of 0.28. Instruments based on further lags of the capital account openness measures or the share of "open" periods during year t-2 to t-5 led to similar results.

Table 1. Share of debt in external liabilities, foreign currency reserves and probability of banking crises

	Pooled OLS	Fixed effects	Fixed effects	First differences	First differences	First differences
Dependent variable:			Start of a banking crisis			
	(1)	(2)	(3)	(4)	(5)	(6)
External debt /	0.036***	0.088***	0.067***	0.114***	0.106***	2.181*
External liabilities	(0.010)	(0.024)	(0.025)	(0.039)	(0.039)	(1.127)
Domestic credit growth	0.032*	0.028	0.023	0.037**	0.039**	0.068**
	(0.018)	(0.018)	(0.017)	(0.018)	(0.019)	(0.032)
(log) Credit over GDP_{t-1}	0.003	0.007	-0.004	0.007	0.009	-0.003
	(0.004)	(0.009)	(0.010)	(0.024)	(0.024)	(0.031)
(log) GDP per capita	0.002	0.022	0.011	-0.007	-0.006	0.030
	(0.003)	(0.013)	(0.014)	(0.028)	(0.028)	(0.035)
(log) Population	0.003***	-0.022	-0.014	-0.033	-0.058	-0.174
	(0.001)	(0.030)	(0.036)	(0.164)	(0.174)	(0.230)
Trade openness	0.001	0.002	0.020	0.022	0.023	0.063
	(0.007)	(0.017)	(0.019)	(0.025)	(0.025)	(0.042)
Assets / GDP excl. reserves	-0.001	-0.002	-0.002	0.003	0.003	-0.001
	(0.004)	(0.009)	(0.009)	(0.017)	(0.017)	(0.003)
$(\text{Assets / GDP})^2$ excl. reserves	-0.001***	-0.001***	-0.001***	-0.000**	-0.000**	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Reserves / GDP	-0.110**	-0.206**	-0.148**	-0.133	-0.127	-0.082
	(0.043)	(0.080)	(0.075)	(0.119)	(0.119)	(0.076)
$(\text{Reserves / GDP})^2$	0.086**	0.184**	0.125*	0.057	0.051	0.064
	(0.041)	(0.072)	(0.073)	(0.095)	(0.095)	(0.089)
Liabilities / GDP	0.001	0.011	0.007	-0.004	-0.004	-0.055
	(0.004)	(0.008)	(0.009)	(0.016)	(0.016)	(0.035)
$(\text{Liabilities / GDP})^2$	0.001***	0.001***	0.001***	0.001***	0.001***	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	No	Yes	Yes	Yes	Yes	Yes
Controls for duration[1]	No	No	Yes	No	Yes	Yes
Instruments[2]	No	No	No	No	No	Yes
Observations	3,851	3,851	3,851	3,604	3,604	3,559
Countries	154	154	154	154	154	152
F-test duration controls[3]			21.93***		1.912	1.516

Note: All regressors are lagged one period. Standard errors are clustered at the country level. * denotes a significant estimate at the 10% level, ** at 5%, *** at 1%.

1. The controls for duration include a quadratic function in the number of years since the last crisis interacted, respectively, with a dummy variable for having, or not having experienced a crisis since 1970.
2. The specification in Column 6 instruments the lagged share of debt in external liabilities by the level of openness to inflows from credit operations, capital and money market securities, and FDI in year t-2.
3. F-test robust to heteroskedasticity and within country autocorrelation for the significance of the controls for duration and state dependence.

Source: OECD calculations.

Credit cycles

22. In the specifications of Table 1, while the level of credit to the private sector is largely insignificant, strong (lagged) credit growth is significantly and positively correlated with the probability of a crisis in all specifications. Based on Column 6, an increase of 4 percentage points in credit growth, from the median to the 3rd quartile of OECD countries in 2007, would imply an increase in the likelihood of banking crisis of 9% (0.3 percentage points). These point estimates corroborate the conjecture of Kaminsky and Reinhart (1999) and Schularick and Taylor (2011) that financial crises can be partly seen as "credit booms gone wrong". This is also in line with the microeconomic evidence: Mendoza and Terrones (2008) find that changes in bank-balance-sheet characteristics point to a loosening of lending standards towards more risky clients during credit booms. This lowering of the quality of banks' assets is later associated with a sharp increase in the share of non-performing loans and a drop in profitability.

Size of financial account and reserves

23. The size of external assets (excluding reserves) and liabilities as a share of GDP are found to be statistically insignificant in general, but external liabilities raise, and external assets reduce the probability of a systemic banking crisis when they become very large.[25] Reserve holdings, as measured by the ratio of reserves to GDP, also reduce the probability of crises. In 2007, if Chile had increased its foreign reserves to the level of Japan (10.3% to 21.7% of GDP), the estimates suggest that its risk of suffering a banking crisis would have decreased by 40% (or 1.2 percentage points, Column 3). However, this effect is non-linear in the sense that the marginal effectiveness of reserve accumulation decreases with increasing levels of reserve holdings.

Banking supervision

24. Table 2 examines the relationship between banking supervision[26] and banking crises.[27] In the pooled OLS and fixed-effects specifications, Columns 1-3, there is a strong negative correlation between stronger supervision and the occurrence of banking crises. An increase in the strength of banking supervision corresponding to an increase in the indicator by one standard deviation in 2005 would lead to a decrease of the probability of banking crises by roughly 58% (1.8 percentage points, Column 3), *ceteris paribus*. There is not enough time variation in banking supervision to identify the impact of banking supervision using first differences, but the initial level of banking supervision may be correlated with the occurrence of a future banking crisis. Therefore, the results of estimating Equation (3) in first differences including the level of regulation as an explanatory variable are reported in Columns 4-7. These estimates of the impact of banking supervision on the occurrence of banking crises support the fixed-effects estimates both in significance and magnitude. Controlling for GDP per capital levels as well as for the size of the banking sector, both of which may be correlated with banking supervision, does not alter the results.[28]

25. This analysis was confirmed by using dummy variables. For each country, the size of the financial account was split in three categories of external positions (low, medium and large) according to the terciles of the cross-sectional dimension. Regressions not reported.

26. It would be highly interesting to carry out this analysis for banking regulation as well, but the current data situation does unfortunately not allow this.

27. As the share of debt in external liabilities is correlated with banking supervision, the former is not included in this specification.

28. Credit, credit growth, and the share of debt in external liabilities could also be an outcome of the quality of banking supervision as stricter banking supervision may prevent excessive lending to the domestic non-financial sector or excessive foreign borrowing. However, replicating the specifications reported in Table 2

Overall, the analysis of the impact of banking supervision on the likelihood of systemic banking crises corroborates findings by Ahrend *et al.* (2011) that indicators of regulatory strength are relatively well correlated with the extent to which countries escaped banking damages during the 2007-9 financial crisis.

Table 2. Banking supervision and probability of banking crises

	Pooled OLS	Fixed effects	Fixed effects	First differences	First differences	First differences	First differences
Dependent variable:				Start of a banking crisis			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Banking supervision	-0.021***	-0.017*	-0.029**	-0.022***	-0.025***	-0.031***	-0.032***
	(0.006)	(0.009)	(0.011)	(0.006)	(0.007)	(0.007)	(0.007)
Trade openness	-0.008	-0.026	-0.010	-0.004	-0.004	0.050	0.049
	(0.019)	(0.049)	(0.052)	(0.102)	(0.101)	(0.103)	(0.101)
Baseline controls[1]	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	No	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls for duration[1]	No	No	Yes	No	Yes	Yes	Yes
Instruments[2]	No	No	No	No	No	Yes	Yes
Controls in level[2]	No	No	No	No	No	No	Yes
Observations	1,908	1,908	1,908	1,813	1,813	1,712	1,708
Countries	83	83	83	83	83	83	83
F-test duration controls[3]			13.44***		1.618	13.48***	13.99**

Note: All regressors are lagged one period. Standard errors are clustered at the country level. * denotes a significant estimate at the 10% level, ** at 5%, *** at 1%.

1. Baseline controls include (log) GDP per capita, (log) population, domestic credit growth and the lagged level of domestic credit over GDP. In addition, all the specifications control for the characteristics of the financial account by including linear and quadratic terms for total assets (excluding reserves) over GDP, external reserves (excluding gold) over GDP, and total liabilities over GDP. The controls for duration include a quadratic function in the number of years since the last crisis interacted, respectively, with a dummy variable for having, or not having experienced a crisis since 1970.
2. In Column 6, the banking regulation in t-1 is instrumented by the banking regulation in t-3. In Column 7, two additional control variables in levels are introduced lagged by one period: GDP per capita and the ratio of deposit over GDP.
3. F-test robust to heteroskedasticity and within country autocorrelation for the significance of the controls for duration and state dependence.

Source: OECD calculations.

External bank debt

25. Table 3 reports the same specifications as Table 1, adding a country's indebtedness to foreign *banks* as a share of its total external liabilities. Total borrowing from foreign-domiciled banks as a share of total external liabilities is only significant in some specifications (Table 3). This suggests that there may be some additional risk to financial stability from financing external debt liabilities through banks, although this effect is not very robust and quantitatively small. However, bank debt may not only affect financial-stability risk directly, but also indirectly by increasing contagion. For a given country, a simple measure of its international bank-balance-sheet (BBS) driven contagion risk is the exposure of its creditor banks in foreign countries to various shocks, as reflected in changes in the perceived creditworthiness of the creditor banks' home country (contagion risk is defined and treated in more detail in the following section). More precisely, the total contagion shocks for country d in period t are defined as

while omitting these three variables (not reported) leads to point estimates for the impact of banking supervision that are only marginally higher, confirming the robustness of the banking-supervision results.

$Contagion_{dt} = \sum_{r \in R, r \neq d} wbl_{drt} \cdot \frac{\Delta rating_{rt}}{rating_{r,t-1}}$, with R the set of lending (reporting) countries, $rating_{r,t}$ the rating of country r, and Wbl_{drt} the share (weight) of bank liabilities of country d held by country r at time t.

Table 3. External bank debt and probability of banking crises

	Pooled OLS	Fixed effects	Fixed effects	First differences	First differences	First differences
Dependent variable:			Start of a banking crisis			
	(1)	(2)	(3)	(4)	(5)	(6)
BIS bank debt / External liabilities	-0.001	0.018**	0.012	0.015	0.013	0.054***
	(0.001)	(0.009)	(0.009)	(0.011)	(0.011)	(0.020)
External debt / External liabilities	0.047***	0.124***	0.088*	0.167***	0.156**	1.698*
	(0.018)	(0.046)	(0.048)	(0.062)	(0.062)	(0.914)
Contagion risk	0.295	-0.112	-0.033	-0.193	-0.186	-0.106
	(0.455)	(0.506)	(0.502)	(0.310)	(0.308)	(0.368)
Contagion risk multiplier[1]	-0.212	-0.436	-0.527*	-0.952***	-0.943***	-0.943***
	(0.381)	(0.295)	(0.268)	(0.112)	(0.110)	(0.164)
Trade openness	-0.005	-0.005	0.019	0.037	0.037	0.068
	(0.015)	(0.026)	(0.028)	(0.038)	(0.038)	(0.048)
Growth of trading partners	-0.497	-0.195	-0.161	-0.368	-0.357	-0.488
	(0.398)	(0.582)	(0.525)	(0.538)	(0.537)	(0.576)
Growth of trading partners × (Export/GDP)$_{t-3}$	0.750	0.629	0.926	-0.595	-0.591	0.189
	(0.708)	(1.029)	(0.937)	(0.956)	(0.953)	(0.983)
Baseline controls(1)	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	No	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Controls for duration(1)	No	No	Yes	No	Yes	Yes
Instruments(2)	No	No	No	No	No	Yes
Observations	2,419	2,419	2,419	2,204	2,204	2,051
Countries	146	146	146	146	146	146
F-test duration controls(3)			22.60***		1.208	1.827

Note: All regressors are lagged one period. Standard errors are clustered at the country level. * denotes a significant estimate at the 10% level, ** at 5%, *** at 1%.

1. The contagion risk multiplier is the interaction between the contagion risk and the lagged bank debt over GDP. Baseline controls include (log) GDP per capita, (log) population, domestic credit growth and the lagged level of domestic credit over GDP. In addition, all the specifications control for the characteristics of the financial account by including linear and quadratic terms for total assets (excluding reserves) over GDP, external reserves (excluding gold) over GDP, and total liabilities over GDP. The controls for duration include a quadratic function in the number of years since the last crisis interacted, respectively, with a dummy variable for having, or not having experienced a crisis since 1970.
2. The specification in Column 6 instruments the share of debt in external liabilities with capital controls in t-2 on inflows from credit operations, capital and money market securities, and FDI. The share of bank debt in external liabilities is instrumented by the lagged level of external bank debt in t-3 and t-4. The contagion risk multiplier is instrumented by the average bank debt as a share of GDP interacted with contagion risk.
3. F-test robust to heteroskedasticity and within country autocorrelation for the significance of the controls for duration and state dependence.

Source: OECD calculations.

26. While bank-driven contagion shocks may influence the probability of financial crises itself, they are more likely to do so when a country's banking system is more internationally integrated, as for example measured by its level of indebtedness to foreign banks. To capture such an effect, a contagion risk multiplier, *i.e.* an interaction term between a country's bank debt (as a share of GDP) and the contagion

variable is useful. Indeed, the estimates of the contagion risk multiplier are large and statistically highly significant, indicating that the risk of financial contagion increases with larger bank debt. These results are also robust to instrumenting (Column 6),[29] while the extensive controls for trade-related variables ensures that the financial contagion variable does not simply capture the transmission of shocks through the trade channel.[30] This implies that the increased risk from bank debt (in comparison to other forms of debt) arises overwhelmingly indirectly through increased contagion risk. To give an order of magnitude, for a country with a consolidated bank-debt-to-GDP ratio of 50% (*e.g.* Italy in 2007), a median-sized negative shock to its creditors creditworthiness would increase crisis risk by 12% (0.4 percentage points) through the financial-contagion channel. More specifically, the estimates would imply that, when in 2008 the rating of Ireland's creditors was downgraded this increased the likelihood of a banking crisis in Ireland by almost 50% (1.5 percentage points) due to a high level of Irish exposure to external bank debt.[31]

3.3. Main empirical results -- currency mismatch

27. This section analyses the effect of the currency mismatch between external assets and liabilities on the likelihood of banking crisis, based on data from Lane and Shambaugh (2010). Their main mismatch measure (henceforth L&S mismatch) captures the sensitivity of a country's external balance sheet to a uniform movement of its domestic currency against all foreign currencies. However, for the purposes of this paper a more relevant variable is the total net wealth effect which is obtained by multiplying the L&S mismatch with a country's degree of international financial integration (as measured by the sum of foreign assets and liabilities divided by GDP). This indicator, which provides the overall valuation effect of a given exchange rate movement in percentage points of GDP, is the one used in the following.[32] For example, in Iceland in 2004, with a measured aggregate L&S mismatch of 13% and international financial integration at 363% of GDP, the currency mismatch was 48%. This implies that a uniform devaluation of the domestic currency by 10% would imply a valuation loss of 4.8% of GDP.

28. Given the limited time-span of the currency mismatch measure, it is not possible to distinguish empirically an increase in external debt from an increase in the aggregate currency mismatch, so that the mismatch regressions do not include the share of debt in total external liabilities.[33] Bearing in mind this caveat, pooled OLS, fixed-effect, first-difference, and first-difference instrumental variables specifications

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29. The instrument for the interaction between a country's level of borrowing from foreign banks and the shock exposure of a country's creditor banks is the interaction between a country's average level of borrowing from foreign banks and the shock exposure of a country's creditor banks. In this specification, the Hansen J statistics (p-value above 0.40) suggests that the instruments are valid, but the value of the Kleibergen-Paap statistics (3.6) shows that weak instruments are likely to generate some bias.

30. The trade channel is accounted for not only by trade openness, as in the baseline specification, but also by including the growth prospects of trade partners (a proxy for export market growth), and the likely impact of export market growth on the economy. Export prospects are measured as the export-weighted sum of trading partners' real growth, and the reliance of the domestic economy on export prospects is quantified by the interaction of the export prospects term with the export to GDP ratio (lagged by three years). All other trade-related explanatory variables are also lagged at least one period. The estimates of the impact of external bank debt are robust to the omission of the additional trade-related explanatory variables.

31. These large shocks to creditor countries may be partly due to the feedback effects' of debtor shocks. The analysis deals with this endogeneity issue by lagging the creditor countries' rating shocks, identifying third party shocks, and isolating creditor specific shocks (Section 4).

32. Lane and Shambaugh refer to this net balance-sheet effect as the "net financial index".

33. The unreported results of these regressions display the same sign suggesting that even after controlling for the characteristics of external debt, the currency mismatch would contribute to financial instability. However, the standard errors are large as the data from Lane and Shambaugh (2010) assume that all FDI and equity inflows are denominated in the host country domestic currency.

all show a consistent positive relationship between the currency mismatch and the likelihood of banking crisis (Table 4). This suggests that the net wealth effect of foreign currency exposure has an impact on the likelihood of banking crisis. Using the first-difference estimate from Column 5, an increase in the foreign-currency exposure from the 2004 position of Mexico to the 2004 level of Turkey would increase the likelihood of banking crisis by 34% (1.1 percentage points), *ceteris paribus*. These results corroborate the empirical findings of Prat (2007) that while a depreciation of the local currency improves international competitiveness over time, thereby ultimately reducing financial-crisis risk, in the short run valuation losses increase this risk.

Table 4. Currency mismatch and probability of banking crises

	Pooled OLS	Fixed effects	Fixed effects	First differences	First differences	First differences
Dependent variable:			Start of a banking crisis			
	(1)	(2)	(3)	(4)	(5)	(6)
Currency mismatch	0.014	0.069*	0.069**	0.063*	0.063*	0.284
	(0.015)	(0.041)	(0.034)	(0.036)	(0.036)	(0.321)
Trade openness	0.010	-0.017	-0.013	-0.015	-0.015	0.013
	(0.014)	(0.062)	(0.060)	(0.064)	(0.064)	(0.067)
Baseline controls[1]	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	No	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Controls for duration[1]	No	No	Yes	No	Yes	Yes
Instruments[2]	No	No	No	No	No	Yes
Observations	1,158	1,158	1,158	1,023	1,023	1,023
Countries	99	99	99	99	99	99
F-test duration controls[3]			17.48***		0.081	0.299

Note: All regressors are lagged one period. Standard errors are clustered at the country level. * denotes a significant estimate at the 10% level, ** at 5%, *** at 1%.

1. Baseline controls include (log) GDP per capita, (log) population, domestic credit growth and the lagged level of domestic credit over GDP. In addition, all the specifications control for the characteristics of the financial account by including linear and quadratic terms for total assets (excluding reserves) over GDP, external reserves (excluding gold) over GDP, and total liabilities over GDP. The controls for duration include a quadratic function in the number of years since the last crisis interacted, respectively, with a dummy variable for having, or not having experienced a crisis since 1970.
2. The specification in Column 6 instruments the lagged first-difference of the currency mismatch with the share of "open" years during t-2 and t-7.
3. F-test robust to heteroskedasticity and within country autocorrelation for the significance of the controls for duration and state dependence.

Source: OECD calculations.

3.4. Main empirical results -- maturity structure

29. The maturity structure of a country's foreign liabilities has often been cited as a factor influencing the risk of financial crises (Rodrik and Velasco, 1999). With the specifications presented earlier, no convincing evidence is found that several measures of the share of short-term debt (maturity < 1 year) in total external liabilities directly influence the risk of banking crises. This could be because the maturity structure of external debt has different effects depending on the creditor, *e.g.* official lending of any maturity may be relatively stable, while short-term bank lending - as conjectured by Kaminsky and Reinhart (2001) - may particularly increase crisis risk as it can generally be withdrawn more quickly than most other loans.

30. Indeed, higher short-term cross-border bank debt (as a share of total liabilities) is found to increase the likelihood of banking crises (Table 5). The focus here should be on results from the instrumented specifications, as non-instrumented estimates are likely to be biased towards zero because the presence of non-negligible debt with unknown maturity in the BIS data (around 8%) is likely to lead to serious measurement error. Based on estimates in Column 6 and compared with these in Table 1, an increase of the share of short-term bank debt in total liabilities by 4½ percentage points (the standard deviation across OECD countries in 2007) would increase the likelihood of banking crisis by 9 percent more than a similar increase in overall external debt not specific to bank creditors and covering all maturities. Moreover, short-term bank debt appears to be particularly risky in the event of external shocks: the contagion multiplier for short-term bank debt (*i.e.* its interaction with contagion shocks) is nearly twice as high as the same multiplier for overall bank debt (see Tables 3 and 5, Columns 4 to 6).

Table 5. Short-term bank debt and probability of banking crises

	Pooled OLS	Fixed effects	Fixed effects	First-differences	First-differences	First-differences
Dependent variable:			Start of a banking crisis			
	(1)	(2)	(3)	(4)	(5)	(6)
Short-term BIS bank debt /	-0.001	0.026***	0.020**	0.014	0.013	0.061***
External liabilities	(0.001)	(0.009)	(0.009)	(0.012)	(0.012)	(0.022)
External debt / External	0.047**	0.116**	0.083*	0.166***	0.155**	1.809*
liabilities	(0.019)	(0.046)	(0.048)	(0.064)	(0.064)	(0.973)
Contagion risk	0.335	-0.086	-0.022	-0.226	-0.219	-0.136
	(0.449)	(0.500)	(0.497)	(0.312)	(0.310)	(0.376)
Contagion risk multiplier[1]	-0.684	-1.421**	-1.520***	-1.773***	-1.758***	-1.755***
	(0.735)	(0.546)	(0.485)	(0.348)	(0.341)	(0.333)
Trade openness	-0.003	-0.005	0.018	0.036	0.037	0.067
	(0.015)	(0.026)	(0.028)	(0.039)	(0.039)	(0.052)
Growth of trading partners	-0.470	-0.061	-0.046	-0.369	-0.357	-0.306
	(0.406)	(0.593)	(0.535)	(0.549)	(0.547)	(0.549)
Growth of trading partners	0.696	0.283	0.622	-0.653	-0.649	-0.013
× $(\text{Export/GDP})_{t-3}$	(0.723)	(1.033)	(0.948)	(0.959)	(0.956)	(0.988)
Baseline controls[1]	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	No	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Controls for duration[1]	No	No	Yes	No	Yes	Yes
Instruments[2]	No	No	No	No	No	Yes
Observations	2,384	2,384	2,384	2,172	2,172	2,014
Countries	146	146	146	146	146	146
F-test duration controls[3]			21.70		1.230	1.827

Note: All regressors are lagged one period. Standard errors are clustered at the country level. * denotes a significant estimate at the 10% level, ** at 5%, *** at 1%.

1. The Contagion risk multiplier is the interaction between the contagion risk and the lagged short term bank debt over GDP. Baseline controls include (log) GDP per capita, (log) population, domestic credit growth and the lagged level of domestic credit over GDP. In addition, all the specifications control for the characteristics of the financial account by including linear and quadratic terms for total assets (excluding reserves) over GDP, external reserves (excluding gold) over GDP, and total liabilities over GDP. The controls for duration include a quadratic function in the number of years since the last crisis interacted, respectively, with a dummy variable for having, or not having experienced a crisis since 1970.
2. The specification in Column 6 instruments the share of debt in external liabilities with capital controls in t-2 on inflows from credit operations, capital and money market securities, and FDI. The share of bank debt in external liabilities is instrumented by the lagged level of external bank debt in t-3 and t-4. The contagion risk multiplier is instrumented by average bank debt as a share of GDP interacted with the contagion risk.
3. F-test robust to heteroskedasticity and within country autocorrelation for the significance of the controls for duration and state dependence.

Source: OECD calculations.

4. International banking contagion

31. Economies are at risk to suffer contagion from financial instability in other countries, as suggested by the occurrence of simultaneous financial crises across countries or their fast spreading. The strength of contagion may, in turn, depend on the degree of international financial integration, an issue examined in numerous theoretical studies.[34] The question of interest is not only the direct contagion which arises when country A is directly affected by financial developments in country B, but also indirect contagion, *i.e.* a situation where a country is affected by financial turmoil not through direct links, but indirectly via the international banking system. This section presents new measures of different types of bank-balance-sheet contagion, and examines the link between financial integration, contagion and financial instability. The main finding is that certain forms of international financial integration amplify contagion shocks and increase crisis risk.

4.1 Channels of contagion

32. Beyond the possibility that simultaneous banking crises may be caused by a common shock, the literature proposes three main channels of contagion:

- *Financial market perceptions*: Negative shocks in one country can worsen the perception of financial market investors about countries with similar characteristics. Especially under high uncertainty among creditors about the cause of the negative shock or the creditworthiness of borrowers, foreign banks may reduce their cross-border lending and institutional investors may reduce asset holdings more generally. This, in turn, could cause self-fulfilling financial crises outside the country that was originally affected.

- *Trade*: Trade linkages can transmit a banking crisis, as a negative shock in one country – decreasing domestic demand and possibly resulting in devaluation and a gain in competitiveness - can reduce the export prospects of other countries.

- *Balance sheets of financial intermediaries*: Deteriorations in the balance sheet of banks or other leveraged financial institutions can push them to sell external assets or to recall external loans to comply with internal rules or with prudential regulations such as capital requirements or maximum leverage ratios. Krugman (2008) refers to such international financial contagion as the "International Finance Multiplier".

33. Direct balance-sheet-driven international financial contagion results, for example, from being indebted to a creditor country with a deteriorating risk profile, and will be referred to as "lending-country spillovers" in the following. In addition, indirect contagion through the international banking system can arise, for example, as banks cut back on loans to a country in response to suffering losses on loans to another country (referred to as "common-creditor contagion" in what follows). Assume that international lenders aim for an internationally diversified portfolio of debt and equity assets with a certain level of risk or leverage for each period - *e.g.* to conform to capital requirements. When their international lending portfolio is hit by a negative shock they could therefore (be forced to) cut credit to borrowers from countries perceived as more risky. Consequently, borrowers may find their access to credit restricted even in a situation where their country's (and their own) credit risk has remained unchanged. This indirect financial multiplier was first suggested by Calvo (1998) to introduce a causal link between the 1998 Russian crisis and the following crisis in Brazil. Similarly, Kaminsky and Reinhart (2001) attribute part of

34. For example, Bolton and Jeanne (2011) show that under financial integration countries are exposed to contagion risk through a bank-balance channel as banks optimally diversify their holdings of sovereign debt in an effort to minimise the costs of an individual country default.

the contagion of the 1997-1998 Asian crisis to a "common creditor" effect, with Japanese and European banks the common creditors in this case.

4.2 Measuring contagion

34. The following section introduces quantitative measures of different types of bank-balance sheet contagion shocks. Apart from a general contagion measure, it proposes two indices that capture more specifically bank-balance sheet contagion shocks through common creditors (CCC), as well as direct bank-balance-sheet effects from shocks to lending countries (LCS). Shocks are constructed from BIS locational statistics which have been collected since 1977. These bilateral data show the total amount that banks from each BIS reporting country have lent to the financial and non-financial institutions of each other country (including to countries that are not reporting to the BIS).[35] Consider country r that reports the international lending of its banking system. The quality of the loan portfolios of country r's banks can be affected either by a domestic shock or a foreign shock – *i.e.* a shock to countries to which country r's banks have lent money. For each period, the degree to which country r's banks are affected by domestic shocks is measured by the change in country r's own rating that is not driven directly by foreign developments.[36] The degree to which country r's banks are affected by foreign shocks is computed as the change in the rating of the countries to which its banks have been lending to, weighted by the share of lending to the respective country.

35. The calculation of the strength with which creditor banks' are affected by domestic and foreign shocks for all BIS reporting countries allows to compute, in a second step, measures of contagion for a given country referred to as country d (debtor). Lending-country spillovers (LCS) are calculated as the (aggregate) degree to which country d's creditor banks have been affected by domestic shocks, weighted by their lending to country d. Similarly, common-creditor contagion (CCC) shocks are calculated as the (aggregate) degree to which country d's creditor banks have been affected by foreign shocks (excluding shocks to country d), weighted by their lending to country d. Total bank-balance-sheet contagion shocks (for simplicity referred to as contagion shocks) capture the total contagion that is transmitted through the balance sheets of external lending-banks, basically aggregating LCS and CCC shocks.[37]

A measure of overall bank-balance-sheet driven contagion

36. More formally, for country d in period t, its level of contagion, *i.e.* the exposure of its creditor banks to shocks, is captured by:

$$Contagion_{dt} = \sum_{r \in R, r \neq d} wbl_{drt} \cdot \frac{\Delta rating_{rt}}{rating_{r,t-1}} \tag{5}$$

35. These data are *e.g.* used by Kalemli-Ozcan *et al.* (2009) to examine the link between financial integration and business cycle synchronisation.

36. Domestic shocks are obtained by using the change in country r's own rating that is orthogonal to changes in foreign ratings of the countries to which country r's banks have lending exposure (see below).

37. The main difference arises from total bank-balance-sheet contagion shocks being a somewhat less proper measure as – contrary to LCS and CCC shocks – they also include "feedback contagion". For a given country d, feedback contagion is the share of a contagion shock it faces that reflects bank-balance-sheet responses from foreign banks to a rating shock that originated in country d itself. In practice, "feedback contagion" is almost always negligible; however, in some rare circumstances it can be substantial for a specific country (an example being Greece in 2010/11).

with R the set of lending (reporting) countries. $rating_{r,t}$ is the rating of country r according to Institutional Investor.[38] This rating is based on bi-annual data from a survey in which institutional investors are asked to grade each of the countries on a scale from 0 to 100, with 100 representing those countries with the best creditworthiness. Grades are then aggregated by weighting them with the actual investment exposure of the different institutional investors in a given country. The used rating is not only available for a much larger sample than ratings from rating agencies, but by being based on the perception of the main investors in each market is also likely to be better reflected in price developments. This is a clear advantage as movements in prices are likely to have balance sheet effects for banks and other leveraged financial intermediaries. Wbl_{drt} is the share (weight) of bank liabilities of country d held by country r at time t.

"Common-creditor" contagion: Balance-sheet contagion through shocks to third-party countries

37. More formally, for country d in period t its level of common creditor contagion (CCC), *i.e.* the exposure of its creditor banks to third-country shocks, is captured by:

$$CCC_{dt} = \sum_{r \in R} (wbl_{drt} \sum_{v \in V, v \neq d} wel_{rvt} \cdot \frac{\Delta rating_{vt}}{rating_{v,t-1}}) \tag{6}$$

with R the set of lending (reporting) countries and V the set of borrowing countries, the latter also including reporting wel_{rvt} is the share (weight) of country v in the external loans extended by country r at time t (excluding the assets of country r located in country d). Wbl_{drt} is the share (weight) of bank liabilities of country d held by country r at time t.

Lending-country spillovers: Balance-sheet contagion through shocks to creditor-countries

38. Lending country spillovers, *i.e.* the exposure of debtor country d to creditor banks' domestic shocks, is measured through changes in the rating of its creditor countries. However, such rating changes do not only reflect domestic developments in the creditor countries, but potentially also shocks to their debtors. Therefore, direct shocks to creditor banks' countries have been isolated from shocks to their international debt portfolio. First, direct shocks were measured as the residuals from a regression of changes in a creditor country's credit rating on the aggregate change in the credit rating of the countries included in its international bank assets portfolio.

$$\Delta country_rating_{ct} = \alpha + \beta \Delta portfolio_rating_{ct} + \varepsilon_{ct}$$

with portfolio_rating being computed as the sum of rating shocks weighted by asset exposure vis-à-vis all countries indebted towards country c:

$$\Delta portfolio_rating_{ct} = \sum_{v \in V} wea_{cvt} \cdot \frac{\Delta rating_{vt}}{rating_{v,t-1}}$$

and where wea_{cvt} is the share (weight) of the external assets of country v in the portfolio of the banks' of the reporting creditor country c at time t.

38. These ratings have been used, *e.g.*, by Reinhart and Rogoff (2009), Eichengreen and Mody (2000) and Hallak (2011), the latter also providing a detailed discussion of them.

39. Second, and alternatively, similar regressions are run that also feature country and year fixed effects.[39]

40. The exposure of country d to direct creditor shocks at time t is then given by the weighted sum of its creditors' domestic shocks:

$$LCS_{dt} = \sum_{r \in R} wbl_{drt} \cdot \hat{\varepsilon}_{rt} \tag{7}$$

with wbl_{drt} again the share (weight) of bank liabilities of country d held by country r at time t.

41. Common-creditor contagion and lending-country spillovers identify different shocks. The common-creditor contagion channel portrays banks as a conduit for transmitting shocks from third-party countries, with banks being unable or unwilling to cushion borrowing countries against such shocks. The lending-country spillover channel represents (at least in part) direct shocks to the main international lending banks.

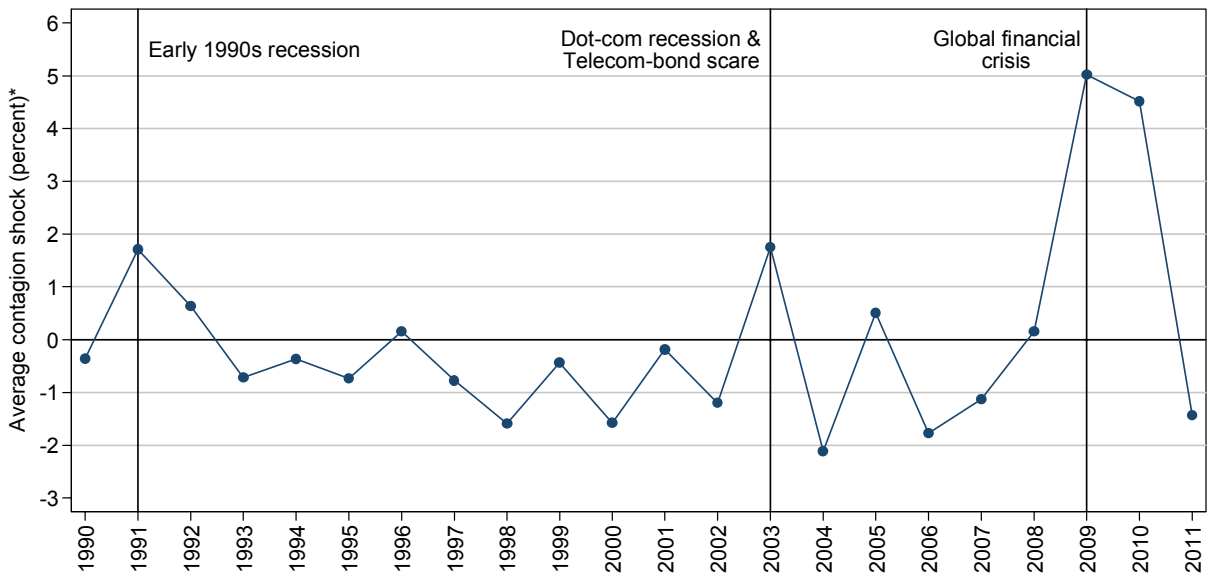
4.3 Contagion -- some empirical evidence

42. Bank-balance-sheet (BBS) driven contagion shocks during the recent global financial crisis have dwarfed previously observed levels of contagion (Figure 3, based on contagion as calculated in Equation 5). Looking at the average level of financial-contagion shocks across countries over the last two decades shows that important episodes of global BBS contagion are mainly related to developments in the large advanced economies. Also, average contagion shocks have a cyclical component in the sense of being particularly high in global recessions. Historically, bank-balance-sheet-driven contagion has been relatively high during the global recession of the early 1990s, as well as in the early 2000s in a situation where economic weakness in the wake of the dot.com boom combined with fears that large telecom companies may default on bonds issued to acquire UMTS licences.

39. This equation is estimated in first difference to partly avoid reverse causality issues.

Figure 3. Financial contagion via the bank-balance-sheet channel

Total financial contagion shock



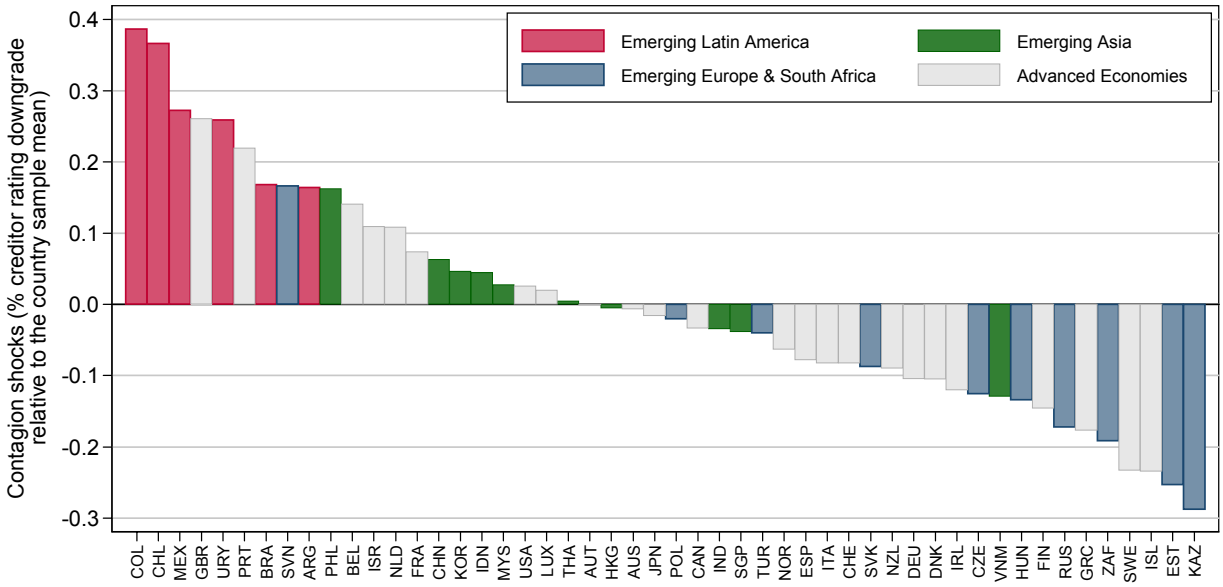
* The average contagion shock is measured as the unweighted average of debtor countries' contagion shocks. Each debtor countries' contagion shock is computed as the weighted sum of its creditors' credit rating percentage changes.

Source: OECD calculations.

43. The 1997-98 Asian crisis or the 1995 Mexican crisis did not lead to visible contagion shocks at the global level, even though at the regional level and for certain emerging economies outside the region strong contagion effects were clearly visible at the time. Figure 4 shows the relative level of BBS-driven contagion shocks faced by each country in 1995 in the wake of the Mexican crisis. It illustrates that Latin-American countries indeed suffered from BBS-driven contagion shocks at the time. Similarly, Figure 5 shows that Asian countries were most affected by BBS contagion shocks during the Asian crisis. While there seems to have been some BBS contagion from Latin America to Asia, and vice versa, during these two crises, emerging economies in Eastern Europe were left largely unaffected, as were most advanced economies. For both the Mexican and Asian crises, contagion to countries in the region occurred through LCS spillovers and CCC shocks (Figure 6), although common-creditor contagion was less widespread for the Mexican crisis, with Brazil, Uruguay and Argentina being most strongly affected.

Figure 4. Bank-balance sheet contagion during the Mexican crisis

Contagion shocks 1995

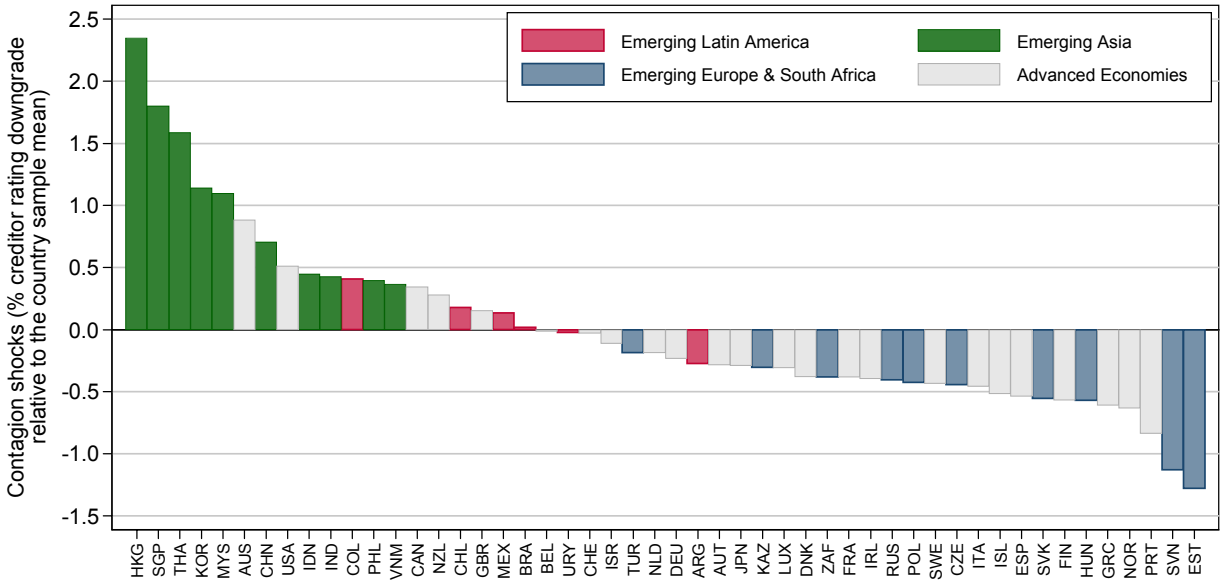


Sample: OECD countries, BRICS and selected economies (Argentina, Colombia, Hong Kong SAR, Indonesia, Kazakhstan, Malaysia, Philippines, Singapore, Thailand, Uruguay, Vietnam). Emerging Latin America refers to: ARG (Argentina), BRA (Brazil), CHL (Chile), COL (Colombia), MEX (Mexico), URY (Uruguay). Emerging Asia refers to: CHN (China), HKG (Hong Kong SAR), IDN (Indonesia), IND (India), KOR (Korea), MYS (Malaysia), PHL (Philippines), SGP (Singapore), THA (Thailand), VNM (Vietnam). Emerging Europe and South-Africa refers to: CZE (Czech Republic), EST (Estonia), HUN (Hungary), KAZ (Kazakhstan), POL (Poland), RUS (Russia), SVK (Slovak Republic), SVN (Slovenia), TUR (Turkey), ZAF (South Africa). The advanced economies refer to: AUS (Australia), AUT (Austria), BEL (Belgium), CAN (Canada), CHE (Switzerland), DEU (Germany), DNK (Denmark), ESP (Spain), FIN (Finland), FRA (France), GBR (United Kingdom), GRC (Greece), IRL (Ireland), ISL (Iceland), ISR (Israel), ITA (Italy), JPN (Japan), NLD (Netherlands), NOR (Norway), NZL (New Zealand), PRT (Portugal), SWE (Sweden), and USA (United States).

Source: OECD calculations.

Figure 5. Bank-balance-sheet contagion during the Asian crisis

Contagion shocks 1998



Source: OECD calculations.

Figure 6. Different types of bank-balance-sheet contagion during the Asian and Mexican crises

Countries most affected by lending-country spillovers and common-creditor shocks in 1995 and 1998

	1995		1998	
Ranking by shock size[1]	**Lending Country Spillovers**	**Common Creditor Shocks**	**Lending Country Spillovers**	**Common Creditor Shocks**
1	Colombia	Brazil	Hong Kong SAR	Singapore
2	Chile	United Kingdom	Singapore	Hong Kong SAR
3	Mexico	Estonia	Thailand	Thailand
4	United Kingdom	Germany	Korea	Malaysia
5	Slovenia	Russia	Malaysia	Australia
6	Uruguay	Portugal	Australia	Korea
7	Brazil	Ireland	China	United States
8	Philippines	Uruguay	India	China
9	Argentina	Japan	Indonesia	United Kingdom
10	Korea	Belgium	Colombia	Mexico

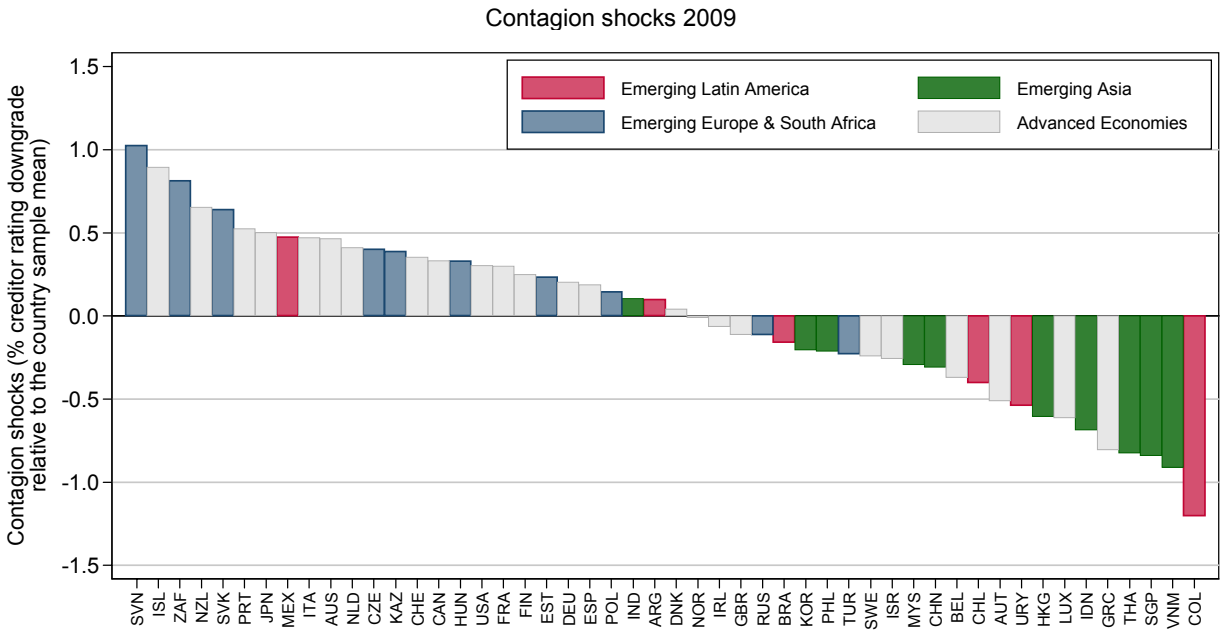
1. Each column shows the ten countries that were most affected by a given type of contagion in a given year. Countries are ranked in decreasing order of contagion. Sample: OECD countries, BRICS and selected other economies (Argentina, Colombia, Hong Kong SAR, Indonesia, Kazakhstan, Malaysia, Philippines, Singapore, Thailand, Uruguay, Vietnam).

Source: OECD calculations.

44. BBS-driven contagion is not the only form of financial contagion, with *e.g.* shifts in financial market perceptions generally seen as another transmission channel of contagion. This implies that a perfect fit of measures of BBS-driven contagion shocks with actual contagion cannot be expected. However, Kaminsky *et al.* (2003) argue that Thailand, Korea, Indonesia and Malaysia were particularly strongly affected by common creditor contagion during the Asian crisis. And indeed, the CCC indicator constructed for this study confirms that – after the financial centers in the region - Thailand, Korea, and Malaysia (plus Australia) faced the largest CCC shocks during the Asian crisis. Similarly, Kaminsky (1999) argues that, outside Asia, Mexico was particularly strongly affected by contagion during the Asian crisis. Again, the CCC indicator confirms that Mexico was the emerging economy that faced the largest CCC shock outside Asia.

45. Even though during the recent global financial crises all countries suffered from contagion, the regional focus was different from the earlier crises of the 1990s. This time, Latin American and Asian economies were among the least affected whereas advanced and European emerging economies were those exposed to the strongest contagion shocks (Figure 7). In particular, Eastern European countries suffered from the strongest common-creditor contagion shocks (Figure 8, Column 2). While this likely reflected large exposure to Western European economies, part of it may also have been explained by the low degree of banking integration within the region. A relatively higher degree of intra-regional banking integration probably amplified the Asian and Mexican crises in the respective regions they originated in, but was this time an advantage in a crisis that originated and mainly affected the most-advanced economies.

Figure 7. Bank-balance-sheet contagion during the recent global financial crisis



Source: OECD calculations.

Figure 8. Different types of bank-balance-sheet contagion during the global financial crisis

Countries most affected by lending-country spillovers and common-creditor shocks in 2009

Ranking by shock-size[1]	Lending Country Spillovers	Common Creditor Shocks
1	New Zealand	Slovenia
2	South Africa	Slovak Republic
3	Iceland	Estonia
4	Mexico	Czech Republic
5	Japan	Norway
6	Australia	Denmark
7	Canada	Kazakhstan
8	United States	Poland
9	Slovenia	Hungary
10	Switzerland	Sweden

1. Each column shows the ten countries that were most affected by a given type of contagion in 2009. Countries are ranked in decreasing order of contagion. Sample: OECD countries, BRICS and selected other economies (Argentina, Colombia, Hong Kong SAR, Indonesia, Kazakhstan, Malaysia, Philippines, Singapore, Thailand, Uruguay, Vietnam).

Source: OECD calculations.

4.4 Banking integration and exposure to contagion

46. This section presents econometric evidence on the BBS contagion channel. The empirical specifications are based on the preferred first-difference equation (3). The identification strategy relies on the fact that similar BBS-driven contagion shocks do not have the same impact across countries. *Ex-ante* banking integration, measured as external bank debt as a share of GDP, strongly differs both across countries and over time. As a result, the vulnerability of countries' banking systems to BBS-driven

contagion shocks differs markedly. These differences are captured by the contagion multipliers, the interaction term between different types of contagion shocks and the *ex-ante* reliance of a country on cross-border bank funding. Specifications with the abovementioned multipliers therefore examine if countries that were *ex-ante* more reliant on foreign bank funding were indeed more affected by different types of contagion shocks than countries that were *ex-ante* less reliant on such funding.

47. Both lending-country spillovers and common-creditor contagion shocks would be expected to increase the likelihood of banking crises in the borrowing country. Indeed, both larger exposure to CCC and LCS (*i.e.* larger exposure of a country's creditor banks to foreign and to domestic shocks) are found to increase the risk of systemic banking crises. Moreover, both the CCC and the LCS multipliers (*i.e.* the interaction terms of both CCC and LCS with the size of the country's external bank debt) are highly significant (Table 6, Columns 2-6), confirming that BBS-driven financial contagion indeed increases with the exposure to external bank debt. With respect to LCS and CCC, a median-sized negative shock to creditor countries' perceived creditworthiness would increase the likelihood of a banking crisis by respectively, 14% (0.5 percentage points) and 75% (2.3 percentage points) in an OECD country with a median level of banking integration (external bank debt of 53% of GDP; based on Table 6, Columns 2 and 3).

48. The common-creditor contagion channel is stronger than the lending-country spillover channel. While the mean and the standard deviation of CCC and LCS shocks are roughly similar, the impact of CCC shocks is much larger than that of LCS shocks. The larger impact of CCC shocks may partly be driven by a lack of precise information about debtor countries that could amplify the (perceived) need for balance-sheet adjustment of the affected creditor banks. For example, Calvo (1998) proposes a "lemons" model in which - in the wake of a shock - investors trying to sell their assets differentiate depending on the amount of information they have about them, accepting larger price discounts for assets in debtor countries about which they have less information. Columns 4 and 5 show that results are robust to jointly introducing exposure to CCC and LCS and to instrumenting.

49. As a further robustness check, the model was also estimated excluding positive shocks, thereby allowing for a different response to positive and negative credit-rating shocks. As expected, the impact of average negative credit rating shocks on the likelihood of banking crisis is always larger than the displayed point estimates. This is coherent with bank-balance-sheet transmission, which would indeed be expected to be more pronounced in the case of negative shocks. Contagion risk was also computed replacing credit-rating changes by variations in GDP growth. While these redefined LCS and CCC multipliers remained negative, the estimates were insignificant at conventional levels. This suggests that contagion effects occur predominantly through the financial channel. In order to ensure that common-creditor contagion shocks or lending-country spillovers do not just proxy for trade integration and trade shocks, all reported specifications in Table 6 control both for lagged *de-facto* trade openness, the growth prospects of trade partners (a proxy for export market growth), and the likely impact of export market growth on the economy. As trade integration is strongly correlated with regional integration, these variables also proxy for unobserved regional shocks that could amplify financial vulnerabilities. The estimations suggest that the financial-contagion channels dominate the trade channel, the latter appearing consistently with the expected negative sign but insignificant.[40]

40. The trade channel becomes significant at the 10% level if the interaction term is included without the non-interacted measure of exposure to trade shocks as in Ilzetzki and Vegh (2008).

Table 6. Bank debt, common-creditor contagion, lending-country spillovers and probability of banking crises

	First differences	First differences	First differences	First differences	First differences
Dependent variable:	Start of a banking crisis				
	(1)	(2)	(3)	(4)	(5)
BIS bank debt / External liabilities	0.013	0.006	0.010	0.006	0.063***
	(0.011)	(0.010)	(0.011)	(0.011)	(0.020)
External debt / External liabilities	0.156**	0.159**	0.146**	0.154**	1.689*
	(0.062)	(0.063)	(0.063)	(0.063)	(0.919)
Contagion risk	-0.186				
	(0.308)				
Contagion risk multiplier[1]	-0.943***				
	(0.110)				
Lending-country spillovers		-0.142		-0.133	-0.297**
		(0.112)		(0.113)	(0.150)
LCS multiplier(1)		-0.863***		-0.695***	-0.488***
		(0.163)		(0.196)	(0.122)
Common-creditor contagion			-2.220*	-2.204*	-1.587
			(1.180)	(1.325)	(1.579)
CCC multiplier(1)			-1.277***	-0.947***	-1.356***
			(0.230)	(0.236)	(0.364)
Trade openness	0.037	0.035	0.038	0.038	0.069
	(0.038)	(0.039)	(0.038)	(0.039)	(0.048)
Growth of trading partners	-0.357	-0.237	-0.313	-0.236	-0.580
	(0.537)	(0.531)	(0.535)	(0.529)	(0.577)
Growth of trading partners × $(\text{Export/GDP})_{t-3}$	-0.591	-0.858	-0.766	-0.803	0.403
	(0.953)	(0.976)	(0.948)	(0.992)	(0.977)
Baseline controls(1)	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Controls for duration(1)	Yes	Yes	Yes	Yes	Yes
Instruments(2)	No	No	No	No	Yes
Observations	2,204	2,148	2,204	2,148	2,051
Countries	146	146	146	146	146
F-test for duration controls(3)	1.208	1.268	1.244	1.225	1.924

Note: All regressors are lagged one period. Standard errors are clustered at the country level. * denotes a significant estimate at the 10% level, ** at 5%, *** at 1%.

1. The contagion, LCS and CCC multipliers are the interaction between contagion, LCS and CCC, and the lagged bank debt over GDP. Baseline controls include (log) GDP per capita, (log) population, domestic credit growth and the lagged level of domestic credit over GDP. In addition, all the specifications control for the characteristics of the financial account by including linear and quadratic terms for total assets (excluding reserves) over GDP, external reserves (excluding gold) over GDP, and total liabilities over GDP. The controls for duration include a quadratic function in the number of years since the last crisis interacted, respectively, with a dummy variable for having, or not having experienced a crisis since 1970.
2. The specification in Column 5 instruments the share of debt in external liabilities with capital controls in t-2 on inflows from credit operations, capital and money market securities, and FDI. The ratio of external bank debt over external liabilities is instrumented by the lagged level of external bank debt over external liabilities in t-3 and t-4. The LCS and CCC multipliers are instrumented by average bank debt as a share of GDP interacted with LCS and CCC.
3. F-test robust to heteroskedasticity and within country autocorrelation for the significance of the controls for duration and state dependence.

Source: OECD calculations.

50. Overall, this provides fairly strong evidence that financial contagion is an important and general mechanism to explain the occurrence of banking crises, with BBS-intermediated contagion shocks being amplified by exposure to borrowing from external banks. This is consistent with the results of Kaminsky and Reinhart (2001) for the Asian (1997-98) and the Mexican (1994-95) crises, or with the recent study by Cetorelli and Goldberg (2011) for the 2007-09 global financial crisis, although these two papers only focus on a few selected events and on domestic credit shortages rather than banking crises. Strong contagion effects through the bank-balance sheet channel are also in line with results from microeconometric analysis. Khwaja and Mian (2008) find that liquidity shocks to banks are transmitted to their borrowing firms, with small unconnected firms in particular being unable to hedge and facing particularly strong financial distress. Hale (2011) uses bank-level data on syndicated loans between 1980 and 2009 to show that banks at the periphery of the banking network (in the sense of being the ultimate debtors among banks and not intermediaries) are most strongly affected by banking crises as their access to bank lending gets curtailed and they often cannot roll-over their maturing debt.

4.5 Banking-debt maturity and external funding risk

51. External funding risk does not only depend on the size of external bank debt, but also on its maturity structure. A sudden inability to refinance external funding positions may force borrowers to liquidate assets not only earlier than planned, but typically in distressed market conditions, and resulting losses may render them insolvent. For a given level of external debt, refinancing needs rise with a shorter maturity structure of the outstanding debt. Consequently, *short-term* borrowing from external banks may pose external funding risk beyond the size of total external bank debt. This section therefore estimates the same specifications as Section 4.4 with the exposure to contagion, LCS, and CCC shocks measured by external *short-term* bank debt, *i.e.* debt with remaining maturity below one year (Table 7). In addition, the estimations are also undertaken for external short-term bank debt as a share of total external *bank* debt (Table 8). These specifications examine if countries with higher external funding needs due to a debt structure that is biased towards short-term bank debt have been more affected by BBS-driven contagion shocks than countries *ex-ante* less reliant on short-term funding by foreign-owned banks.

52. Table 7 shows that both the CCC and the LCS multipliers of short-term bank debt are highly significant. The point estimates of the CCC and LCS multipliers are almost two times larger for *short-term* bank debt than for overall bank debt (Tables 4 and 7). For example, for a country with the creditor profile and the short-term banking debt exposure of Ireland in 2007, a median-sized negative LCS shock would imply an increase in the likelihood of a banking crisis by almost 70% (2.2 percentage points; based on Column 3). Results are robust to jointly introducing exposure to CCC and LCS (Column 4).

53. The effects of CCC shocks are, as for *bank debt*, substantially larger than the impact of LCS shocks. Treating the problem of possible endogeneity of the maturity structure of external bank debt by using instrumental variable estimates leads to a CCC multiplier of *short-term* bank debt that is roughly three times larger than the corresponding LCS multiplier (Column 5). With an additional specification that uses the long-term debt obligations that matured in t-1 as a source of exogenous variation for instrumenting short term debt, the difference between the CCC and LCS multipliers is even larger (Column 6).[41] Based on the preferred specification (Column 5), median-sized negative CCC and LCS shocks would increase the likelihood of a banking crisis by 47% and 9% (1.5 and 0.3 percentage points), respectively, for an OECD country at median levels of short-term debt (as a share of GDP). As regards financial risk during the recent global financial crisis, the estimates would imply that, holding everything else constant, being exposed to both the median CCC and LCS shocks observed in 2009 increases the likelihood of banking crisis by 585% (18 percentage points) for an OECD country at 2009 median levels of short-term debt.

41. Specifically, the ratios of debt with remaining maturity between one and two year over external liabilities and GDP at the end of year t-3 were used as instrument for short-term debt in t-1.

Table 7. Short-term bank debt, common-creditor contagion, lending-country spillovers and probability of banking crises

	First differences	First differences	First differences	First differences	First differences	First differences
Dependent variable:	Start of a banking crisis					
	(1)	(2)	(3)	(4)	(5)	(6)
Short-term BIS bank debt / External liabilities	0.013	0.004	0.007	0.000	0.076***	0.154
	(0.012)	(0.011)	(0.012)	(0.012)	(0.022)	(0.120)
External debt / External liabilities	0.155**	0.160**	0.143**	0.153**	1.789*	1.295
	(0.064)	(0.064)	(0.064)	(0.064)	(0.979)	(1.031)
Contagion risk	-0.219					
	(0.310)					
Contagion risk multiplier[1]	-1.758***					
	(0.341)					
Lending country spillovers		-0.165		-0.156	-0.290*	-0.313*
		(0.114)		(0.116)	(0.165)	(0.160)
LCS multiplier[(1)]		-1.330***		-1.057***	-0.896***	-0.476*
		(0.264)		(0.282)	(0.241)	(0.275)
Common Creditor contagion			-2.218*	-2.238*	-1.624	-2.653
			(1.195)	(1.347)	(1.609)	(1.743)
CCC multiplier[(1)]			-1.769***	-1.645***	-2.569***	-2.754***
			(0.557)	(0.595)	(0.627)	(0.580)
Trade openness	0.037	0.037	0.038	0.039	0.067	0.030
	(0.039)	(0.039)	(0.038)	(0.039)	(0.051)	(0.058)
Growth of trading partners	-0.357	-0.202	-0.291	-0.187	-0.395	0.221
	(0.547)	(0.541)	(0.544)	(0.539)	(0.548)	(0.639)
Growth of trading partners × $(\text{Export/GDP})_{t-3}$	-0.649	-1.032	-0.882	-1.036	0.177	-1.465
	(0.956)	(0.993)	(0.953)	(1.009)	(0.968)	(1.284)
Baseline controls[(1)]	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Controls for duration[(1)]	Yes	Yes	Yes	Yes	Yes	Yes
Instruments[(2)]	No	No	No	No	Yes	Yes
Observations	2,172	2,116	2,172	2,116	2,014	1,914
Countries	146	146	146	146	146	145
F-test for duration controls[(3)]	1.230	1.297	1.289	1.269	1.957	1.319

Note: All regressors are lagged one period. Standard errors are clustered at the country level. * denotes a significant estimate at the 10% level, ** at 5%, *** at 1%.

1. The contagion, LCS and CCC multipliers are the interaction between contagion, LCS and CCC, and the lagged short-term bank debt over GDP. Baseline controls include (log) GDP per capita, (log) population, domestic credit growth and the lagged level of domestic credit over GDP. In addition, all the specifications control for the characteristics of the financial account by including linear and quadratic terms for total assets (excluding reserves) over GDP, external reserves (excluding gold) over GDP, and total liabilities over GDP. The controls for duration include a quadratic function in the number of years since the last crisis interacted, respectively, with a dummy variable for having, or not having experienced a crisis since 1970.
2. The specification in Column 5 instruments the share of debt in external liabilities with the capital controls in t-2 on inflows from credit operations, capital and money market securities, and FDI. The share of short-term BIS bank in external liabilities is instrumented by the lagged level of short-term external bank debt in t-3 and t-4. The LCS and CCC multipliers are instrumented by the average short-term bank debt as a share of GDP interacted with LCS and CCC. The specification in Column 6 instruments the share of debt in external liabilities with the capital controls in t-2 on inflows from credit operations, capital and money market securities, and FDI. The share of short-term BIS bank in external liabilities is instrumented by the lagged level of external bank debt with maturity between one and two years at the end of t-3. The LCS and CCC multipliers are instrumented by the external bank debt with maturity between one and two years at the end of t-3 as a share of GDP (in t-3) interacted with LCS and CCC.
3. F-test robust to heteroskedasticity and within country autocorrelation for the significance of the controls for duration and state dependence.

Source: OECD calculations.

Table 8. Share of short-term bank debt, common-creditor contagion, lending-country spillovers and probability of banking crises

	First differences	First differences	First differences	First differences	First differences
Dependent variable:	Start of a banking crisis				
	(1)	(2)	(3)	(4)	(5)
Short-term BIS bank debt / BIS bank debt	-0.023	-0.023	-0.034	-0.025	-0.045
	(0.029)	(0.029)	(0.029)	(0.030)	(0.252)
External debt / External liabilities	0.128*	0.128*	0.133*	0.129*	1.325
	(0.068)	(0.068)	(0.068)	(0.068)	(1.103)
Contagion risk	0.140				
	(0.416)				
Contagion risk multiplier[1]	-1.625***				
	(0.593)				
Lending country spillovers		0.385		0.453	-0.282
		(0.330)		(0.341)	(0.778)
Lending country spillovers × Share of short-term bank debt		-1.318**		-1.418**	-0.267
		(0.607)		(0.629)	(1.271)
Common Creditor contagion			-1.378	-1.254	-0.391
			(1.324)	(1.507)	(2.046)
Common Creditor contagion × Share of short-term bank debt			-1.562**	-1.753**	-2.770*
			(0.715)	(0.848)	(1.422)
Trade openness	0.042	0.039	0.044	0.039	0.052
	(0.052)	(0.053)	(0.051)	(0.053)	(0.068)
Growth of trading partners	-0.191	-0.076	-0.115	-0.033	-0.299
	(0.545)	(0.524)	(0.540)	(0.525)	(0.658)
Growth of trading partners × $(Export/GDP)_{t-3}$	-0.958	-1.086	-1.173	-1.203	-0.833
	(1.094)	(1.152)	(1.090)	(1.156)	(1.482)
Baseline controls[(1)]	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Controls for duration[(1)]	Yes	Yes	Yes	Yes	Yes
Instruments[(2)]	No	No	No	No	Yes
Observations	1,916	1,868	1,916	1,868	1,670
Countries	144	144	144	144	141
F-test for duration controls[(3)]	1.323	1.339	1.333	1.327	0.877

Note: All regressors are lagged one period. Standard errors are clustered at the country level. * denotes a significant estimate at the 10% level, ** at 5%, *** at 1%.

1. Baseline controls include (log) GDP per capita, (log) population, domestic credit growth and the lagged level of domestic credit over GDP. In addition, all the specifications control for the characteristics of the financial account by including linear and quadratic terms for total assets (excluding reserves) over GDP, external reserves (excluding gold) over GDP, and total liabilities over GDP. The controls for duration include a quadratic function in the number of years since the last crisis interacted, respectively, with a dummy variable for having, or not having experienced a crisis since 1970.
2. The specification in Column 5 instruments the share of debt in external liabilities with the capital controls in t-2 on inflows from credit operations, capital and money market securities, and FDI. The share of short-term BIS bank debt is instrumented by the lagged level of short-term external bank debt in t-3 and t-4. The interactions between LCS and CCC and the share of short term bank debt are instrumented by the interaction of the LCS and CCC with the average share of short-term bank debt, and with the external bank debt with maturity between one and two years at the end of t-3 as a share of bank debt (in t-3).
3. F-test robust to heteroskedasticity and within country autocorrelation for the significance of the controls for duration and state dependence.

Source: OECD calculations.

54. Table 8 replicates the previous specifications with the share of short-term external bank debt in total external *bank* debt, which may more accurately capture the risks emerging from the maturity structure of external bank debt, rather than bank debt as such. This measure of maturity bias of external bank debt is consistently and statistically significantly found to amplify the different contagion shocks (Columns 1-5), with results being very similar to those reported in Table 7. This confirms the finding that external short-term bank debt is more risky than external bank debt, as the increased external funding risk further amplifies contagion shocks.

55. These results partly contradict the microeconometric results of Benmelech and Dvir (2011) who find that banks' exposure to short-term debt does not predict bank failures during the 1997-1998 Asian financial crisis. This paper shows that higher short-term borrowing from foreign banks increases crisis risk when countries are hit by contagion shocks. Besides the larger sample of external bank-balance-sheet shocks considered in the estimations in this paper, one important difference is that Benmelech and Dvir consider the Asian crisis as a uniform shock over five countries, while the empirical specifications presented here rely on country-specific external funding shocks that are determined *ex-ante* by the international funding structure of each countries' banking system. However, estimated effects are in line with findings of Cetorelli and Goldberg (2011) who, using the last financial crisis as a natural experiment, show that emerging markets that were exposed to creditors with higher short-term US dollar funding needs suffered larger contractions in cross-border lending by foreign banks during the crisis.

Conclusion

56. This paper investigates the effects of financial account vulnerabilities on the likelihood of banking crises and proposes a new empirical strategy to identify contagion through international banking integration. The results indicate that financial account characteristics have large impacts on the occurrence of systemic banking crises. Moreover, the paper provides evidence for the existence of a strong bank-balance-sheet channel that propagates shocks, implying that increased bank integration poses serious dangers to global financial stability. In future work it would be interesting to explore to what degree contagion is specific to the bank-balance-sheet channel, or whether it arises also more broadly through other forms of financial integration. Moreover, it would be interesting to analyse which structural policies can reduce the strength of bank-balance-sheet contagion.

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APPENDIX

Table A.1. Definition of the main explanatory variables

Measure	Definition and source
Systemic banking crisis start	Systemic banking crises are defined according to Laeven and Valencia (2008, 2010), with data taken from the 2010 update.
Debt bias	The share of debt liabilities in total external liabilities taken from Lane and Milesi-Ferretti (2010), "External Wealth of Nations" dataset, 1970-2007.
Currency mismatch	The index measures the balance sheet valuation losses (as a share of GDP) associated with exchange rate shocks. Positive values indicate an overexposure to exchange rate risk. Foreign currency reserves are included in the calculation of the index. The index is the negative of the "net financial index" from Lane and Shambaugh (2010).
Debt currency mismatch	The index represents balance sheet valuation losses (as a share of GDP) associated to currency shocks for the debt part of the balance sheet only. Data are from Lane and Shambaugh (2010) and Lane and Milesi-Ferretti (2010).
Assets, reserves and liabilities as a share of GDP	The ratio of assets, liabilities and reserves over GDP are taken from Lane and Milesi-Ferretti (2010), "External Wealth of Nations" dataset, 1970-2007.
GDP per capita	GDP in current US dollars, taken from Lane and Milesi-Ferretti (2010), "External Wealth of Nations" dataset, 1970-2007. Population as defined below.
Population	The primary source is the WB WDI. Missing values are filled with data from the IMF IFS and, subsequently, from the IMF WEO when available.
Credit and credit growth	Private credit by deposit money banks and other financial institutions, taken from Beck *et al.* (2009), divided by GDP taken from the IMF IFS. Data updated in November 2010.
Bank debt	Bank debt is measured by the debt liabilities towards BIS reporting banks (BIS Table 9, Variable A). The BIS consolidated banking statistics (on the immediate borrower basis) report banks' on-balance-sheet financial claims on the rest of the world and provides a measure of the risk exposures of lenders' national banking systems.
Short-term bank debt	Short-term bank debt is measured by the debt liabilities towards BIS reporting banks with residual maturity below one year (BIS Table 9, Variable B). The BIS data report the residual maturity (not the original maturity) of bank debt.
International debt issues over GDP	The ratio of net flows of international bond issues over GDP. The variable is taken from Beck *et al.* (2009). Data updated in November 2010.
Openness to trade	The sum of imports and exports divided by GDP from the WB WDI. Missing values are completed with data from the IMF-IFS.
Banking regulation, and financial reforms (Abiad *et al.* 2010)	The banking supervision is an index between 0 and 3. 3 indicates the highest level of banking supervision. This variable is based on the following three questions: (1) Has a country adopted a capital adequacy ratio based on the Basle standard? (yes=1; no=0) (2) Is a banking supervisory agency independent from the executives' influence? (3) Does a banking supervisory agency conduct effective supervisions through on-site and off-site examinations?
Capital account openness	The dummy variables are defined by Brune (2006) from the IMF Annual Reports on Exchange Arrangements and Exchange Restrictions. The analysis uses the openness to inflows and outflows of three main categories: flows pertaining to capital and money market securities, flows pertaining to credit operations, and inward direct investment (equity, joint ventures and FDI).
Credit rating	Based on ratings from "Institutional Investor". Published each March and September, these ratings are based on a survey of institutional investors, who assign a numerical value ranging from 0 to 100 (with 100 indicating zero probability of default).
Contagion risk, common-creditor contagion (CCC) and lending-country spillovers (LCS)	These indices are calculated based on changes in credit ratings from "Institutional Investor" and bilateral assets position of BIS reporting banks on a locational basis. The locational banking statistics gather quarterly data on international financial claims and liabilities of banks in the BIS reporting countries.
Growth of real GDP in country trading partners	Export-weighted average of GDP growth of a country's trading partners. Export weights are computed as average exports over the period 1990-2009 from UNCTAD data. Real GDP growth is based on (by order of importance): OECD, IMF WEO, IMF IFS, or proxied by real industrial production growth from the IMF IFS to extend the sample coverage.

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