The main determinants of banking crises in OECD countries

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Abstract

Banks’ stability can be affected by economic fluctuations, banks’ risk-taking behavior, connections among banks and countries’ financial system structure. At the same time, banking regulation and supervision were designed to protect banks from failure, but a large number of banking crises weren’t prevented recently. Using binary response models for panel data and centering on OECD countries, this paper studies the main determinants of banking crises over a period of 19 years. Results suggest bank’s high debt and country’s low GDP growth rate as the major determinants of banking crises. There is also evidence of contagion between countries from the same region and from G7 to other OECD countries and that bank-based financial systems are less prone to crises. Regulatory and supervision practices are found to have been either not relevant (the former) or only marginally significant (the latter) in bankruptcy prevention.

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1. Introduction

The explanation for banking crisis episodes has been investigated since the 19th century, mostly in the United States of America (USA). Economists and researchers generally try to find a warning system able to prevent these events. One of the first proposals was based on the volume of liabilities observed in failed firms (Gorton, 1988), because the failure of a large number of firms allows recession prevision, a situation in which banking crises will be more likely. However, in the 1950s and 60s, several banking crises occurred as a result of financial system liberalization and due to the monetary and exchange rate regimes and fiscal policies adopted by countries (Wolf, 2008). On the other hand, in the 80s and 90s, a large number of developed and developing countries experienced severe banking crises, with widespread propagation due to the strong contagion in this sector having generalized impact: credit to firms and families decreased, investment slowed down and many firms collapsed (Demirgüç-Kunt and Detragiache, 1998). More recently, the sub-prime crisis led supervisory authorities to revise regulatory boards across the world, highlighting the role of liquidity and solvency in banks’ activities. This crisis had severe effects on many other sectors and is classified as a systemic crisis due to its impact on payment systems worldwide.

Given the importance and the large variety of factors that may originate banking crises, the central aim of this study is to identify which are the main determinants that lead countries to banking crises. In particular, bearing in mind that banks’ characteristics, macroeconomic conditions, contagion effects, regulation and supervision, and financial system orientation are expected to influence banks’ stability, the aim of this paper is to offer some insights into the impact of each of these aspects on banking crisis probability. This study differs from previous research due to this comprehensive set of banking crisis determinants analyzed, its focus on OECD countries and the methodology employed.

Many banking attributes and characteristics such as leverage, dimension and solvency tend to be emphasized in research about banking crises (Benston et al., 2003; Cebenoyan and Strahan, 2004; Inderst and Muller, 2008; and Brewer et al., 2008). Moreover, the economic context and its influence on banking crisis episodes have already been analyzed by Demirgürç-Kunt and Detragiache (1998, 2000), Duttagupta and Cashin (2011) and Klomp (2010), for example. The authors concluded that low real GDP growth rates, high real interest taxes and banks’ exposure to the private sector increase banking crisis probability. These events are also more likely to happen when credit grows sharply. In this paper, we use a different methodology to revisit these findings and answer the following general questions: (1) “Do banks’ characteristics influence banking crisis probability in OECD countries?”;
and (2) “Do macroeconomic conditions, observed in OECD countries, affect banking crisis probability?”.

Apart from these special features of banks and countries, particular attention must be focused on regulation and supervision, due to its relevance for banks’ activities. Some authors concluded that countries with fewer episodes of banking crises are those presenting lower regulation (Joyce, 2010) and whose monetary market also suffers fewer speculative attacks. While others, such as Barth et al. (2001a), observed greater implementation of regulation requirements after a banking crisis. Typically, regulation assumes that a well-capitalized bank will remain solvent even when it suffers a shock with many potential losses. According to this point of view, banks with lower required capital ratio are more prone to fail and those with higher capital ratios will always recover from any shock. However, this is not what always happens, because it is hard for all banks to manage their businesses exactly as they did before the crisis. Furthermore, capital-based regulation, following Basel II principles, didn’t prevent the subprime crisis, because the main problems were liquidity and banks’ leverage. Moreover, in Moosa’s (2010) opinion, even if the Basel Accord II included liquidity and leverage, it would be insufficient for preventing or mitigating crises, because the original agreement is too centered on commercial banks and the most recent crisis (sub-prime crisis) emerged from the weak risk management policy of investment banks. This paper’s contributions include the proposal of two indexes, a regulation index and a supervision index, as a scheme to compile information about these topics and answer the question: (3) “Can regulation and supervision prevent banking crises?”.

The contagion effect is responsible for the propagation of a crisis worldwide or across countries connected by their institutions’ businesses. This contagion can also result from market expectations about banks solvency. If a bank fails, depositors at other banks (even those not involved in the collapse) will withdraw their savings and cause solvent banks to fail. This effect is commonly observed in bordering countries, but sometimes the initial shock is strong enough to reach institutions in distant countries, affecting a much wider geographical area than the initial one (Allen and Gale, 2007). In order to answer the question (4) “Do banking crises result from a contagion effect?”, this article proposes studying the entire scope of the contagion effect by analyzing the contagion: between countries from the same region (bordering or close countries); among countries from different regions (any OECD country); or induced by the most developed countries in OECD (G7 countries).

The final question that this paper tries to answer is the following: (5) “Do countries with bank-based financial systems present less banking crisis probability?” Using Demirgüç-Kunt and Levine’s (2001) classification, this paper separates OECD countries in marked-based and bank-based
countries, which allows us to identify the most crisis-prone financial system. According to these authors, in bank-based financial systems banks mobilize savings, allocate capital, control corporate managers’ decisions about investment and develop risk management vehicles. Thus, they play a crucial role in countries based on such a system. On the other hand, in market-based financial systems, corporate control, allocation of firms’ savings and risk management are shared by banks and securities markets. Hence, answering this question will bring some insights about how those differences in countries organization and banks’ role can influence banking crisis probability.

To empirically investigate the five questions formulated, a dataset composed of longitudinal data for OECD countries is analyzed. Because the variable of interest (occurrence of a banking crisis) is a binary outcome, several alternative binary panel data models are applied to study the determinants of a banking crisis. This is therefore another contribution of this paper, since, to the best of our knowledge, no previous empirical studies have used such models in the study of banking crises.

The paper is organized in six sections. Following this section, section 2 reviews the literature on banking crises and formulates the empirical hypotheses that this paper examines. Section 3 presents the data and describes OECD’s crises. Section 4 describes the econometric methodology. Section 5 discusses the results. Finally, section 6 provides some conclusions and identifies some future research opportunities.

2. The determinants of banking crises

A bank’s stability depends on its ability to remain solvent and meet its obligations. However, banks, just like all market players, are exposed to the systemic risk that they cannot diversify and sometimes become insolvent, ask for governmental intervention or even collapse. When bankruptcy occurs, the banking system of the affected country experiences a banking crisis. Hence, through the years, several studies of banking crises have emerged in the financial and economic fields, but these events are recorded by regulators, central banks and academics from many different perspectives. This section reviews some of the most relevant studies on this subject and describes the formulated hypotheses tested in the empirical component of this paper.
2.1. Previous research on banking crises

There are many studies about banking crises, developed using many different methodologies and perspectives. The literature presents many case studies and surveys and considers several estimation techniques (Duttagupta and Cashin, 2011), such as the signals approach and (cross-sectional) binary response models. In the signals approach, authors study the behavior of economic indicators before and after banking crisis events and identify the variables that best signal those crises (Kaminsky and Reinhart, 1999). On the other hand, using binary response models\(^2\) (probit and logit), authors determine banking crisis probability (Demirgüç-Kunt and Detragiache, 1998), with the aims of testing hypotheses related to banking crises after their occurrence and/or trying to predict them.

Breuer (2004) and Čihák and Schaeck (2010) identify four categories of theoretical models for explaining banking crises. The first category focuses on macroeconomic factors and their influence on deposit runs and contagion effects that may lead banks to failure (Miskhin, 1978; Calomiris and Mason, 1997). The second category analyzes depositors’ behavior as the main cause of banking crises, which emerge from depositors’ expectations: if they fear and expect bankruptcy, they will withdraw their deposits, causing bank distress (Diamond and Dybv, 1983; Gorton, 1988). The third category refers to business cycles, economy breaks and banks’ lending policies: at times of economic growth, banks lend more than they should and accept real estate properties and securities as collateral, facilitating lending booms; if there is a break in asset prices, economic growth slows down and non-performing loans increase, compromising banks’ solvency (Čihák and Schaeck, 2010 and Demirgüç-Kunt and Detragiache, 2000). Finally, the last category concerns the characteristics of banks which may lead to macroeconomic disorders and other issues such as shareholder protection and creditor rights; the role of law; contract enforcement; regulatory and supervisory boards; depositors’ protection schemes; and the socioeconomic context (Demirgüç-Kunt and Detragiache, 1998; Hutchinson and McDill, 1999; and Hutchinson, 2002).

In parallel to these theoretical developments, empirical analyses brought relevant insights to the subject of banking crises, focusing on issues such as: regulation; banking capital; banking crisis determinants; and contagion effects.

Capital is one of the regulators’ main concerns, but there is no common agreement on the extent of its influence on banks activities. Indeed, previous empirical research has resulted in a range of

\(^2\) Or alternative methods such as non-parametric binary classification trees (Duttagupta and Cashin, 2011).
opinions with regard to this particular question. According to Diamond and Rajan (2000), more capital makes banks safer and improves their performance during periods of crisis (Berger and Bouwman, 2013), because this capital ensures their profitability and the continuation of business even after a crisis. Moreover, Benston et al. (2003) point out that government concern for banks’ capital requirements serves as a protection not just for banks but for the government itself. On the other hand, Gropp and Heider (2010) conclude that regulation does not affect banks’ capital structure, because banks tend to present more capital than is required by supervisors, especially in countries such as the USA (Jacques and Nigro, 1997, and Aggarwal and Jacques, 2001) and Switzerland (Rime, 2001).

Nevertheless, after a banking crisis, some countries adopt stricter regulatory and supervisory practices (Dincer and Neyapti, 2008), but over the years these levels do not change substantially, as observed by Barth, Caprio and Levine (2008a). These authors found that there have been no visible changes in regulation adopted by countries during the first decade of the 21st century. Moreover, they found that while some countries may have enforced required capital levels and increased the number of supervisory agencies, this does not seem to have improved banks’ stability and efficiency. Indeed, several exceptions to the Basel Accord II remain and banking crises have still occurred.

Thus, regulation and capital are not the only determinants of banking crises. These episodes frequently result from the quality of banks’ assets. More lending may imply a higher probability of loans becoming non-performing and liquidity losses for banks (Kaminsky and Reinhart, 1999). However, according to some authors, most banking crises are homogeneous and a number of common factors serve to explain them (Demirgüç-Kunt and Detragiache, 1998 and Kaminsky and Reinhart, 1999). Most crises have the same origin and the same consequences (Englund, 1999 and Kaminsky and Reinhart, 1999). This common cause, according to Klomp (2010), is deregulation followed by credit expansion and asset price rise, originating a bubble that when it bursts will bring drastic falls in asset prices, market disruption and bankruptcy. Then, non-performing loans emerge and liquidity problems arise. Government intervenes, some bank nationalization and recapitalization may occur and the whole banking system crumbles.

In addition, these events can be propagated to other financial institutions due to the contagion effect. Moreover, when a crisis occurs in one region, credit in neighbouring regions loses value and the initial crisis spreads to them (Allen and Gale, 2007). This contagion effect also results from asymmetric information (Kodres and Pritsker, 2002; Calvo and Mendoza, 2000), because when an event occurs in one region, it is expected to be repeated in another and the nervous behavior of all market players increases propagation of the initial shock.
In studying banking crises, we deal with all these features. If we consider that crises may result from similar causes, but that countries are different, we may include a mechanism to act as a control for those differences. La Porta et al. (1998) classified countries’ legal and cultural systems as based on common law (those presenting British influence) and based on civil law, or code law (all those inspired in the continental European tradition, such as French, Scandinavian and German traditions). Demirgüç-Kunt and Levine (2001) proposed an alternative classification for countries. First, bank-based financial systems, which mobilize the necessary capital for the right projects and where the activities of managers can be monitored by banks that are influential enough to enforce firms to disclose information and meet their obligations. Second, market-based financial systems, where information disclosure is permanent, investment diversification is frequent and there are standard risk management mechanisms.

2.2. Empirical hypotheses

The empirical studies we have just described allow the identification of several factors as possible determinants of banking crises. Based on these studies, we formulate a number of hypotheses to study the impact of each factor on the probability of banking crises.

Five groups of hypotheses were tested. The first group includes hypotheses related to bank characteristics, namely:

H1: *Bank size decreases the probability of banking crises*

Large banks can influence government and supervisory entities, due to their importance in the financial system. In addition, depositors and firms tend to place greater trust in large banks for deposits and investment financing. Large banks are also expected to present better internal organization and be more likely to recover from distress (Berger and Bouwman, 2013). Therefore, in countries where banks are larger, less probability of banking crises is expected.

H2: *Bank debt increases the probability of banking crises*

H3: *Customers’ deposits decrease the probability of banking crises*

Banks finance their activity with deposits, (non-deposit) debt and equity capital. Each source of funds implies different risk-taking levels and, as such, is expected to influence the probability of banking crises in distinct ways. Therefore, in this paper we treat separately deposits and debt, in contrast to
other banking studies, where deposits are considered as just another form of debt, being used as interchangeably terms (e.g., Prescott, 2001 and Inderst and Muller, 2008). Because what matters is the relative importance of each financing source, no explicit hypothesis on the effect of equity capital needs to be formulated.

High debt means banks are more dependent on creditors and consequently less liquid, mainly if at the same time the amount of equity finance – referred by Aiyar et al. (2015) as a buffer to bank loan losses prevention - is short. If a massive deposit withdrawal occurs, banks with a large proportion of debt will not have enough liquidity and may collapse. Thus, a positive relationship is expected between debt and the probability of banking crises: the greater the debt, the greater the probability of failure.

Customers’ deposits are an alternative and complementary buffer to avert bankruptcy. They are a source of both capital and liquidity, protecting banks from default. Hence, the greater the amount of deposits, the larger the liquidity of banks and less the probability of banking crises.

H4: Bank solvency decreases the probability of banking crises

More solvent banks are able to meet their medium and long-term liabilities. This capacity should be one of banks’ fundamental attributions, according to Cebenoyan and Strahan (2004). If banks respond to all creditors and remain solvent, the probability of failure through bankruptcy will be lower, implying a negative relationship between banks’ solvency and the probability of banking crises.

The second group of hypotheses concerns the expected effects of the macroeconomic context and includes the following hypotheses:

H5: The real gross domestic product growth rate is negatively related to banking crisis probability

The real gross domestic product (GDP) growth rate is the main economic indicator. Its fall is a sign of recession and when this happens the whole economy collapses. Recession increases the probability of banking crises, according to many authors (Bordo et al., 2001; Demirgüç-Kunt and Detragiache, 1998, 2000; Demirgüç-Kunt et al. 2006; and Duttagupta and Cashin, 2011). Thus, a negative relationship is expected between high GDP and banking crisis probability.

H6: Inflation is positively related to banking crisis probability
When the inflation rate is higher, the demand for domestic products decreases in the international context (Hoggarth et al., 2005). The labor market will be compromised and some jobs may be lost. Economic indicators slow down, failures will increase and all the conditions for banking crises converge. Thus, we expect a positive relationship between inflation and banking crisis probability.

H7: Domestic product per capita is negatively related to banking crisis probability

GDP per capita is a measure of the average income of a country and is commonly used as an indicator of its development. More developed countries are expected to have sounder institutions and more developed financial systems, being thus less prone to bank failures and banking crises; see inter alia Klomp (2010). Hence, we expect a negative relationship between GDP per capita and banking crisis probability.

Contagion of a banking crisis is tested by the third group of hypotheses. Contagion among banks can happen at many levels. In this study, we analyze three levels: contagion among countries from the same region; contagion between countries from different regions; and contagion induced by G7 countries. The empirical hypotheses to be tested may be expressed as follows:

H8: There is contagion between countries from the same region

The most significant contagion is expected to occur inside the same region, because the nearest countries are culturally similar, have common businesses and straight negotiable relations. Thus, a crisis in one country will easily spread to a bordering one.

H9: There is contagion between countries from different regions

The globalization of financial services and the rise of large multinational financial groups led to the growth of business relations between remote countries, including some from different continents. Even when one of a series of geographically-distant banks collapses, the entire network of financial relations can follow suit and fail too. Consequently, the crisis can be extended worldwide in spite of the distance from the initial country and there will be contagion among different regions (Allen and Gale, 2007).

H10: There is contagion induced by G7 countries
Financial dealings also frequently occur with the most developed countries in the world. According to Chenguel (2014), all G7 countries (excluding Japan) were the major contagion sources of the subprime crisis, so contagion induced by G7 countries will also be tested in the last hypothesis of this group.

The fourth group of hypotheses will test the influence of regulation and supervision on banking crisis probability and includes two hypotheses:

\[ H_{11}: \text{Regulation prevent banking crises in OECD countries} \]
\[ H_{12}: \text{Supervision prevent banking crises in OECD countries} \]

These two hypotheses are described together because we expect the same effect from both. Regulation and supervision were designed to promote bank stability, but some of the recent literature concluded for no relation between regulation/supervision and banks’ performance. Indeed, there are studies pointing to less probability of banking crises in countries with more open regulations (Glick et al., 2006; Dincer and Neyapti, 2008; Joyce, 2010) and others concluding that regulation does not affect banks’ capital structure (Gropp and Heider, 2010) or observing that higher regulation do not guarantee better performance for banks (Barth, Caprio and Levine, 2008a). However, there are also conclusions on the opposite direction related with specific regulation topics such as deposit insurance, bank capital requirements and restrictions on banking activity. For example, Angkinand (2009) observed that output losses of crises are smaller in the presence of deposits insurance, while the severity of crisis (specially for the systemic ones) could be mitigated by bank capital requirements and fewer restrictions on bank activities. According to the author’s conclusions, “requiring banks to hold sufficient capital can reduce their excessive risk taking.”

Given these contradictory perspectives, in this paper we investigate whether regulation and supervision have a relevant negative effect on banking crises probability, as a result of the prevention role of regulation and the monetarization function of supervision.

The last hypotheses concern the financial system of each country, as follows:

\[ H_{13}: \text{Bank-based financial systems are less prone to banking crisis} \]

In bank-based financial systems, banks have a central role and benefit from greater government protection. Banks are more powerful than in market-based financial systems. Bank-based countries
usually present less competitive capital markets and investments are well controlled and collateralized in order to prevent default. Hence, banking crisis probability is lower in countries with bank-based financial systems (Čihák and Schaeck, 2010).

H14: The negative effect of debt on banking crises probability is higher for countries with market-based financial systems

In bank-based financial systems banks are included in a larger safety net than they are in market-based financial systems (a similar effect is provided for countries with deposit insurance schemes, see Miao and Wang, 2015). Therefore, it is expected that in the former systems there will be higher government guarantees and protection patterns which may allow banks to recover easier from systemic shocks. When confronted with the possibility of financial collapse, the national government will bail out banks in order to promote stability and risky lending policies by the banks will have less implications for failure probability. This means that a large amount of debt is likely to be a more frequent determinant of banking crises in countries with market-based financial systems, were banks are less protected by government and other authorities. Therefore, the expected influence for the interaction between debt and bank-based financial systems is negative.

3. Data description and analysis

This section describes the sample and the variables used in the study of banking crises. It also gives a characterization of past OECD banking crises.

3.1. Sample

The dataset used this paper has several sources. Banking data was taken from Bureau Van Dijk’s Osiris database, which compiles financial information about financial and non-financial firms publicly listed worldwide. Sample banks with negative values of equity and observations from New Zealand, due to the low representation in the dataset (only one bank observed in two years), were excluded. Overall, the sample includes 2,287 publicly listed banks from 33 OECD countries during the period 1991 to 2009. These countries have different financial system orientations, as presented in Table 1. There is a larger number of countries with bank-based financial systems, but 75% of the

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3 All OECD countries except New Zealand.
observed banks are located in market-based economies (due to the United States orientation for market).

Table 1
Distribution of countries according to their financial system orientation. This table shows the financial system orientation of each OECD country included in the sample. 
Source: Authors, based on Demirgüç-Kunt and Levine (2001).

| Country          | Bank-based N. of banks | Market-based N. of banks |
|------------------|------------------------|--------------------------|
| Austria          | 14                     | Australia 22             |
| Belgium          | 11                     | Canada 20                |
| Czech Republic   | 4                      | Chile 11                 |
| Estonia          | 3                      | Denmark 54               |
| Finland          | 7                      | Iceland 8                |
| France           | 75                     | Mexico 16                |
| Germany          | 60                     | Netherlands 15           |
| Greece           | 19                     | South Korea 61           |
| Hungary          | 4                      | Sweden 12                |
| Ireland          | 7                      | Switzerland 36           |
| Israel           | 13                     | Turkey 30                |
| Italy            | 66                     | United Kingdom 93        |
| Japan            | 183                    | United States 1,346      |
| Luxembourg       | 7                      |                          |
| Norway           | 27                     |                          |
| Poland           | 19                     |                          |
| Portugal         | 12                     |                          |
| Slovakia         | 6                      |                          |
| Slovenia         | 7                      |                          |
| Spain            | 19                     |                          |
| **Total (n.)**   | 563                    | **Total (n.)** 1,724     |
| **Total (%)**    | 24,62%                 | **Total (%)** 75,38%     |

Macroeconomic information was extracted from EIU country data, also distributed by Bureau Van Dijk, and data for regulation and supervision indexes were found in the 2000, 2003 and 2008 versions of the Bank Regulation and Supervision Survey, from World Bank (Barth, Caprio and Levine, 2001b, 2003, 2008b). There are some missing values in the macroeconomic data and our panel is therefore unbalanced, with 604 country-year observations.

In this paper, banking crises are defined as in Laeven and Valencia’s (2013) study, being classified as systemic or borderline/non-systemic. A banking crisis is classified as systemic when two conditions are fulfilled: (1) the occurrence of significant bank runs, losses in the banking system and/or bank liquidation; and (2) significant banking policy intervention measures in response to significant losses in the banking system. It is considered as borderline or non-systemic crisis when
the two conditions above are not met, but at least 3 out of 6 policy interventions from the following list are experienced: extensive liquidity support, gross restructuring costs for banks, significant bank nationalizations, significant guarantees put in place, significant asset purchases and deposit freezes and/or bank holidays. Throughout most of the paper, systemic and non-systemic crises are not analyzed separately.

Data on banking crises were taken from Laeven and Valencia’s 2013 database. The sample comprises 83 out of the 88 banking crisis episodes registered in OECD countries from 1991 to 2009 according to those authors, including 56 out of 60 systemic crises.

3.2. Banking crises analysis

In order to analyze the possibility of contagion, OECD countries were organized in sub-regions according to their geographical location; see Table 2.

| Region          | Countries                                      |
|-----------------|------------------------------------------------|
| Eastern Europe  | Czech Republic, Hungary, Poland, Slovakia and Slovenia. |
| Western Europe  | Austria, Belgium, France, Germany, Luxembourg, Netherlands, Switzerland, Greece, Italy, Portugal and Spain. |
| Northern Europe | Denmark, Finland, Iceland, Ireland, Sweden, United Kingdom, Estonia and Norway. |
| Asia and Pacific| Canada, United States of America, Mexico, Chile, Japan, South Korea, Turkey, Israel and Australia. |

In the period 1991-2009, Australia, Canada, Chile and Israel were the only countries not experiencing any crisis. On the other hand, Hungary and Sweden were the countries most affected by this kind of event, with each country suffering 7 episodes. In 2008 and 2009, OECD countries recorded 38 banking crisis episodes. The longest crises occurred over five consecutive years in Finland, Sweden and Hungary from 1991 to 1995; in the Czech Republic from 1996 to 2000; in Slovakia from 1998

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4 A banking crisis episode occurs when a country experiences a banking crisis in a given year. Therefore, if in the same year two countries experience a banking crisis, two episodes are considered; if the banking crisis in a given country spans over two years, two episodes are also considered.
to 2002; and in Japan from 1997 to 2001. Overall, Northern Europe had the greatest number of banking crises.

From 1991 to 2009, almost all crises happen at the same time in bordering countries, due to a possible contagion effect as Table 3 illustrates.

**Table 3**

Banking crisis by region.

This table shows the concentration of banking crises per region (defined on Table 2) across time. Each reference to each country represents one year experiencing a crisis. The “no banking crises” period refers to the period between 2003 and 2006 when none of the OCDE countries observed such event.

*Data source: Laeven and Valencia (2013).*

| Year | Eastern Europe | Western Europe | Northern Europe | Asia and Pacific | N. of banking crises episodes |
|------|----------------|----------------|-----------------|-----------------|-------------------------------|
| 1991 | Hungary        |                | Finland, Sweden, Norway |                | 4                             |
| 1992 | Hungary, Poland, Slovenia | | Finland, Sweden, Norway |                | 7                             |
| 1993 | Hungary, Poland |                | Finland, Sweden, Norway, Estonia | Mexico | 6                             |
| 1995 | Hungary        |                | Finland, Sweden, Norway, Estonia |                | 6                             |
| 1996 | Czech Republic |                | Finland, Sweden, Estonia |                | 2                             |
| 1997 | Czech Republic |                | Finland, Sweden, Estonia | Japan, South Korea | 3                             |
| 1998 | Czech Republic, Slovakia | | Finland, Sweden, Estonia | Japan | 4                             |
| 1999 | Czech Republic, Slovakia | | Finland, Sweden, Estonia | Japan | 3                             |
| 2000 | Slovakia      |                | Finland, Sweden, Estonia | Japan, Turkey | 4                             |
| 2001 | Slovakia      |                | Finland, Sweden, Estonia | Japan, Turkey | 3                             |
| 2002 | Slovakia      |                | Finland, Sweden, Estonia |                | 1                             |
| 2003 |                |                | Finland, Sweden, Estonia |                | 0                             |
| 2004 |                |                | Finland, Sweden, Estonia |                | 0                             |
| 2005 |                |                | Finland, Sweden, Estonia |                | 0                             |
| 2006 |                |                | Finland, Sweden, Estonia |                | 0                             |
| 2007 |                | United Kingdom |                | United Kingdom | 2                             |
| 2008 | Hungary, Slovenia | Austria, Belgium, France, Germany, Italy, Luxembourg, Switzerland, Netherlands, Greece, Portugal, Spain | Denmark, Iceland, Ireland, United Kingdom, Sweden | United States of America | 19                            |
| 2009 |                |                | Denmark, Iceland, Ireland, United Kingdom, Sweden | United States of America | 19                            |

*Total* 88
3.3. Regulation and supervision indexes

To construct regulation and supervision indexes, we use the responses to the Bank Regulation and Supervision Survey (BRSS) conducted in 2000, 2003 and 2008 by the World Bank (Barth, Caprio and Levine, 2001b, 2003, 2008b). BRSS has 12 topics, with numerous questions included in each one and some adjustments year by year.

In constructing the regulation and supervision indexes, for the latest and the most complete applied version (the 2008 survey), we examined 45 questions about regulation and 17 about supervision. Then, we added 1 point whenever an expected answer was observed for the leading questions and 0.5 points for each expected answer observed for the sub-questions. As described in the supplementary text about the construction of the two indexes, an expected answer is the response that induces the best compliance of regulatory and supervisory practices. All the expected answers were defined according to our expectations about what should be a strong regulation and a strong supervision and were based on previous research about this topic.

Because BRSS was applied to countries only in 2000, 2003 and 2008, the regulation and supervision indexes were calculated directly only for those years. For the 1991 to 1999 observations, we used 2000 BRSS’ responses; for the years 2001 and 2002, we used 2003 responses; and for the years 2004 to 2007 we used 2008 responses. We also applied the 2008 responses to 2009 because, although the 2011/2012 results have already been published, that survey had many changes that could eventually create a biased comparison with previous years.

3.4. Variables and descriptive statistics

Table 4 presents a description of all variables used in the empirical study carried out in Section 5, while Table 5 provides some descriptive statistics for them.

5 1. Entry into banking, 2. Ownership, 3. Capital, 4. Activities, 5. External auditing requirements, 6. Internal management/organizational requirements, 7. Liquidity and diversification requirements, 8. Depositors’ (savings) protection schemes, 9. Provision requirements, 10. Accounting/information disclosure requirements, 11. Discipline/problem institutions/exit and 12. Supervision.

6 Full details about the construction of these indexes may be found in the supplementary text available at https://www.dropbox.com/s/5kwernxk0f9ztv/Supplementary%20material%20-%20Indexes%20Construction.pdf?dl=0
Table 4

Variables description.
Crisis is the dependent variable, following Laeven and Valencia’s (2013) definition.
All the explanatory variables concerning bank information are represented by average values for each country/year pair.
Contagion variables were defined by the authors according to Table 2. All the questions used to construct the regulation
and supervision indexes were taken from the World Bank Regulation and Supervision Survey (Barth, Caprio and Levine,
2001b, 2003 and 2008b). The dummy bank-based financial system is based on Demirgüç-Kunt, A. and Levine, R. (2001).

| Variable                          | Description                                                                 |
|-----------------------------------|-----------------------------------------------------------------------------|
| Crisis                            | 1 if there is a crisis on country $i$ and year $t$. 0 otherwise.            |
| Size                              | Logarithm of total assets by country/year, deflated by consumer's price index, 2005=100. |
| Debt                              | Average ratio of banks' non-deposit debt to total liabilities and equity, by country/year. |
| Debt including customers' deposits| Average ratio of banks' debt plus customers' deposits to total liabilities and equity, by country/year. |
| Customers' deposits               | Average ratio of customers' deposits to total liabilities and equity, by country/year. |
| Debt structure                    | Average ratio of customers' deposits to deposits and non-deposit debt, by country/year. |
| Solvency                          | Average solvency ratio by country/year (equity / total liabilities).        |
| Real GDP growth rate              | Growth rate of real GDP.                                                   |
| Inflation rate                    | Growth rate of consumer's price index (annual average).                     |
| GDP per capita                    | Logarithm of GDP per capita (gross domestic product divided by mid-year population) by country/year, deflated by consumer's price index, 2005=100. |
| Contagion same region             | 1 at year $t$ if there was a crisis in one or more countries from the same region at year $t-1$. 0 otherwise. |
| Contagion other region            | 1 at year $t$ if there was a crisis in one or more countries from other region at year $t-1$. 0 otherwise. |
| G7 contagion                      | 1 at year $t$, if there was a crisis in one or more countries from G7 at year $t-1$. 0 otherwise. |
| Regulation index                  | 1 point for each regulatory practice and 0.5 points for each sub-practice observed in country $i$ and year $t$, including: 4 questions about 'entry into banking', 1 question about 'ownership', 11 questions about 'capital', 4 questions about the topic 'activities' (considered together as only one practice), 5 questions about 'external auditing requirements', 4 questions about 'liquidity and diversification requirements', 6 questions about 'depositor (savings) protection schemes', 3 questions about 'provisioning requirements', 5 questions about 'accounting/information disclosure requirements' and 2 questions about the topic 'discipline/problem institution/exit'. |
| Supervision index                 | 1 point for each regulatory practice and 0.5 points for each sub-practice observed on country $i$ and year $t$, including 8 questions about 'supervision', 6 questions about 'external auditing requirements', 1 question about 'internal management/organizational requirements', 1 question about 'accounting/information disclosure requirements' and 1 question about 'discipline/problem institutions/exit'. |
| Banks orientation                 | 1 if country's financial system is bank-based. 0 otherwise.                |
The wide dispersion displayed by some of the variables reveals that the banking industry and the countries analyzed are very heterogeneous. For example: the average debt of banks in some countries is close to zero, while in others it is over half of the total liabilities and equity value; the solvency ratio ranges from 2,35% to 59,95%; the growth rate of gross domestic product varies between a negative rate of 13,90% and a maximum of 24,62%; and the inflation rate ranges from a negative value of 4,48% to an extreme maximum of 104,54% registered in 1994 in Turkey.

Table 5
Descriptive statistics.

| Variable                         | Obs. | Mean  | Standard deviation | Minimum | Maximum |
|----------------------------------|------|-------|--------------------|---------|---------|
| Crisis                           | 604  | 0,13  | 0,34               | 0       | 1       |
| Size                             | 604  | 16,8  | 1,40               | 10,25   | 20,38   |
| Debt                             | 604  | 0,19  | 0,11               | 0,0001  | 0,57    |
| Debt including customers' deposits | 604 | 0,89  | 0,06               | 0,58    | 0,97    |
| Customers' deposits              | 585  | 0,70  | 0,22               | 0       | 0,97    |
| Debt structure                   | 556  | 0,79  | 0,22               | 0       | 1,00    |
| Solvency (%)                     | 604  | 12,7  | 9,37               | 2,35    | 59,95   |
| Real GDP growth rate (%)         | 604  | 2,83  | 3,27               | -13,9   | 24,62   |
| Inflation rate (%)               | 604  | 5,59  | 11,08              | -4,48   | 104,54  |
| GDP per capita                   | 604  | 10,06 | 0,73               | 8,43    | 14,56   |
| Contagion same region            | 604  | 0,35  | 0,48               | 0       | 1       |
| Contagion other region           | 604  | 0,73  | 0,44               | 0       | 1       |
| G7 contagion                     | 604  | 0,38  | 0,49               | 0       | 1       |
| Regulation index                 | 604  | 0,60  | 0,08               | 0,41    | 0,79    |
| Supervision index                | 604  | 0,72  | 0,13               | 0,39    | 0,96    |
| Banks orientation                | 604  | 0,60  | 0,49               | 0       | 1       |
| Debt x banks orientation         | 604  | 0,11  | 0,12               | 0       | 0,57    |
4. Econometric methodology

This section describes the panel data binary outcome models used in this study to determine banking crisis probability. The following models are used:

- Pooled logit and pooled probit;
- Pooled logit and pooled probit with individual-specific effects;
- Fixed effects logit;
- Random effects logit and probit.

The pooled models without individual-specific effects are the typical models used in the cross-sectional framework:

\[
Pr(y_{it} = 1 \mid x_{it}, \beta) = G(x_{it}\beta),
\]

where \(y_{it}\) is the binary outcome which takes the value 1 if a banking crisis occurred in country \(i\) in year \(t\) and is 0 otherwise; \(x_{it}\) is the vector of \(k\) explanatory variables observed for country \(i\) in year \(t\); \(G(z) = e^z/(1 + e^z)\) (logit model) or \(G(z) = \Phi(z)\), with \(\Phi(\cdot)\) being the standard normal cumulative distribution function (probit model); and \(\beta\) represents explanatory variables’ coefficients. Estimates for \(\beta\) are obtained by maximizing the log-likelihood function based on following density function for the \(i\)-th observation \(y_i \equiv (y_{i1}, \ldots, y_{iT})\):

\[
f(y_i|\gamma_i, \beta) = \prod_{t=1}^{T} G(x_{it}\beta)^{y_{it}}[1 - G(x_{it}\beta)]^{1-y_{it}}.
\]

Typical panel data models include individual-specific effects (\(\alpha_i\)). In linear models, it is usual to apply the within transformation or first differencing to remove them. However, for binary models these transformations are not available, so one alternative is to estimate the individual-specific effects directly. These so-called pooled models with individual-specific effects (which in the linear framework are equivalent to fixed effects models) are defined using expressions similar to (1) and (2), but the index function \(z\) in \(G(z)\) is now given by \(z = x_{it}\beta + D_i\alpha_i\), where \(D_i\) assumes the value 1 if the observation regards the country \(i\) and is 0 otherwise, and \(x_{it}\) does not include a constant term.\(^{7}\)

Fixed effects estimation that eliminates \(\alpha_i\) from the model is possible in the case of the logit. In this case, see Cameron and Trivedi (2005), the model is estimated by maximum likelihood conditional on

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\(^7\) Country dummies were only included for countries with recorded banking crises.
the sufficient statistic $\sum_t y_{it} = c$. Let $B_c = \{d_i | \sum_t d_{it} = c\}$ be the set of all possible sequences of 0 and 1 for which the sum of $T$ binary outcomes is defined by $\sum_t y_{it} = c$. Subsequently, estimates for $\beta$ are obtained by maximizing the log-likelihood function based on the following density function:

$$f (y_i | \sum_t y_{it} = c, x_i, \beta) = \frac{\exp[(\sum_t y_{it} x_{it}) \beta]}{\sum_{d \in B_c} \exp \{(\sum_t d_{it} x_{it}) \beta\}}$$

(3)

In this context, it is not possible to estimate the model for countries with $c = 0$, so the panel used in this case comprises only countries that suffered at least one banking crisis in the period 1991 to 2009. As in linear fixed effects models, unchanged country characteristics are removed from the model, which in this case was bank orientation.

Finally, random effects models assume that the individual effects are normally distributed, with $\alpha_i \sim N(0, \sigma^2)$. In this case, maximum-likelihood estimation of $\beta$ and $\sigma^2$ is based on the following density function:

$$f (y_i | x_i, \beta, \sigma^2) = \int f (y_i | x_i, \alpha_i, \beta) \frac{1}{\sqrt{2\pi \sigma^2}} \exp \left(\frac{-\alpha_i^2}{2\sigma^2}\right) d\alpha_i,$$

(4)

where $f (y_i | x_i, \alpha_i, \beta)$ is defined similarly to (2) but with $G(x_{it} \beta)$ replaced by $G(x_{it} \beta + \alpha_i)$.

5. Empirical results

We first present the results obtained for five variants of the panel data probit model with individual-specific effects described in the previous section. Then, the remaining models discussed in Section 4 are estimated and some specification tests and robustness checks are applied. All models were estimated using Stata 13 and considering cluster-robust standard-errors.

5.1. Main results

The five models considered in Table 6 differ on the form how debt is included. Models (1) and (5) consider only non-deposit debt, model (2) includes also customers’ deposits in the definition of debt.
and models (3) and (4) include variables that allow us to separate the effects of customers’ deposits and non-deposit debt on banking crisis probability.

Table 6
Regression results.
Models (1) - (5) differ on the form how debt and customers’ deposits are included. Statistical significance is represented as *, ** and ***, denoting significance at 10%, 5% and 1% levels, respectively. Standard error adjusted for 33 clusters (countries) are presented in parentheses.

| Pooled probit with individual-specific effects |
|-----------------------------------------------|
| (1)   | (2)   | (3)   | (4)   | (5)   |
| Size  |       |       |       |       |
| -0.368* | -0.157 | -0.397* | -0.133 | -0.408** |
| (0.189) | (0.201) | (0.207) | (0.230) | (0.186) |
| Debt  | 5,531*** | 5,819*** | 11,229*** |
| (1,684) | (1,642) | (3,329) |
| Customers’ deposits | 0.108 | (0.459) |
| Debt including customers’ deposits | -3.338 | -5.073 |
| (3.656) | (3.671) |
| Debt structure |       |       |       |       |
| -0.864** | (0.439) |
| Solvency |       |       |       |       |
| -0.024 | -0.033 | -0.024 | -0.046 | -0.034 |
| (0.026) | (0.034) | (0.029) | (0.037) | (0.025) |
| Real GDP growth rate | -0.162*** | -0.184*** | -0.194*** | -0.212*** | -0.156*** |
| (0.042) | (0.040) | (0.050) | (0.044) | (0.046) |
| Inflation rate | 0.046* | 0.032 | 0.045* | 0.029 | 0.049** |
| (0.024) | (0.022) | (0.025) | (0.018) | (0.020) |
| GDP per capita | 0.326 | 0.411 | 0.389 | 0.528 | 0.312 |
| (0.290) | (0.355) | (0.319) | (0.415) | (0.277) |
| Contagion same region | 1,140*** | 1,224*** | 1,286*** | 1,326*** | 1,090*** |
| (0.274) | (0.312) | (0.341) | (0.361) | (0.282) |
| Contagion other region | 0.092 | -0.221 | 0.196 | 0.049 | 0.073 |
| (0.307) | (0.322) | (0.365) | (0.380) | (0.316) |
| G7 contagion | 0.747** | 0.763*** | 0.816** | 0.741** | 0.818*** |
| (0.312) | (0.282) | (0.337) | (0.314) | (0.300) |
| Regulation index | -0.461 | -1.492 | 0.275 | 0.016 | -0.693 |
| (2.860) | (2.856) | (2.962) | (2.827) | (2.876) |
| Supervision index | -2.240 | -1.245 | -3.570* | -2.557 | -2.678 |
| (2.103) | (2.010) | (2.120) | (2.181) | (2.096) |
| Banks orientation | -4.824*** | -5.461*** | -5.362*** | -5.195*** | -3.281*** |
| (1.008) | (1.005) | (1.090) | (5.195) | (1.457) |
| Debt x banks orientation |       |       |       |       | -6.860** |
| (3.552) |       |       |       |       |
| Number of clusters | 33 | 33 | 33 | 33 | 33 |
| Number of observations | 604 | 604 | 585 | 556 | 604 |
Our results reveal a significant, positive effect of non-deposit debt on banking crisis probability in models (1), (3) and (5) by analyzing the coefficient of the variable Debt and also in model (4) through the variable Debt structure. In contrast, customers’ deposits are not a relevant factor in model (3) and have a negative influence on banking crises in model (4). Given the opposite effects of both financing sources, it is no surprise no relevant effect is found when they are considered together, see model (2). Overall, we find full support for hypothesis H2, observing a higher probability of banking crises for countries where banks are on average more indebted; and partial support for hypothesis H3 in the sense that a higher proportion of customers’ deposits in total debt mitigates the probability of failure by representing a buffer against bankruptcy.

In three of the models, bank size is also a significant variable for explaining banking crises, having a negative influence on banking crisis probability, as stated in hypothesis H1. Hence, countries where banks are, on average, larger, have a lower probability of failure.

At the macroeconomic level, the most robust results are presented by the Real GDP growth rate, the only significant variable of this group in all estimated models at a significance level of 1%. As formulated in hypothesis H5, we find that economic growth is negatively related to banking crisis probability, thus suggesting that crises are more likely under a weak macroeconomic environment. Inflation rate also seems to be an important determinant of banking crisis, affecting positively its probability of occurrence, as conjectured in hypothesis H6, and being also significant in three models. As regards GDP per capita, this variable appears to have no relevance in explaining a banking crisis.

These results highlight the role of economic growth on the financial stability of countries as suggested by previous research. If economic growth slows down, non-performing loans rise, some depositors will withdraw their savings to face their financial needs and banks’ liquidity decreases. Conversely, in times of economic growth the probability of these occurrences is lower, mitigating the possibility of bankruptcy. Our results also corroborate Demirgüç-Kunt and Detragiache (1998) findings with regard to the effect of high inflation rates on banking problems. These authors argued that high inflation is associated with high and volatile nominal interest rates that difficult the maturity transformation performed by banks.
We find strong evidence of contagion between OECD countries, be it between those in the same region or induced by G7 countries. In contrast, the contagion effect between countries from different regions does not seem to be particularly relevant after accounting for the other possible types of contagion. Thus, the major inducers of the propagation of banking crises across countries are those from the same geographic area and, due to their global financial relevance, G7 countries. Hence, hypotheses H8 and H10 are validated.

According to our results, regulation and supervision do not seem to be significant for preventing crises, since only supervision is significant and only in one of the estimated models. Hence, it appears that the regulation measures and supervision systems implemented by countries have not been sufficient to decrease banking crisis probability.

The final hypotheses tested concern the influence of the financial system orientation on banking crisis probability and its interaction with debt. Our results suggest that crises are less probable in countries with bank-based financial systems. Moreover, the interaction variable has a negative signal, which indicates that debt is likely to be a more frequent determinant of banking crises in countries with market-based financial systems, where banks are less protected by government and other authorities. Hence, both hypotheses H13 and H14 are supported by our results.

5.2. Alternative methods and specification tests

Given the conclusions about the effects of debt-related variables on banking crises, from now on we consider only model (5). Table 7 presents the results obtained for this model when the alternative functional forms discussed in Section 4 were considered.

In general, the six alternative regression models estimated corroborate the conclusions achieved in the previous section. For most variables, the sign and significance of the effects are the same. Nevertheless, there are two variables that, unlike before, now appear significant: GDP per capita,
with a significant, positive effect on banking crisis probability in 5 out of the 6 new models, giving some support to hypothesis H7; and Supervision index, which is (marginally) significant in half of the new models, suggesting it may have had some role in preventing the occurrence of more banking crises.

Table 7
Regression results – alternative models.
All results were obtained considering model (5) – see Table 6.
Statistical significance is represented as *, ** and ***, denoting significance at 10%, 5% and 1% levels, respectively.
Standard error adjusted for 33 or 28 clusters (countries) are presented in parentheses.

|                      | Other probit models | Fixed effects logit models | Other logit models |
|----------------------|---------------------|---------------------------|-------------------|
|                      | Probit | Random effects probit | Pooled logit with individual-specific effects | Panel data fixed effects logit model | Logit | Random effects logit |
| Size                 | -0.152* | -0.178** | -0.717* | -0.389 | -0.313* | -0.356** |
| (0.090)              | (0.084) | (0.401) | (0.278) | (0.178) | (0.157) |
| Debt                 | 6.280*** | 7.012*** | 21.025*** | 23.005*** | 12.039*** | 13.130*** |
| (1.682)              | (1.743) | (6.555) | (6.787) | (3.343) | (3.244) |
| Solvency             | -0.001 | -0.004 | -0.053 | -0.046 | 0.001 | -0.003 |
| (0.010)              | (0.011) | (0.053) | (0.033) | (0.021) | (0.021) |
| Real GDP growth rate | -0.152*** | -0.152*** | -0.295*** | -0.227*** | -0.288*** | -0.284*** |
| (0.038)              | (0.026) | (0.106) | (0.064) | (0.081) | (0.053) |
| Inflation rate       | 0.016** | 0.020** | 0.115** | 0.099*** | 0.028* | 0.034** |
| (0.008)              | (0.009) | (0.049) | (0.038) | (0.015) | (0.016) |
| GDP per capita       | 0.293* | 0.381** | 0.384 | 1.137** | 0.576* | 0.735** |
| (0.152)              | (0.171) | (0.630) | (0.463) | (0.305) | (0.319) |
| Contagion same region| 0.980*** | 1.018*** | 2.080*** | 1.951*** | 1.806*** | 1.900*** |
| (0.174)              | (0.215) | (0.517) | (0.525) | (0.288) | (0.409) |
| Contagion other region| 0.221 | 0.245 | 0.087 | 0.421 | 0.505 | 0.550 |
| (0.292)              | (0.297) | (0.595) | (0.664) | (0.564) | (0.593) |
| G7 contagion         | 0.385 | 0.443** | 1.582*** | 1.277*** | 0.711 | 0.818** |
| (0.288)              | (0.209) | (0.601) | (0.448) | (0.550) | (0.387) |
| Regulation index     | 1.002 | 1.165 | -0.020 | 3.607 | 1.926 | 2.242 |
| (1.445)              | (1.340) | (5.722) | (3.734) | (2.665) | (2.499) |
| Supervision index    | -1.487 | -1.703* | -4.639 | -4.144* | -2.897 | -3.215** |
| (0.932)              | (0.871) | (4.102) | (2.465) | (1.808) | (1.617) |
| Banks orientation    | 1.398** | 1.525*** | -11.150*** | - | 2.857*** | 3.029*** |
| (0.548)              | (0.481) | (3.040) | - | (1.098) | (0.915) |
| Debt x banks orientation | -3.967** | -4.276** | -12.689* | -16.993** | -7.734** | -8.108** |
| (1.939)              | (1.815) | (6.974) | (6.914) | (3.770) | (3.401) |
| Intercept            | -3.359 | -4.044* | - | - | -6.173 | -7.511* |
| (2.151)              | (2.097) | - | - | (3.998) | (3.977) |

Number of observations | 604 | 604 | 604 | 515 | 604 | 604
Number of clusters    | 33  | 33  | 33  | 28  | 33  | 33
More importantly, there is a major difference between pooled and random effects models, on the one hand, and fixed effects models, on the other hand: according to the former models, bank-based financial systems are more prone to banking crises, while in the latter it occurs the opposite. Therefore, it is important to use econometric tests to assess, from a statistical point of view, which type of model is more suitable to describe our data.

For the same reason that traditional fixed effects models are not available for panel data binary regression models, Hausman tests cannot be applied in this context. In alternative, we employed the following two LR tests. The first test assesses whether the variance of the individual effects is zero, in which case the random effects models reduce to the pooled models. The second compares pooled models with and without individual-specific effects, and thus is an indirect form of testing whether those effects may be interpreted as fixed or random, since pooled models produce consistent estimators only in the latter case.

The results reported in Table 8 show that pooled models are not rejected against random effects models, but are rejected against the variant of fixed effects models considered. Overall, this shows that the most suitable models are the pooled models with individual-specific intercepts and reinforce that, as concluded in the previous section, in bank-based financial systems there is a lower probability of occurring a banking crisis.

|                  | Probit | Logit |
|------------------|--------|-------|
| H₀ - Pooled models; H₁ - Random effects models (p-value) | 0.138  | 0.143 |
| H₀ - Pooled models; H₁ - Individual-specific effects models (p-value) | 0.000  | 0.000 |

5.3. Robustness checks

As Table 1 shows, the US banks account for more than half of our sample. Therefore, in order to check the robustness of the previous findings, the probit with individual-specific effect estimation was re-estimated excluding US banks. The results are presented in Table 9 and confirm the conclusions obtained for the original panel. All variables maintain their statistical significance in explaining banking crises and all signs still show the same direction of influence.

Another robustness test concerns the type of crises included in the analysis. So far, all types of crises, be it classified as systemic or borderline, have been considered (see Section 3.1). However, some countries only suffered from borderline crises (Czech Republic, France, Hungary, Portugal, Slovenia,
Sweden and Switzerland). Hence, in order to ascertain whether there are differences when only systemic crises are considered, our main model was re-estimated excluding the borderline banking crisis episodes.

Table 9 reveals that in general most of the previous conclusions are still valid when considering only systemic crises. The most relevant difference is that, for this type of crisis, there are no relevant differences between bank and market-based financial systems. This suggests that the greater government protection that banks have in the former system does not reduce the probability of banking crisis in case of major financial shocks.

**Table 9**
Robustness checks – All crises (excluding observations for the USA) and systemic crises (all countries).
All results were obtained considering model (5) – see Table 6.
Statistical significance is represented as *, ** and ***, denoting significance at 10%, 5% and 1% levels, respectively.
Standard error adjusted for 33 (systemic crises) or 32 clusters (results excluding USA crises) are presented in parentheses.

| Probit with individual-specific effects | Excluding US crises | Systemic crises |
|----------------------------------------|---------------------|-----------------|
| **Size**                               | -0.440**            | -0.653***       |
|                                       | (0.192)             | (0.227)         |
| **Debt**                               | 11.035***           | 14,191**        |
|                                       | (3.350)             | (5.473)         |
| **Solvency**                           | -0.035              | -0.039          |
|                                       | (0.025)             | (0.028)         |
| **Real GDP growth rate**               | -0.144***           | -0.124**        |
|                                       | (0.044)             | (0.050)         |
| **Inflation rate**                     | 0.053***            | 0.034***        |
|                                       | (0.020)             | (0.010)         |
| **GDP per capita**                     | 0.259               | 0.440           |
|                                       | (0.298)             | (0.292)         |
| **Contagion same region**              | 1.152***            | 1.123***        |
|                                       | (0.310)             | (0.289)         |
| **Contagion other region**             | 0.185               | -0.075          |
|                                       | (0.309)             | (0.397)         |
| **G7 contagion**                       | 0.823***            | 1.025***        |
|                                       | (0.315)             | (0.391)         |
| **Regulation index**                   | -0.507              | 0.028           |
|                                       | (3.036)             | (3.019)         |
| **Supervision index**                  | -1.457              | -4.334*         |
|                                       | (1.995)             | (2.543)         |
| **Banks orientation**                  | -3.389**            | 0.282           |
|                                       | (1.425)             | (2.673)         |
| **Debt x banks orientation**           | -6.485**            | -8.005          |
|                                       | (3.555)             | (5.893)         |
| **Number of observations**             | 585                 | 604             |
| **Number of clusters**                 | 32                  | 33              |
6. Conclusions

The aim of this paper was to identify the determinants of the banking crises in OECD countries. The results suggest that banking crises tend to occur mostly in countries where banks are smaller and present higher levels of debt and when the economic environment slows down and a higher inflation rate is registered. There is evidence of a contagion effect across countries, namely between those located in the same region or induced by G7 countries. Despite all the concern about regulation and supervision of banking activities, past practices seem to have contributed only marginally to the prevention of banking crisis episodes. We also found that countries with bank-based financial systems present less probability of banking crises and that debt is a more important determinant of distress for market-based countries, namely when both systemic and borderline crises are considered.

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