Depositors' discipline for better or for worse. What enhanced depositors' confidence in the banking system in the last 10 years?

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The objective of this paper was to study the extent of depositors' discipline before, during and after the global financial crisis. To that end we built up a model for testing whether depositors do discipline banks based on different degrees and measures of bank risk and changes in the features of deposit insurance schemes. To test our hypothesis, we gathered a sample of banks located in 22 countries belonging to the Organisation for Economic Co-operation and Development covering the period from 2005 to 2014.

The results suggest that the exercise of depositors' discipline differed through the periods analysed. The deposit insurance schemes did not influence depositors' discipline before or during the global financial crisis; conversely, they proved to be positively valuated by depositors in the post-crisis period. Finally, in the post-crisis period the exert of discipline increased and bank profitability became relevant to depositors' discipline.

1. Introduction

Over the last decade, severe banking crises, such as the global financial crisis and the sovereign debt crisis, have struck in several markets, with heavy consequences for depositors' confidence in the banking system. After every banking crisis, banking authorities usually tight supervision and prudential regulation. Because of the ever-increasing complexity of the banking business, it is difficult to regulate banks effectively based solely on prescribed rules. Alternatively, rather than depending exclusively on regulatory action, banking authorities may increase their reliance on market discipline to oversee banks (Martinez Peria & Schmukler, 2001).

In the past, many regulators and academic researchers have underestimated market discipline as a means to improve the safety and soundness of the banking system. For example, Bliss and Flannery (2002) define market discipline as 'an article of faith among financial economists'. This cannot be true anymore due to today's complex financial landscape. In some crises, the missing ingredient for ensuring financial stability was found in the failure of bank regulators and market forces to discipline financial institutions directly. In light of this, the use of market discipline for prudential purposes was incorporated by the policymakers in the Basel II (2004) frameworks.

The objective of this paper is to study the factors that deterred depositors' confidence in the banking system and pushed depositors to exercise discipline before, during and after the global financial crisis. To do so, we created a new dataset comprising balance sheet data for 9,754 banks in 22 countries of the Organisation for Economic Co-operation and Development (OECD) in the period 2005–2014, and the corresponding features of deposit insurance schemes (DISs) for each country and period analysed. In particular, we built up a model for testing the extent of depositors' discipline in the pre-crisis period (2005–2007), the crisis period (2008–2012) and the post-crisis period (2013–2014).

The main findings of our analysis are notable in several respects. First, we found that the

factors that deterred depositors' confidence differed when the crisis was present from when it was absent, but they also differed before and after the crisis. Second, the DISs proved to be irrelevant before 2013; conversely, the government interventions necessary to restore depositors' trust and prevent the bank runs that occurred after the global financial crisis were accepted by the market and positively valuated by depositors. Third, some aspects of adverse discipline emerged before and during the crisis (e.g., the higher the bank risk, the greater the deposits); nevertheless, depositors' discipline avoided such situations in the post-crisis period.

This paper differs from previous empirical studies in several ways. First, the present work analyses the years before, during and after the global financial crisis, covering the period from 2005 to 2014, whereas the academic literature on market discipline is quite dated. It is worth pointing out that Anginer et al. (2014) examined bank risk and systemic stability together with the effect of DISs during a period of global financial instability by analysing these effects for the crisis period from 2007 to 2009, as well as for the three years leading up to the global financial crisis (2004–2006), although with different aims and research questions. Second, the period of analyses allows us to directly study the changes in depositors' discipline in good and bad times. In fact, traumatic episodes such as banking crises may act as wake-up calls for depositors, increasing depositors' awareness of the risk of their deposits. As a consequence, after crises we might see a rise in market discipline. Third, the existing literature on market discipline focuses primarily on whether market discipline exists in a particular country—typically in the United States (US) market—during a given period. In contrast to previous research, we studied 22 OECD countries covering three different continents. Fourth, this research combines different elements that might influence depositors' discipline, namely, bank business risk, bank stability and the DISs. In particular, there are only a few studies that link depositors' discipline and DISs: Demirgüç-Kunt and Huizinga (2000) and Martinez Peria and Schmukler (2001) studied the effects of DISs on bank risk (but each study adopted different measures and sample periods). Fifth, the present work gathered a new dataset that merged data from four different sources.

The remainder of the study is organised as follows. The next section analyses the literature specific to this topic. Section 3 describes the data collection, the hypotheses we aimed to test in this study and the research methods we applied. Section 4 reports the results of our analyses, and Section 5 restates our major conclusions and discusses the implications for regulators and further research.

2. Literature review

Financial regulators are concerned that the growing complexity of large banking organisations makes them difficult to monitor and control using traditional supervisory tools. Consequently, regulators have been increasingly drawn to the idea that private investors can affect the actions of financial firms by punishing them for risky behaviours. Moreover, the social cost of supervising banks may be lowered if regulators concede greater control to market forces that can distinguish between good and bad banks (Martinez Peria & Schmukler, 2001). Many regulatory reforms have been made with the hope that the monitoring of banks by private agents would directly influence risk-taking decisions by banks (Morgan & Stiroh, 2001). In the present work, we focus on market discipline exerted by depositors—that is, depositors' discipline. Depositors' discipline can be described as a situation in which depositors penalise banks with risky behaviours (e.g.: low capitalization, poor asset quality, great variability of revenues,…) by requiring higher interest rates on deposits or by

withdrawing deposits (Cubillas et al., 2016). Conversely, the situation in which depositors prefer banks with risky behaviours and increase their deposits in them is defined as adverse discipline: an increase in the bank risk corresponds to a rise in the deposits.

In general, the market discipline paradigm requires that: the information be publicly available and the private benefits of monitoring outweigh the costs, rational investors continually gather and process information about traded firms whose securities they hold and markets in which they operate, investors' assessments of firm condition and future prospects are stored into the firm's equity and debt prices, and managers operate in the security holders' interests. The prices of a firm's traded securities are the most obvious public signals by which the stakeholders make their evaluations known to management (Bliss & Flannery, 2002). Further, one relevant condition for market discipline is that depositors bear some losses generated by bank risk-taking (Cubillas et al., 2016).

Market discipline can be beneficial in two ways: (i) it may reduce the moral hazard incentives that government guarantees create for banks to undertake excessive risks; and (ii) market discipline may improve the efficiency of banks by pressuring some of the relatively inefficient banks to become more efficient or to exit the industry (Martinez Peria & Schmukler, 2001). The mere 'threat' of such market discipline can plausibly inhibit or influence the decision-making process of banking firms towards more conservative/safer positions (Hoang et al., 2014).

The use of market discipline for prudential purposes has also gained considerable importance in recent years as policymakers—increasingly attuned to its likely beneficial role—have incorporated it in their regulatory frameworks (Pawarda et al., 2013). This is best exemplified by the third Pillar of the regulatory framework of the Basel Committee on Banking Supervision, commonly known as Basel II (2004). Pillar 3 developed a set of disclosure requirements for individual banks to allow market participants to assess capital levels, risk exposures and risk management. Further, Pillar 3 recognises that market discipline has the potential to reinforce capital regulation and other supervisory efforts to promote safety and soundness in banks and financial systems (Hoang et al., 2014). However, there are other conflicting views on market discipline. In particular, Bliss and Flannery (2002) define it as 'an article of faith among financial economists' and point out that supporters of market discipline generally think of its beneficial influence, while forgetting the negative side.[1]

The academic literature on market discipline is deeply divided and provides conflicting results. First, empirical tests of the discipline hypothesis have investigated the extent to which spreads on bank and bank bond issues correlate with proxies for the issuers' risk and performance. Avery et al. (1988) found virtually no relationship. Flannery and Sorescu (1996) and Jagtiani et al. (2000) found significant relationships between bank and bank bond spreads and various proxies for risk. However, Morgan and Stiroh (2001) found that the market's discipline of banks was stronger than previously thought, as it deters risk-taking. Goldberg and Hudgins (1996) and Calomiris and Wilson (1998) examined this question by concentrating on the level or change of deposits. By examining the behaviour of uninsured deposits at savings and loan associations (S&Ls) from 1986 to 1989, Goldberg and Hudgins (1996) found that failing S&Ls exhibit declining levels of uninsured deposits and attract fewer uninsured deposits prior to failure than do non-failing ones. Calomiris and Wilson (1998)

[1] Bliss and Flannery (2002) argued that the use of market discipline as a regulatory tool is 'gaining credibility', while it normally remains 'more a matter of faith than of empirical evidence'.

found that in the 1930s the rising of deposit default risk led to deposit withdrawals. In response, banks increased riskless assets and cut dividends. Banks with high default risk or high costs of raising equity contracted dividends the most.

By analysing the period immediately before the onset of the global financial crisis (1989–2007), Cubillas et al. (2016) considered whether higher risk-taking incentives in large banks contributed to the crisis. Their results indicated that, on average, depositors discipline large banks less than they do smaller banks.

Banking crises are unique situations to examine market discipline. First, during crises, there are large aggregate shocks to the economy and to the banking sector. In addition, bank interventions, typical of crises, temporarily immobilise deposits and interest rates. Second, the risks of bank failure and of losing deposits, temporarily or permanently, become more evident and are magnified during these events. Further, the ability of the DISs to continue guaranteeing deposits can be questioned and jeopardised. Demirgüç-Kunt and Huizinga (2004), Hoggarth et al. (2005), Nier and Baumann (2006), Cubillas et al. (2010) and Hadad et al. (2011) analysed countries with and without banking crises and found that wider safety nets also weaken market discipline. Demirgüç-Kunt and Huizinga (2004) found that explicit DIS reduced required deposit interest rates, while at the same time it lowered market discipline on bank risk-taking. Hoggarth et al. (2005) demonstrated that safety nets reduced market discipline and thus increased the likelihood of a banking crisis. Nier and Baumann (2006) analysed 729 individual banks from 32 different countries between 1993 and 2000 and found that moral hazard existed and that market discipline played a role in mitigating the banks' risk of insolvency. Cubillas et al. (2010) analysed the cost of deposits during 1989–2007, and found that, on average, market discipline weakened after a banking crisis. Hadad et al. (2011) analysed changes in the DISs and capital regulation in Indonesian banks following the 1997–1998 financial crisis. They found that the adoption of a blanket guarantee scheme weakened market discipline, although market discipline worked better in listed banks than unlisted banks and in foreign banks than domestic banks.

Further, Hoang et al. (2014) analysed whether market discipline changed after banking crises. They studied subordinated debt and interbank deposits for banks in the G7 nations during the period 1996–2010. Their results suggest that market discipline helps to reduce bank risk (both equity and credit risk). Moreover, they found that the positive impact of market discipline was stronger in the presence of a risk-adjusted insurance premium, and during the post-global financial crisis period. However, the disciplinary effect of market discipline was not enhanced in the presence of bank capital.

To the best of our knowledge, only four papers have specifically investigated the effects of the design of deposit insurance on market discipline: Mondschean and Opiela (1999), Martinez Peria and Schmukler (2001), Demirgüç-Kunt and Huizinga (2004) and Imai (2006). Mondschean and Opiela (1999) examined the effects of changes in the DISs on the market for bank time deposits in Poland. In an environment of less restrictive bank supervision and a deposit insurance policy that favoured state banks, they found that depositors exacted a price for risk-taking. However, after a new law increasing coverage for private banks went into effect, bank-specific variables became less important in explaining differences in deposit interest rates. Martinez Peria and Schmukler (2001) investigated the interaction between market discipline and deposit insurance and the impact of banking crises on market discipline in Argentina, Chile and Mexico during the 1980s and 1990s. Their results demonstrate that depositors do discipline banks by withdrawing deposits and by requiring higher interest rates, and that deposit insurance does not appear to diminish the extent of market discipline.

Imai (2006) analysed market discipline and the DIS in Japan when unlimited coverage for some deposits was introduced (sample period: 2001–2003). He found that depositors did not exercise discipline for insured deposits, while they required higher interest rates for partially insured deposits.

The examination of market discipline in the bank deposit market is of interest to policymakers as they consider deposit insurance reform to enhance market discipline. Deposit insurance systems are designed to protect small depositors and to avoid systemic bank insolvencies. Such insolvencies involve several costs to the banks, their customers and to governments. In particular: (i) they lead to the destruction of a bank's relationship capital gathered in previous bank–customer relationships; (ii) the disruption of bank lending and of the payments system cause a reduction in investment and other economic activity; (iii) bank depositors potentially lose heavily because of bank failures; and (iv) governments tend to incur large costs in remedying a banking crisis (Demirgüç-Kunt & Huizinga, 2004). To reduce the chance of financial system breakdowns and to limit their costs if they do occur, nearly all developed countries have DIS in place. However, deposit insurance, structured to reduce the vulnerability of the financial system, appears to have either stabilising or destabilising effects on the banking system.

The DIS in place in a country may greatly affect the extent of market discipline. If depositors know that their funds are safe and liquid, they will not have an incentive to withdraw their deposits from their bank when they see other banks fail. Consequently, deposit insurance can lower the probability of systemic bank runs. At the same time, a credible DIS curbs the incentives of insured depositors to monitor banks, as well as weakening their vigilance to demand correct prices relative to bank risk, and so banks are incentivised to switch funding sources to insured deposits. However, if the DIS is not credible or if there are costs associated with the recovery of deposits following a bank failure, insured depositors will be compelled to monitor banks (Martinez Peria & Schmukler, 2001).

The DISs differ markedly across countries. Influencing factors for the differences are a country's decision on whether to adopt an explicit system for a DIS, and, for countries that decide to adopt an explicit DIS, the type of design features that are embedded within it. The presence of an explicit DIS and how it is designed affects many constituencies, particularly banks, depositors, creditors, specialised bureaucracies and taxpayers (Demirgüç-Kunt, Kane, & Laeven, 2008). The following principal features are embedded in an explicit DIS (Demirgüç-Kunt et al., 2013):

(i) organisation and administration, which can be public, private or jointly public and private

(ii) presence of ex-ante collected fund or ex-post funding mechanism

(iii) presence of a risk-adjusted premiums mechanism or flat premiums.

The objective of the first feature is to ensure that there will be a credible first layer of private loss in case of bank failure; such losses provide private parties with incentives to continue to monitor banks and to remain vigilant. In that sense, a jointly public and private organisation and administration of the DIS is perceived to be stronger. The second feature deals with the ability to repay losses and the speed of doing so in case of bank insolvency. Repayments through the insurance fund usually take time, imposing liquidity costs on depositors—that is why it is better to have an ex-ante collected fund. Regarding the third feature, a risk-based deposit insurance premium can reduce bank risk, since such insurance premiums are based on bank risk classifications regarding capital adequacy and supervisory ratings. The market can impose stronger discipline and reduce bank risk under a risk-

adjusted insurance premium regime. It is likely that a risk-adjusted insurance premium scheme induces banks to be more prudent in their risk-taking. Uninsured liabilities can provide useful information and improve bank supervisors' assessments of bank risk profiles. Since risk-adjusted insurance premium criteria are based on supervisory ratings, improvements in the supervisory process can lead to an insurance premium imposed on banks that is better matched to their risk-taking. Therefore, market discipline may assist a risk-adjusted premium scheme to monitor and reduce bank risk.

Further, other design features can be embedded within the DIS, such as the type of deposit coverage, which could exclude particular types of deposits (e.g., foreign-currency or interbank deposits) from the system and set coverage limits; type of assessment, which can be calculated on total deposits, eligible deposits or covered deposits; funding source, which can be public, private or jointly public and private; and participation, which can be expanded to local branches of foreign banks. In the European Union (EU) the level of harmonisation of DIS (with Directive 94/19/EC) was found to be too low during the global financial crisis. Consequently, a multiplicity of DISs coexisted and the wide variety of DISs were proven not to be crisis-resilient, and large government interventions were necessary to manage failing banks to restore depositors' trust and prevent bank runs. Therefore, the project to establish a European Banking Union led to the revision of the 1994 Directive; after many regulatory steps,[2] Directive 2014/49/EU was created with the aim of strengthening the protection of depositors. For the most part, Directive 2014/49/EU has been implemented and effective from 3 July 2015. A relevant step contemplated in the Directive is the creation of a European Deposit Insurance Scheme, but this communitisation is not an easy step at the moment because of heterogeneous national interests in Europe.

In contrast to Europe, in the US the deposit insurance scheme, established by the Federal Deposit Insurance Corporation (FDIC), has performed a pivotal role in the financial system for many years because it has performed tasks well beyond the mere insurance function. In addition, in the US, after the global financial crisis, the Dodd–Frank Wall Street Reform and Consumer Protection Act of 2010 gave the FDIC more responsibility for bank examination and resolution processes, such as transferring receivership authority over failing institutions to the FDIC.

Australia was one of the few developed countries that did not have deposit insurance facilities in place. With the growing uncertainty surrounding the health of the global financial markets in 2008, the Australian Government decided to introduce protection for deposits and wholesale funding. In this case, deposit insurance measures were introduced not because of a

[2] On 15 October 2008 the European Commission proposed a revision to EU rules on DGSs, and on 11 March 2009 the European Parliament and the Council publicised Directive 2009/14/EC, amending Directive 94/19/EC to change regulations for coverage level and payout delay of DISs. On 12 July 2010 the European Commission adopted a legislative proposal that stated that depositors should enjoy the same level of deposit protection in all EU states; the principal aim was to create a level playing field, with a focus on coverage limits and a preference for ex-ante funding. On 12 September 2012, the European Commission publicised the proposals for a Single Supervision Mechanism, which appears to be the first step of a complex process. Finally, on 11 December 2013, the European Parliament reached an agreement on bank recovery and resolution, and on 17 December reached a provisional agreement on the protection of deposits. The new rules, which should enter into force on 1 January 2015, provide authorities with the means to intervene decisively both before problems occur and early in the process. Concerning the protection of deposits, the new rules ensure bank deposits in all EU states continue to be guaranteed up to 100,000 euros per depositor per bank if a bank fails. From a financial stability perspective, this guarantee prevents depositors from making excessive withdrawals from their banks, thereby preventing severe economic consequences.

threat to domestic stability of the banking system but mainly as a precautionary action to face deteriorating conditions in overseas financial markets.

Studies of how political factors affect DIS reform focus predominantly on the US context (e.g., Calomiris & White, 1994; Economides, Hubbard, & Palia, 1996; Kane & Wilson, 1998; Kroszner, 1998; Kroszner & Strahan, 2001). Studies on the relationship between DISs and banking sector stability present different theoretical views, with arguments for and against each aspect of the financial supervisory regime (see Demirgüç-Kunt et al., 2008; Gropp & Vesala, 2004; Hasan, Jackowicz, Kowalewski, & Kozłowski, 2013; Huizinga & Nicodème, 2006; Lane & Sarisoy, 2000; Merton, 1977).

Ioannidou and Penas (2010) analysed the effect of DISs on the risk-taking behaviour of banks in the context of a quasi-natural experiment using detailed credit-registry data. Using the case of an emerging economy—Bolivia—that introduced a DIS during the sample period, they compared the risk-taking behaviour of banks before and after the introduction of this system. They found that in the post-deposit insurance period banks were more likely to initiate riskier loans (i.e., loans with worse internal ratings at origination). These loans carry higher interest rates and are associated with worse ex-post performance (i.e., they have higher default and delinquency rates). Banks did not seem to compensate for the extra risk by increasing collateral requirements or decreasing loan maturities. They also found evidence that the increase in risk-taking was due to the decrease in market discipline from large depositors. Finally, differences between large ('too-big-to-fail') and small banks diminished in the post-deposit insurance period.

Only Anginer et al. (2014) examined the effect of a DIS on bank risk and systemic stability during a period of global financial instability by analysing these effects for the crisis period from 2007 to 2009, as well as for the three years (2004 to 2006) leading up to the global financial crisis, with a sample of 4,109 publicly traded banks in 96 countries. They found that the influence of DISs on bank risk differed during normal periods and periods of systemic downturns. Their results indicated that DISs enhanced depositors' confidence and had positive stabilisation effects during the recent global financial crisis, despite the fact they contributed to the occurrence of the crisis in the first place, demonstrating an overall destabilising effect over the full sample. They found that generous financial safety nets increased bank risk and reduced systemic stability in non-crisis years, while good supervision enhanced the positive effects of DISs during turbulent periods and dampened the negative effects that arose from moral hazards during normal periods.

There is an important gap in the literature given that economic theories suggest that DISs involve both benefits and costs that are likely to vary with economic conditions. That is, while DISs can increase the moral hazard and make financial systems more vulnerable to crises during good times, they can also enhance depositors' confidence and reduce the likelihood of contagious bank runs during turbulent periods, such as the recent global financial crisis.

It is possible that following bank interventions and failures depositors may become more aware of the risk of losing deposits, so they may start exercising stricter market discipline. Nevertheless, governments usually respond to banking crises with containment and resolution policies that strengthen depositors' protection. As a consequence, depositors may be more relaxed if a new banking crisis occurs and have fewer incentives to exercise discipline. The systemic problems in the finance sector that followed the global financial crisis provide a key impetus to improving our understanding of the determinants of bank risk. Evaluating bank risk is important to regulators/supervisors, borrowers, and stock and bond holders. Regulators (including implicit and explicit safety net providers) and supervisors who

are responsible for maintaining financial stability have a keen interest in bank risk-taking due to the costs associated with bankruptcy, contagion and possible disruption in the allocation of credit. Conversely, during economic contractions banks tend to be weak and the probability of bank failure increases. Creditors and depositors will increase the level of monitoring and assess bank risk accordingly. Further, during such difficult market times the safety nets have to absorb the loss from any banking failures, and this increases the chance that these mechanisms cannot fully shoulder banking system failure. Hence, the hypothesis is as follows: market discipline is stronger in reducing bank risk post-global financial crisis.

Our paper contributes to the existing strands of literature by analysing the importance of market discipline and DISs before, during and after the global financial crisis, which, as yet, has not been scrutinised in any research on the determinants of bank risk. The unique dataset concerning the features of DIS for each country and the bank-level information we put together enable us to shed new light on the links between market discipline, deposit insurance, bank risk and banking crises.

3. Data and method

One important contribution of this paper is the novel dataset we put together and analysed. In particular, we combined bank-level data with features of DISs. Bank-level data were collected from the Fitch-IBA Ltd BankScope Database (hereafter BankScope database).[3] We analysed active banks located in 22 OECD countries (see Table 2 for the list of the countries).[4] As our sample of banks was drawn from a set of countries that were affected by the financial crisis to varying degrees, we had sufficient variability across the sample to detect any meaningful relationship between market discipline and bank risk.

We included only commercial banks, cooperative banks and savings banks as defined by BankScope. Data were collected in units of euros for the period 2005–2014.[5] We removed from the sample the outliers and banks with all missing values. The final sample comprises 9,754 banks, with 67,261 bank-year observations. Data about features of DISs were hand-collected, combining data from three different studies, namely Demirgüç-Kunt et al. (2005), Cihak et al. (2012) and Demirgüç-Kunt et al. (2014), supplemented when necessary by the study of the single regulatory authorities.

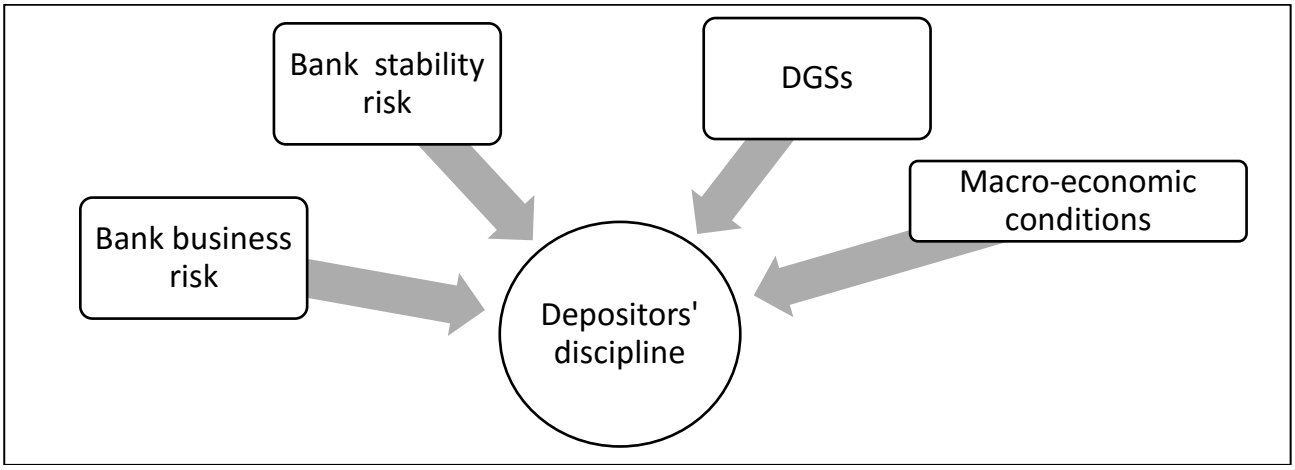
Our dataset allowed us to build up a model to study the factors that affect depositors' discipline, which have been identified in bank business risk, bank stability risk, DISs and macroeconomic/environmental conditions (see Figure 1).

[3] BankScope database is the Bureau Van Dijk database, which contains comprehensive information on banks across the globe. BankScope database has up to 16 years of detailed accounts for each bank and comprises information on 30,000 banks.

[4] Active banks are those that are not in administration or receivership, in bankruptcy, dissolved (merger or demerger), in liquidation, or inactive.

[5] We chose to use for the data collection process the currency that was used by the greatest number of banks in the sample to minimise any possible conversion problem; however, data were processed as a ratio or in logarithmic form, so the unit of measurement became irrelevant.

Figure 1
Factors affecting market discipline. Source: our elaboration.



We linearised these relationships and estimated a model—the Depositors' Discipline Equation (DDE)—for testing the influence of the drivers of depositors' discipline. We tested the DDE in three different periods, set according to the global financial crisis: the pre-crisis period (2005–2007), the crisis period (2008–2012) and the post-crisis period (2013–2014). This allowed us to study how the global financial crisis changed the effects of depositors' discipline on bank risk. Through the use of the Stata 11 software package,[6] we ran a generalised least squares (GLS) regression model with random-effects for unbalanced panel data separately for the three periods.[7]

In previous research, scholars have generally begun their research by considering that depositors need to feel protected to deposit their money in banks. Consequently, having higher deposits per cent growth in a particular bank has generally been considered a signal of safety. The dependent variable is the per cent variation of deposits and short-term funding (D%DSTF) and is designed to measure the depositors' discipline.

D%DSTF provides a more complete test of depositors' discipline than interest revenues, because it measures both market and regulatory discipline. In fact, banks may respond to regulatory pressure to comply with capital standards by reducing their assets, and consequently their liabilities. Further, deposit variation measures both the monitoring ex-post and the influence ex-ante of the risk-taking by pricing such risks and reducing their ex-ante profitability.

The explanatory variables consist of banks' business risk, banks' stability and features of DISs; we also included control variables and error terms in the regression along these lines:

$$D\%DSTF_{i,t} = \alpha_0 + \alpha_1 business\_risk_{i,t} + \alpha_2\, stability\_risk_{i,t} + \alpha_3\, DISs_{i,t} + \alpha_4\, Control +$$

[6] Stata is an integrated statistical software package that provides tools for data analysis, data management and graphics. It was created in 1985 by StataCorp.

[7] In this paper, we were interested in studying time-invariant variables such as the features of DGSs in the three periods; random effects models estimate the effects of time-invariant variables while fixed effects models are not useful for estimating the effects of the variables that do not change over time. Further, we decided to adopt a random effects model, as the subjects of our analyses—banks—change little, or not at all, across time. In this case, a fixed effects model may not work very well, or at all, as there needs to be within-subject variability in the variables; otherwise, the standard errors from fixed effects models may be too large to tolerate (Allison, 2009).

$$\varepsilon_{i,t} \quad (1)$$

Values were calculated for each bank *i* in period *t*. Here, $\varepsilon_{i,t}$ is a random residual.

The banks' business risk was estimated by the Z-score index (Altman, 1977). The Z-score provides a direct measure of bank solvency as it indicates the number of standard deviations from the mean by which returns would have to fall to wipe out all equity in the bank (Boyd & Runkle, 1993); a higher Z-score can be interpreted as a symptom of bank stability because it is inversely related to the probability of bank insolvency. Recently, Laeven and Levine (2009), Cubillas et al. (2012), Beck et al. (2013), Bertay et al. (2013) and Cubillas et al. (2016), among others, have used the Z-score as a proxy for bank risk. In the present work, a time-varying Z-score measure was adopted, consistent with the data analysed.[8] We used the definition of Yeyati and Micco (2007), who employ moving mean and standard deviation estimates $\mu_{ROA,i,t}$ (n) and $\sigma_{ROA,i,t}$ (n)—with n = 3 window width[9]—that wer calculated for each period t ϵ {1…T}, and combined these with current period T values of $LEVERAGE_{i,T}$, as follows:

$$Z - score_{i,t} = \frac{\mu_{ROAi,t} + LEVERAGE_{i,T}}{\sigma_{ROAi,t}} \quad (2)$$

We included in the DDE both the single value for the banks (ZscoreB) and the mean value for each combination country-year (ZscoreCY) as a measure of country risk.[10]

The banks' stability consists of five indexes that respectively determine asset quality, capitalisation, profitability, liquidity and size. As lending remains the primary business line for the banking industry, and credit quality remains the predominant source of risk, the quality of bank assets is an evaluation of the loan quality. The loan quality is computed by the impaired loans on gross loans (IL/GL): the higher the ratio, the lower the quality of banks' assets. The capital adequacy ratios seek to measure whether the pool of permanent funds available to the bank is sufficient to neutralise the risks. They should be evaluated in light of the bank's profitability, asset quality and liquidity. In this paper, the capitalisation is calculated by the capital funds on total assets ratio (CF/A) and is greater for banks exhibiting a higher ratio. Liquidity is a measure of the ease with which an asset can be converted into cash. For banks, liquidity risk is the risk that a large number of depositors and investors may withdraw their savings—that is, the bank's funding—at once, leaving the bank short of funds. Such situations can force banks to sell assets—most likely at an unfavourably low price—when they would not otherwise choose to do so. The per cent of liquid assets on deposits and short-term funding (LA/DSTF) measures bank liquidity; banks with better liquidity are the ones with a greater ratio. The bank profitability embraces the efficiency and operational performance of banks. The profitability is computed by the ratio between the net interest revenue and the total assets (NIR/A). It examines the returns generated from the bank's assets. An increase in the ratio corresponds to an increase in profitability for the bank. Finally, we included the size as approximated by the natural logarithm of total assets (NLA) in the regression. The collapse of a large bank can threaten the stability of a country's whole financial system through further failures as a result of direct credit losses, contagion effects or a general loss of confidence. Governments aim to avoid this negative systemic effect when they bail out a failed large bank.

[8] For more about time-varying Z-score, see Lepetit and Strobel (2015).

[9] To determine the Z-score in 2005 and 2006, we collected data for 2003 and 2004.

[10] Overall, there are 220 country-year combinations.

The 'too-big-to-fail' problem appears when the creditors of large banks expect a public bailout. This expectation exacerbates moral hazard problems in large banks because it reduces depositors' incentives to discipline banks and may enable banks to increase risk-taking and, ultimately, overall financial fragility (Cubillas et al., 2016). In this scenario, not only would large banks have risk-taking incentives but smaller banks would also have incentives to increase their size in order to be considered 'too-big-to-fail'. Further, large banks tend to have lower capital, less stable funding and more market-based activities, and be more organisationally complex than small banks (Laeven et al., 2014).

The DISs were codified in three dummies that respectively indicate the presence of risk-adjusted premiums (RiskAdjPre), the presence of ex-ante funding (ExAnteFund) and the joint administration of the fund from public and private institutions (AdminJoint). All three dummies were calculated for each stage and represent the diverse DISs as changed in three periods.

Differences in bank entry barriers, restrictions on non-traditional bank activities, official supervision, government bank ownership and institutions all may be responsible for differences across countries in changes in market discipline after a banking crisis. As these variables may influence the extent of market discipline both before and after a crisis, they may also affect a change in market discipline (Imai, 2006). Further, the amount and variation of deposits is influenced by macroeconomic variables—for example, the amount of money and quasi-money, the labour-force participation rate, the population above age 65 and the gross domestic product (GDP)—so we included control dummy variables related to country of location to control for macroeconomic conditions. We also included as control variables dummies that explain accounting standard, listing and type of bank.[11]

The null hypothesis of the DDE is H_0: all return coefficients = 0, and states that there is no depositors' discipline. However, given the potential risk and uncertainty surrounding the bank crisis, we expected depositors to punish risky banks. Depositors' influence and monitoring requires that α_1, α_2 and α_3 in Equation (1) differ significantly from zero. In particular, if $\alpha_1 = 0$, depositors do not to respond to the changes in bank business risk. This finding would not support the hypothesis of depositors' discipline. An estimated $\alpha_1 \neq 0$ implies that the bank business risk is evaluated by depositors: precisely, $\alpha_1 > 0$ means that depositors discipline the business risk assumed by banks and price it negatively; conversely, $\alpha_1 < 0$ corresponds to an adverse discipline situation in which a growth in bank business risk leads to a rise in bank deposits.

In case of α_2 equal to zero, there is no market discipline by depositors on bank stability; conversely, any estimation of $\alpha_2 \neq 0$ implies that there is depositors' discipline or adverse discipline on bank stability. Specifically, if α_2 corresponds to an improvement in stability ratios, it means that there is depositors' discipline; if α_2 corresponds to a detrimental effect on stability it is the case of adverse discipline. Further, concerning bank size, $\alpha_2 > 0$ means that the bank is 'too-big-to-fail' and so depositors avoid disciplining the largest banks. Conversely, an α_2 lower than zero means that the growth in bank size undermines the ability of any deposit insurance fund to credibly commit to rescue the largest banks and so the biggest

[11] Dummies related to the accounting standard are IFRS (dummy excluded as considered as the benchmark), local GAAP, US GAAP and other standards. Dummies related to listing are listed (dummy excluded as considered as the benchmark), delisted and unlisted. Dummies related to the type of bank are savings bank (dummy excluded as considered as the benchmark), commercial banks, and cooperative banks.

banks are perceived by depositors to be 'too-big-to-save'.[12]

Further, if $\alpha_3 = 0$, it follows that the features of DISs do not influence the variation of bank deposits. This finding would mean that DISs are not determinants of depositors' discipline. An estimated $\alpha_3 \neq 0$ implies depositors' discipline on DISs.

Beyond this, the coefficient α_4 concerns control variables and is not relevant to the present study.

We applied this methodology to actual data. The final model for DDE is the following:

$$D\%DSTF_{i,t} = \beta_0 + \beta_1 ZscoreB_{i,t} + \beta_2 ZscoreCY_{i,t} + \beta_3\, IL/GL_{i,t} + \beta_4\, CF/A_{i,t} + \beta_5\, LA/DSTF_{i,t} + \beta_6\, NIR/A_{i,t} + \beta_7\, NLA_{i,t} + \beta_8\, RiskAdjPrem_{i,t} + \beta_9\, ExAnteFund_{i,t} + \beta_{10}\, AdmJoint_{i,t} + \beta_{11}\, Country\_dummies + \beta_{12}\, Listing\_dummies + \beta_{13}\, Specialization\_dummies + \beta_{14}\, Accounting\_dummies + \varepsilon_{i,t} \quad (3)$$

The precise constructs of the variables analysed in the present work, along with data sources, are reported in the appendix (see Table A).

The descriptive statistics of the variables investigated are reported in Table 1 for the pre-crisis, crisis and post-crisis periods. We also ran a test for the Analyses of Variance (ANOVA test) for each variable considered.

Table 1.

Descriptive statistics of variables analysed in DDE (mean, standard deviation and one-way ANOVA test). Source: our elaborations on BankScope database.

Variable	**Pre-crisis**		**Crisis**		**Post-crisis**		**ANOVA test**
	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.	
D%DSTF	0.16	2.76	0.16	2.50	0.10	0.88	0.0024***
ZscoreB	205.46	679.67	171.20	615.62	287.90	1021.70	0.0000***
ZscoreCY	215.18	190.25	171.50	194.71	287.91	343.93	0.0000***
IL/GL	0.99	2.28	3.39	4.45	3.58	5.60	0.0000***
CF/A	11.87	10.37	11.42	9.26	11.78	9.07	0.0000***
LA/DSTF	16.46	33.31	17.08	32.52	16.45	33.26	0.0154*
NIR/A	3.34	1.25	3.14	3.29	2.97	1.32	0.0000***
NLA	19.01	1.74	19.26	1.77	19.43	1.76	0.0000***
RiskAdjPrem	0.74	0.44	0.75	0.43	0.76	0.43	0.0000***
ExAnteFund	0.88	0.33	0.90	0.30	0.90	0.30	0.0000***
AdmJoint	0.19	0.39	0.04	0.21	0.20	0.40	0.0000***
Country dummies	4.48	6.06	4.48	6.06	4.48	6.06	1.0000
Listing dummies	1.99	0.18	1.99	0.18	1.99	0.18	1.0000
Specialisation dummies	2.01	0.56	2.01	0.56	2.01	0.56	1.0000
Accounting dummies	3.16	1.14	3.16	1.14	3.16	1.14	1.0000

* = 10% level of significance; ** = 5% level of significance; *** = 1% level of significance.

D%DSTF is lower in the post-crisis period, amounting to 0.10 in the post-crisis period and 0.16 in both the pre-crisis and the crisis periods. The standard deviation of the ratio is greater in the pre-crisis period, and declines in the crisis and post-crisis periods.

The mean value of the banks' Z-score (ZscoreB) presents a U-shape: from a mean value of 205.46 in the pre-crisis period it declines to 171.20 in the crisis years and grows to 287.90 in the post-crisis years. In fact, the distances from failure for banks decline during the crisis and

[12] This was the case with Iceland in 2008, Ireland in 2010, and Cyprus in 2013 (Demirgüç-Kunt & Huizinga, 2013).

subsequently—because of regulatory interventions—become greater than the pre-crisis years. However, the standard deviation of the Z-score is greater for the post-crisis years, as a great variability emerges between stable banks and some cases of distressed situations.

Likewise, the mean of the Z-score indexes for country-year combinations (ZscoreCY) drops from 215.18 to 171.50 from the pre-crisis to crisis period, and rises to 287.91 in the post-crisis years. In addition, the standard deviation is greater in the post-crisis period.

The index IL/GL grows during the years analysed, from 0.99 in the pre-crisis period to 3.39 in the crisis period and 3.58 in the post-crisis period. It follows that there is growth in the amount of impaired loans on total bank loans in the whole period. Similarly, the standard deviation grows over the years.

The variable CF/A presents a drop during the crisis, declining from 11.87 in 2005–2007 to 11.42 in 2008–2012, whereas it rises during the post-crisis period, even remaining below the initial values (11.78). However, the variation of the capitalisation for banks measured by the standard deviation of capital funds on assets ratio declines from the pre-crisis period to the post-crisis period because of the bulk regulation that forces banks to maintain some fixed levels of capitalisation.

The index LA/DSTF exhibits an average value of 16.46 in the pre-crisis period, 17.08 in the crisis period and 16.45 in the post-crisis period. It is clear that to cope with the liquidity crisis banks increased their liquidity during the global financial crisis, and then returned to the initial value in the subsequent period. The standard deviation of the liquidity moves in the same way.

The profitability of banks declines over time in the period analysed; in effect, the mean value of NIR/A drops from 3.34 before the crisis to 3.14 during the crisis, and ends at 2.97 after the crisis.

The amount of total assets (in natural logarithm) remains stable in the years analysed, with values just above 19. Specifically, it grows from 19.01 through 19.26 to 19.43. The standard deviation of NLA is steady at around 1.75.

The variable RiskAdjPrem presents growth in the three periods analysed, as the number of countries adopting risk-adjusted insurance premiums mechanisms rise during and following the crisis (the dummy grows from 0.74 in the pre-crisis period to 0.75 in the crisis period, finally reaching 0.76 in the post-crisis period).

The crisis enhances the mean number of countries choosing an ex-ante funding mechanism: the value of ExAnteFund growths from the pre-crisis mean value of 0.88 to the mean value of 0.90 during the crisis. Further, this value remains stable at 0.90 during the post-crisis period.

A private or public administration of the guarantee fund in the DISs is preferred to a public-private joint administration during the crisis (the mean value of the dummy AdmJoint falls from 0.19 to 0.04). Also, public-private joint administration is reintroduced in the subsequent period (mean value of 0.20).

As they are worded, country dummies present the same mean and standard deviation in the three periods analysed. For the same reason, listing dummies, specialisation dummies and accounting dummies have peer average values and variations.

The per cent variation of deposits and short-term funding (D%DSTF) have different means between groups in the three periods analysed (confidence level of the ANOVA test of 0.0024***).

As emerges from the ANOVA test, all explanatory variables present different means between the three periods analysed. This implies that the variables present different

characteristics in the pre-crisis, crisis and post-crisis periods. All but the ratio LA/DSTF—for which the ANOVA test is significant at 0.0154* confidence level—present a significance of the test less than the 0.0001*** confidence level.

As expected, country dummies, listing dummies, specialisation dummies and accounting dummies are perfectly correlated (confidence level of the ANOVA test of 1.0000).

The number of banks and the number of observations of bank deposits for each country are presented in Table 2. The country with the highest number of banks is the US, with almost 6,500 banks and more than 62,000 observations of bank deposits variation, followed by Germany, which comprises around 1,500 banks and more than 14,000 observations of D%DSTF of the sample, then Italy, with around 500 sample banks and nearly 4,300 observations of the variation of deposits. The countries under-represented in the sample are the Slovak Republic with 11 banks and 85 related observations of variations of deposits, Ireland with 10 banks and 70 observations, and Greece with nine banks and 84 observations.

As reported in Table 2, no country presents a mean amount of D%DSTF lower than zero. That means that, despite the crisis, depositors continued to feel safe and, overall, increased their bank deposits. Surprisingly, the highest mean variation of deposits is exhibited by banks in the Czech Republic (+0.3168), followed by Belgium (+0.2460). It is not surprising to find the United Kingdom as the third highest country for deposit variation (+0.2201). On the other hand, the last three countries for the mean amount of D%DSTF are Germany (+0.0651), the Slovak Republic (+0.0634) and Portugal (+0.0543).

Table 2.

Number of banks, number of observations for deposits and mean per cent variation for deposits for each country analysed. Source: our elaboration on BankScope database.

Country	No. of banks	No. of observations	Mean D%DSTF
Australia	28	160	+0.1580
Austria	233	1,868	+0.1411
Belgium	32	267	+0.2460
Czech Rep.	19	158	+0.3168
Denmark	69	560	+0.0977
Finland	43	131	+0.0992
France	195	1,608	+0.1300
Germany	1,571	14,380	+0.0651
Greece	9	84	+0.1059
Hungary	22	164	+0.1476
Ireland	10	70	+0.1140
Italy	508	4,257	+0.1589
Luxembourg	62	483	+0.1663
Netherlands	29	208	+0.1502
Poland	39	281	+0.1799
Portugal	108	360	+0.0543
Slovak Republic	11	85	+0.0634
Slovenia	17	153	+0.0724
Spain	127	862	+0.1011
Sweden	78	635	+0.0990
United Kingdom	120	844	+0.2201
United States	6,424	62,086	+0.1689

Table 3 reports the mean amount of the Z-score index for each combination of country and year analysed in the present work. The table shows great variability between countries and years. However, it can be stated that the lowest amount of the Z-score—that corresponds to

the lowest distance for bank failure and consequently the highest bank risk—is, in general, displayed in the period from 2008 to 2010.

The banks in Australia present a lower Z-score for 2009 despite the country only experiencing marginal effects of the global financial crisis.[13] Additionally, the amount of the index is very low compared with the safest European countries; in any case, the Australian Z-score is one of the highest indexes in 2013.

Austrian banks experienced decreasing Z-scores from 2005 to 2009, then regained the initial values in subsequent years.

In Belgium, the Z-score index is always under 100. The lowest amount, equal to 27.87, is for 2008. The banks in Belgium increased their Z-score in subsequent years.

The Z-score for Czech banks in the period takes the form of a 'W', meaning that there was a rise in bank risk, a brief recovery for banks' safety, and a further increase in bank risk. In fact, the Z-score for banks in the Czech Republic decreases to one-third of the initial value from 2005 to 2009, reaching a peak in 2010 and going back down to the values of 2009 in 2013.

In Denmark, banks present a very low Z-score in 2008, equal to 16.51. After a period of alternating increases and decreases, the distance from the failure for Danish banks amounts to almost 85 in 2014.

The Z-score for banks located in Finland do not present a clear trend: it doubles in 2008, when other analysed countries were facing the most troublesome period of the global financial crisis; it drops in the subsequent two years, then grows again in the following two years, reaching the highest value for the period analysed, before decreasing again.

In France, the Z-score index is always around or above 100, denoting a low-risk picture for French banks. The highest value is reached in 2006.

Regarding the mean Z-score for banks in Germany, it was not unexpected considering the German financial stability expressed in this period that German banks present the greatest mean value for the Z-score index among the countries in the sample, and thus the lowest risk for each year analysed. The index reaches 10–20 times the value presented by other countries in the sample, showing the great reliability of German banks. At any rate, the Z-score marginally decreases until 2009 and then climbs in the succeeding years.

The Z-score for Greek banks in 2005 is one of the first six indexes in the countries analysed. Nevertheless, due to the effects of the global financial crisis, the sovereign debt crisis, economic recession and the liquidity emergency,[14] the distance from failure for banks in Greece declines to less than 3 in 2012. The last two years analysed show an increase in the Z-score index, although they remain the lowest values in the sample.

In Hungary, the Z-score reaches its lowest value in 2011. The value is not very high across the whole period.

A great decline in the Z-score emerges in Ireland until 2010: the index drops from nearly 140 in 2005 to less than 7 in 2010. After this point, the Z-score index for Irish banks rises.

It is important to highlight that Italian banks in 2005 are second only to German banks for banks' safeness and reliability. Moreover, due to a progressive decline in the subsequent period, the Z-score index in 2009 is collapsed to a tenth of the initial value. Later on, a growth in the Z-score emerges for banks in Italy in 2010/2012, and a brief fall in 2013 occurs, to end

[13] The Australian GDP growth (annual per cent) is positive for the whole period analysed (World Bank, 2016).

[14] In April 2010, a leading credit agency assigned Greek debt its lowest possible credit rating and, as Greek banks held a significant portion of sovereign debt, the banking system was adversely affected by the write down (Central Intelligence Agency World Factbook, 2015).

with a value that amounts to one-fourth the value of the index in 2005.

In Luxemburg, banks face two declining periods for the Z-score index: the first between 2007/2009, and the latter in the years 2012 and 2013. Moreover, the values taken do not seem to undermine the stability of the banking system, as they are over 50 and reach a final peak of nearly 150.

The situation is similar for banks in the Netherlands: there is a Z-score period of decline in 2007–2008, and in 2010. Likewise, the values of the Z-score do not seem to undermine the banking system's stability, as they are between 55 and 200.

The banks located in Poland present great variability in Z-scores between the years analysed. Following alternating periods of increase and decrease, the final value of the index is one of the highest, at above 100.

Portuguese banks dealt with three years of troubles due to a government crisis and the global financial crisis, impacting bank risk: 2005, 2008 and 2009. It is important to note that during the sovereign debt crisis the mean Z-score in Portugal is surprisingly high; this is mainly driven by a lean amount of data available for representing the whole banking system and the presence of some outliers.

The value of banks' Z-score in the Slovak Republic is between 155 (expressive of low risk) and 25 (expressive of high risk). The lowest value is reached in 2010, while the greatest value is reached in 2008, which was generally one of the most turbulent years of the global financial crisis.

As can be observed in Table 3, except in 2006, Slovenian banks do not show a high value for Z-score. The greatest bank risk emerges in 2013 (Z-score equal to 12.18).

The Z-score index for banks in Spain is among the highest analysed. This means that Spanish banks are considered safe and reliable. Nonetheless, in the last year analysed, the value of the Z-score falls to about a third of the previous year, almost equal to the lowest value—relative to 2010—shown across the period.

Swedish banks present a Z-score value lower than 50 in the period 2005–2010. Conversely, the value of the Z-score is higher in subsequent years.

The Z-score for banks in the United Kingdom faces a decline from 2007 to 2009. However, the value of the index for UK banks in 2014 is almost equal to the highest value exhibited in 2006.

Finally, in the US, banks experience a decreasing Z-score from 2005 to 2010 and a growing index from 2011 to 2014. The final value in 2014 is twice the crisis value in 2010.

Table 3.

Mean Z-Score index for each combination country-year analysed (ZscoreCY). Source: our elaboration on BankScope database.

Country/Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Australia	n.a.	72.66	271.25	80.23	35.55	74.29	65.88	85.13	210.05	167.85
Austria	226.50	191.21	173.60	114.54	58.97	158.59	257.58	120.85	183.37	269.50
Belgium	66.01	83.62	38.89	27.87	32.17	35.10	49.73	82.95	72.95	74.42
Czech Rep.	181.82	149.15	80.78	61.91	60.75	209.02	131.92	89.62	63.13	91.77
Denmark	59.60	62.68	67.66	16.51	74.93	58.42	50.29	51.13	54.14	84.14
Finland	53.29	73.36	47.22	108.60	49.35	35.44	75.27	267.75	108.23	94.20
France	121.54	289.92	212.20	100.88	113.91	121.19	146.84	97.57	143.63	125.62
Germany	577.26	708.18	574.58	421.66	407.18	503.60	708.16	857.01	1017.62	1,117.20
Greece	172.61	56.80	63.85	54.42	37.57	39.21	3.83	2.94	4.49	12.55
Hungary	38.13	48.55	51.96	45.05	22.88	24.65	21.87	34.15	43.00	27.08
Ireland	139.94	49.28	72.79	20.74	18.17	6.62	18.79	58.16	22.80	20.31
Italy	546.84	246.42	128.23	98.90	58.89	61.34	115.61	116.20	102.60	112.23
Luxembourg	97.06	130.85	85.53	84.15	56.51	77.62	99.33	79.54	58.46	143.44
Netherlands	65.05	116.71	84.36	67.25	114.27	55.28	70.23	72.47	98.62	194.76
Poland	47.91	116.40	51.93	40.88	56.59	63.04	110.54	76.53	98.62	107.30
Portugal	32.24	182.73	69.28	28.31	29.21	49.24	46.67	536.42	404.37	258.33
Slovak Republic	63.14	101.78	115.79	154.86	29.95	24.79	48.69	115.93	120.87	113.60
Slovenia	41.43	113.53	46.69	39.79	37.72	51.04	41.01	20.88	12.18	30.47
Spain	189.19	327.42	102.67	213.37	107.13	93.35	125.37	95.93	293.46	93.62
Sweden	38.86	38.25	48.19	27.25	33.87	36.89	127.03	89.74	159.91	90.11
United Kingdom	102.90	153.59	78.34	49.87	35.21	47.49	69.05	72.93	100.72	150.75
United States	129.79	121.65	120.16	93.69	76.31	77.00	99.94	114.08	124.31	148.76

Table 4 reports the values for the principal features of the DISs in the countries analysed for the three periods. Generally, the three DISs' observed features were introduced and/or eliminated in the period analysed. Among the countries that changed their DISs' features, the most-reliable country for Z-score index (Germany) and the riskiest country (Greece) are both included.

The risk-adjusted insurance premium mechanism was sometimes introduced and other times abolished in the crisis and post-crisis periods. Likewise, in the crisis and post-crisis periods there was sometimes a change in the authorities that administrate the fund. The ex-ante funding mechanism was introduced during the crisis and presented no changes in the subsequent period analysed.

Table 4.

DISs for each country analysed in the pre-crisis, crisis and post-crisis periods. Source: our elaboration on Demirgüç-Kunt, Karacaovali and Laeven (2005), Cihak, Demirgüç-Kunt, Martinez Peria and Mohseni-Cheraghlou (2012) and Demirgüç-Kunt, Kane and Laeven (2014).

Country	**RiskAdjPre**			**AdmJoint**			**ExAnteFund**		
	Pre-crisis	Crisis	Post-crisis	Pre-crisis	Crisis	Post-crisis	Pre-crisis	Crisis	Post-crisis
Australia	0	0	0	0	0	0	0	0	0
Austria	0	0	0	0	0	0	0	0	0
Belgium	0	1	0	1	1	1	1	1	1
Czech Rep.	0	0	0	0	1	1	1	1	1
Denmark	0	0	0	1	1	1	1	1	1
Finland	1	1	1	0	0	0	1	1	1
France	0	1	1	0	0	1	0	1	1
Germany	0	0	0	1	0	1	1	1	1
Greece	0	0	1	1	1	1	1	1	1
Hungary	1	1	1	1	1	1	1	1	1
Ireland	0	0	0	0	0	0	1	1	1
Italy	1	1	1	0	0	0	0	0	0
Luxembourg	0	0	0	0	0	0	0	0	0
Netherlands	0	0	0	0	0	0	0	0	0
Poland	0	0	0	1	1	0	1	1	1
Portugal	1	1	1	0	1	0	1	1	1
Slovak Republic	0	0	0	1	1	1	1	1	1
Slovenia	0	0	0	0	0	0	0	0	0
Spain	0	0	0	1	1	0	1	1	1
Sweden	1	0	1	0	0	0	1	1	1
United Kingdom	0	0	0	0	0	0	0	0	0
United States	1	1	1	0	0	0	1	1	1

4. Results

We now present and interpret estimation results for the DDE. Equation (3) provides a simple framework for estimating the relationship between market discipline, represented by the variation of deposits, DISs and bank risk. Essentially, the per cent variation of bank deposits gives us a signal of how the market disciplines the banks. Our empirical model was designed to capture the linear relationship between the above-mentioned factors in the pre-crisis, crisis and post-crisis periods.

Table 5 presents these coefficients and their corresponding statistical significance for the specification in Equation (3). Results are reported in column 2 for the pre-crisis period, column 3 for the crisis period and column 4 for the post-crisis period. We identify some significant influence coefficients (the analogues of α in Equation (1)). Therefore, the null hypothesis that all return coefficients are equal to zero is rejected.

Table 5.

Results for DDE. Random-effects GLS regression model for panel data, including 9,754 banks in 2005–2007 (pre-crisis), 2008–2012 (crisis) and 2013–2014 (post-crisis). Coefficients and p-values (p-values in brackets). Source: our elaborations on BankScope, Demirgüç-Kunt, Karacaovali and Laeven (2005), Cihak, Demirgüç-Kunt, Martinez Peria and Mohseni-Cheraghlou (2012) and Demirgüç-Kunt, Kane and Laeven (2014).

Variable	Pre-crisis	Crisis	Post-crisis
ZscoreB	−0.0002 (0.0390**)	0.0000 (0.0610*)	0.0000 (0.1040)
ZscoreCY	0.0073 (0.0000***)	−0.0008 (0.0070***)	0.0033 (0.0000***)
IL/GL	0.0344 (0.0340**)	−0.0079 (0.0000***)	−0.0082 (0.0000***)
CF/A	0.0738 (0.0000***)	0.0471 (0.0000***)	−0.0015 (0.0090***)
LA/DSTF	−0.0026 (0.1990)	−0.0035 (0.0000***)	0.0003 (0.0030***)
NIR/A	0.0491 (0.0790*)	−0.0427 (0.0000***)	0.0275 (0.0000***)
NLA	0.0609 (0.0190**)	0.0020 (0.8110)	0.0180 (0.0000***)
RiskAdjPrem	−0.4067 (0.7600)	0.2096 (0.6060)	−0.4570 (0.0000***)
ExAnteFund	1.0016 (0.5510)	−0.1066 (0.8230)	0.5661 (0.0000***)
AdmJoint	−3.6424 (0.0590*)	−0.1466 (0.6890)	0.6722 (0.0000***)
Country dummies	Yes	Yes	Yes
Listing dummies	Yes	Yes	Yes
Specialisation dummies	Yes	Yes	Yes
Accounting dummies	Yes	Yes	Yes
Intercept	−3.9061 (0.0050***)	−0.2581 (0.4730)	−0.9908 (0.0000***)
No. of obs.	18.275	34.402	14.584
No. of groups	6.322	7.867	7.767

* = 10% level of significance; ** = 5% level of significance; *** = 1% level of significance.

As emerges in column 2, in the pre-crisis period the regressor ZscoreB is statistically significant, with a negative coefficient of −0.0002 and a p-value of 0.0390**. In addition, the variable ZscoreCY is statistically significant (p-value < 0.0001***), with a positive coefficient (0.0073).

The ratio IL/GL is statistically significant with a positive coefficient of 0.0344 and a p-value of 0.0340**. In addition, the index CF/A presents a statistically significant coefficient (p-value < 0.0001***) and has a positive coefficient (0.0738). Further, the ratio NIR/A has a positive coefficient (0.0491) and a statistically significant value (p-value 0.0790*). The NLA presents a positive coefficient that amounts to 0.0609 and is statistically significant (p-value 0.0190**). Concerning the stability ratios, only LA/DSTF is not statistically significant in the pre-crisis period.

The dummy RiskAdjPrem for the presence of risk-adjusted premium mechanism is statistically insignificant; likewise, the dummy ExAnteFund for the existence of an insurance fund collected ex-ante does not present a statistically significant value either. Conversely, the dummy AdmJoint—for public and private administration of the insurance fund—is significant (p-value 0.0590*) with a negative coefficient (−3.6424).

Additionally, the intercept of the model is significant (coefficient −3.9061, p-value 0.0050***) and some control dummies, as well.

As reported in column 3, in the crisis period the Z-score for banks is positive and statistically significant (p-value 0.0610*); however, the coefficient is lower than 0.0001. Conversely, the mean Z-score for country-year combinations presents a negative coefficient equal to −0.0008 that is statistically significant (p-value 0.0070***).

The index IL/GL is statistically significant (p-value lower than 0.0001***), with a negative coefficient that amounts to −0.0079. In addition, the ratio CF/A is statistically significant (p-value < 0.0001***), although the coefficient is positive (0.0471). Further, the model provides statistical significance (with p-values lower than 0.0001***) for the indexes LA/DSTF and NIR/A, which present negative coefficients equal to −0.0035 and −0.0427, respectively. Conversely, the regressor NLA is not significant.

None of the variables related to DISs—RiskAdjPrem, ExAnteFund and AdmJoint—assumes a statistically significant value in the model in the crisis period. Instead, some control dummies are statistically significant. The intercept does not enter statistically significant value.

In the post-crisis regression (column 4), the variable ZscoreB is not statistically significant, while the regressor ZscoreCY is highly significant (p-value < 0.0001***), with a positive coefficient equal to 0.0033.

All stability indexes undertake significant values in this regression: IL/GL and CF/A both present negative coefficients, whereas LA/DSTF, NIR/A and NLA all have positive coefficients. Specifically, the index IL/GL has a coefficient equal to −0.0082 (p-value < 0.0001***); CF/A presents a coefficient that amounts to −0.0015 (p-value 0.0090***); LA/DSTF has a coefficient of 0.0003 (p-value 0.0030***); the coefficient for NIR/A is 0.0275 (p-value < 0.0001***); and NLA presents a coefficient that is equal to 0.0180 (p-value < 0.0001***).

Further, the dummies related to DISs are all highly significant, with a p-value lower than 0.0001***. It is important to note that the coefficients for all three specifications are, in absolute values, higher than the other regressors; hence, they have higher impacts.

The coefficient for the dummy RiskAdjPrem for the presence of risk-adjusted premium mechanism is negative (−0.4570); the dummy ExAnteFund for the existence of an insurance fund collected ex-ante presents a positive coefficient equal to 0.5661; the dummy AdmJoint for public and private administration of the insurance fund has a positive coefficient of 0.6722.

The model presents some control variables of statistical significance.

Finally, the constant of the model is statistically significant with a negative coefficient (coefficient −0.9908; p-value 0.0000***).

5. Conclusions

The increasing complexity of the financial environment entails difficulties for banking authorities to oversee banks based merely on prescribed rules. Consequently, regulators try to rely on depositors' capabilities to discipline banks. The behaviour of depositors is influenced by many features relating to the single bank, the specific DIS and the macroeconomic conditions in a certain period.

In the pre-crisis period of this study, the countries' risk, the banks' profitability and the banks' capitalisation were relevant for depositors' discipline, but there was adverse discipline on banks' asset quality and business risk. Depositors were also influenced by the banks' sizes: for banks considered too-big-to-fail, depositors did not exercise discipline at all. In addition,

the DISs did not influence depositors' confidence, and the same is true for banks' liquidity. Therefore, in this period depositors were, in general, not interested in how banks managed their risks, and moral hazard was not deterred by depositors' discipline.

Following the pre-crisis period, the crisis period made depositors feel unsafe. Consequently, depositors disciplined the banks' asset quality, the banks' capitalisation and the banks' liquidity, adversely disciplining the banks' profitability. Yet there was adverse discipline on the banks' business risk—both the bank-specific risk and the country-year risk. Again, in this period the DISs were not a determinant of market discipline. Moreover, the bank size was no longer relevant as a factor of safety; in fact, the paradigm 'too-big-to-fail' no longer applied. Compared with the previous period, it is important to note that depositors did not 'play' with the quality of the banks' assets—that is, there was no adverse discipline—but they did strictly evaluate them by exercising market discipline. The banks' liquidity—which was not considered a relevant issue in the pre-crisis period—was seriously disciplined by depositors in the crisis years. The need for more market discipline during the crisis years corresponded to an increase in the depositor's discipline.

In the post-crisis period, the sovereign debt crisis in some European countries made the countries' risk relevant for depositors, who exercised discipline. Some bailouts of important banks let depositors positively evaluate the banks' size. These will probably not be true in 2016 in the countries where the bail-ins have been implemented. The literature has recently suggested, as the opposite of the 'too-big-to-fail' effect, that depositors may discipline large banks more if they expect countries to have limited capacity to absorb their losses and if large banks become too big to save.

In the crisis period, the DISs started to become relevant in restoring depositors' confidence in the banking system. Not by chance, as a result of the crisis in many countries there have been some important changes in the main features of their DISs. Our results confirm that these changes have moved in the right direction, restoring depositors' confidence. Further, depositors do discipline banks' stability in terms of liquidity, asset quality and profitability; the latter was not considered relevant during the (liquidity) crisis years but became relevant in the post-crisis years as the changes in the environment eroded the banks' margins. Conversely, depositors' discipline on banks' capitalisation was adverse. This is most likely because the more stringent capital requirements were something that banks could not choose—it was compulsory and tended to be uniform through the banking system.

Overall, in the pre-crisis period depositors felt safe and their discipline was restricted to a few features of risk, and thus some situations of moral hazard emerged. Subsequently, the crisis diminished feelings of safeness for depositors and pushed them to discipline banks. In the post-crisis years, the objectives of depositors' discipline changed significantly and the interventions by the authorities proved to be correctly acknowledged by depositors.

Limitations and directions for further research

It is possible to augment this work by including a larger sample of countries and banks. We also suggest studying the DDE, considering only unsecured deposits. Further, it would be interesting to analyse other measures of bank risk and discipline. Another step is to apply other methodologies to the current research.

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Any errors and opinions expressed in this paper are exclusively the authors' responsibility.