Banking regulation and banks' risk-taking behavior: The role of investors' protection[1]

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Abstract

This paper examines whether the influence of banking regulation on banks' risk is channeled through the level of investors' protection, using panel data from a sample of 535 banks from OECD countries, for the 2004–2016 period. As banking regulatory factors, we consider activity restrictions, capital stringency and supervisory power. We find that the overall effect of banking regulation on banks' risk is conditional on the level of investors' protection, with investor protection playing the role of reinforcing each of these individual effects. Investor protection reinforces the positive effect of activity restrictions and capital stringency on banks' risk and also reinforces the negative effect of supervisory power on this risk. These results are robust to a different estimation method and a different proxy for banks' risk. Additional robustness tests reveal that some of the banking regulation effects are contingent on banks' size and the systemic banking crisis period.

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1. Introduction

The international financial system faced profound and structural reforms after the 2008-09 global financial crisis. The banking industry was one of the most affected with this new regulatory environment, especially in what concerns banks' risk. The existing literature shows that, in addition to banking regulation, the level of investors' protection is also a determinant of banks' risk-taking behaviour. Going one step further, this paper focus on how the protection of investors' rights (shareholders' and creditors' protection) shape the effect of banking regulation on banks' risk.

Following this context, there is an extant literature studying the effect of several regulatory adjustments on banks' risk, namely restrictions on banks' activities, capital stringency and supervisory power, with mixed empirical evidence. For instance, while Barth et al. (2004), Laeven and Levine (2009), Ashraf (2017), Wu et al. (2017, 2019), Li (2019), Danisman and Demirel (2019) and Al-Shboul et al. (2020) show that financial systems become less stable in the presence of more restrictions on banks' activities, Fernandez and Gonzalez (2005), Pasiouras et al. (2006), Agoraki et al. (2011), Wang and Sui (2019) and Teixeira et al. (2020a) find a negative relationship between activity restrictions and banks' risk. Regarding capital stringency, Besanko and Kanatas (1996), Blum (1999), Calem and Rob (1999), Ashraf (2017), Li (2019) and Al-Shboul et al. (2020) reveal evidence that banks' risk increases as the regulatory capital becomes more stringent. On the contrary, Barth et al. (2004), Beltratti and Stulz (2012), Agoraki et al. (2011), Wu et al. (2017, 2019) and Danisman and Demirel (2019) argue that capital stringency has a negative effect on banks' risk. Finally, Stigler (1971), Anginer et al. (2014), Garcia-Kuhnert et al. (2015), Mohsni and Otchere (2018), Clark et al. (2018) and Al-Shboul et al. (2020) show that banks become less stable as the supervisory power of authorities increases, while Wu et al. (2017, 2019) and Danisman and Demirel (2019) argue that banks' risk increases as the power given to supervisory authorities also increases.

Another strand of the literature studies the effect of the institutional environment, namely the level of investors' protection (shareholders' and creditors' protection) on banks' risk, following the foundations of the law and finance literature (La Porta et al., 1998). On the one hand, Laeven and Levine (2009) argue that banks assume more risks when shareholders benefit from a higher level of protection. On the other hand, there is a mixed evidence regarding the effect that creditors' protection has on banks' risk. While Acharya et al. (2011) document that firms' risk-taking is reduced when creditors' rights are stronger, Fang et al. (2014) find that banks stability increases as creditors' rights become stronger.

The study of the direct effect of banking regulation and investors' protection on banks' risk-taking behavior, as discussed above, is then complemented with another strand of literature that recognizes the existence of important channels through which banking regulation influences risk: market power (Agoraki et al., 2011, and Danisman and Demirel, 2019); deposit insurance (Ashraf et al., 2020), banks' ownership (Laeven and Levine, 2009, and Boubakri et al., 2020), financial transparency (Houston et al., 2010) and political institutions (Dutra et al. 2020).

This literature lacks, however, on providing a comprehensive investigation on whether investors' protection plays a role on shaping the effect of banking regulation on banks' risk. Although Teixeira et al. (2020a) provide some hints on this interplay, we believe this topic deserves further investigation. It is important to further examine the possible reinforcing or mitigating effect of investors' protection when analyzing the effect of restrictions on banks' activities, capital stringency and supervisory power on banks' risk-taking behavior. We aim to fill this gap in the literature.

Based on a sample of 535 banks from Organisation for Economic Co-operation and Development (OECD) countries for the period of 2004-2016, we find that while activity restrictions and stricter capital stringency tend to increase banks' risk, more supervisory power

tends to reduce this risk. Furthermore, we conclude that banks' risk increases in countries with high levels of shareholders' protection and decreases in countries with high levels of creditors' rights. Regarding the interplay between banking regulation, investors' protection and banks' risk, we find that investors' protection (shareholders' rights and creditors' rights) reinforces both the positive effect of activity restrictions and capital stringency on banks' risk and the negative effect of supervisory power on banks' risk.

These results are robust to a different estimation method and a different proxy for banks' risk. Further analysis reveals that the effect of banking regulation on banks' risk is contingent on banks' size and the systemic banking crisis reinforces (mitigates) the positive (negative) effect of regulation on banks' risk.

This study contributes to the literature in at least four important ways. First, we add to the literature that considers important channels through which banking regulation (activity restrictions, capital stringency and supervisory power) affects banks' risk. We document that investors' protection reinforces the effect of banking regulation on banks' risk. Second, we contribute to the law and finance literature by providing further evidence of the direct effect of banking and investors' protection on banks' risk. Third, we contribute to the existing literature on the determinants of banks' risk, as Laeven and Levine (2009), Houston et al. (2010), Anginer et al. (2014), Haq et al. (2014), Fang et al. (2014), Luo et al. (2016), Ashraf (2017), Wang and Sui (2019), Teixeira et al. (2020a) and Dutra et al. (2020). Finally, we perform additional tests to understand how the effect of banking regulation through investors' protection on banks' risk changes during the systemic banking crisis period and whether this effect is different for larger banks compared to smaller ones.

The remainder of the paper is structured as follows. Section 2 presents the various channels through which banking regulation and investors' protection influence banks' risk. Section 3 describes the data, sample and variables and explains the empirical analysis. Section

4 displays the empirical results and the robustness checks. Section 5 presents the concluding remarks.

2. Literature review and hypotheses development

2.1. The effect of banking regulation on banks' risk-taking behavior

2.1.1. Activity restrictions and banks' risk

According to Barth et al. (2004), the economic theory provides mixed predictions about the relationship between the restrictions on banks' activities and their risk. For instance, Hellmann et al. (2000) and Gonzalez (2005) claim that as the restrictions on banks' activities increase, they lose profitability, making pressure on banks' managers to invest on risky projects. Moreover, banks are able to diversify their sources of income and reduce their risk when facing less activity restrictions. This means that, under this view, banks' risk increases for higher levels of activity restrictions. By contrast, Boyd et al. (1998) argue that when banks are allowed to engage in more activities, they have naturally more opportunities to take risk. Due to moral hazard problems, the effect of less activity restrictions on increasing banks' risk is magnified. According to this theory, banks' risk should decrease for higher levels of activity restrictions.

The empirical evidence that relates activity restrictions and banks' risk supports both effects (positive and negative). While Barth et al. (2004), Laeven and Levine (2009), Li (2019), Ashraf (2017), Wu et al. (2017, 2019), Danisman and Demirel (2019) and Al-Shboul et al. (2020) document that financial systems become less stable in the presence of more restrictions on banks' activities, Fernandez and Gonzalez (2005), Pasiouras et al. (2006), Agoraki et al. (2011), Wang and Sui (2019) and Teixeira et al. (2020a) provide evidence that as activity restrictions increase, banks' risk decreases.

Based on the above arguments, we test the following hypothesis:

H1: Activity restrictions have a positive or negative effect on banks' risk.

2.1.2. Capital stringency and banks' risk

As reviewed by Santos (2001), the economic also provides conflicting predictions about the relationship between capital stringency and banks' risk. On the one hand, Dewatripont and Tirole (1994) posit that the effect of capital stringency on banks' risk is negative since with higher regulatory capital requirements banks are more comfortable and solid, with a greater buffer against losses, which contributes to reduce their risk. Moreover, the propensity of banks to engage in new and riskier investments is lower if they have to fulfill higher levels of capital requirements. On the other hand, Koehn and Santomero (1980), Kim and Santomero (1988) and Blum (1999) argue that capital stringency has a positive effect on banks' risk. If the cost of fulfilling higher capital requirements is high, banks are forced to invest on risky projects today in order to increase their profitability.

There is empirical evidence aligned with both these theoretical effects of capital stringency on banks' risk. While Besanko and Kanatas (1996), Blum (1999), Calem and Rob (1999), Ashraf (2017), Li (2019) and Al-Shboul et al. (2020) find evidence of a positive effect of capital stringency on banks' risk, Barth et al. (2004), Agoraki et al. (2011), Beltratti and Stulz (2012), Wu et al. (2017, 2019), Danisman and Demirel (2019) and Teixeira et al. (2020a) show that higher capital requirements decrease banks' risk.

Considering this exposition, we test the following hypothesis:

H2: Capital stringency has a positive or negative effect on banks' risk.

2.1.3. Supervisory power and banks' risk

As pointed out by Barth et al. (2004), the supervisory power is given by the power that supervisory authorities have over banks, namely on controlling their activity and restricting their risk-taking decisions if needed. On this dimension of banking regulation, two theoretical

views on the effect of supervisory power on banks' risk are presented by the literature: the private interest and the public interest view. Boot and Thakor (1993) and Quintyn and Taylor (2002) argue that supervisory agents may not have the right incentives when performing their duty. When facing the wrong incentives, such as using their power to maximize their own welfare instead of correctly supervising banks, supervisory agents tend to make mistakes and take bad decisions, leading to corruption, reduced banks' efficiency and, consequently, increased banks' risk. Under this view, banks' risk increases as supervisory power increases. Conversely, the public interest view, aligned with Stigler (1971) and Barth et al. (2004), states that supervisory power leads to the improvement of the banking system and to the correction of banking market failures, like information asymmetry. In this case, banks' risk is lower as more power is given to the supervisory authorities.

Given these two distinct views, there is empirical evidence supporting both a negative and a positive effect of supervisory power on banks' risk. On the one hand, Pasiouras et al. (2009), Wu et al. (2017, 2019) and Danisman and Demirel (2019) find that strong supervisory power encourages excessive banks' risk-taking. On the other hand, Anginer et al. (2014), Garcia-Kuhnert et al. (2015), Mohsni and Otchere (2018), Clark et al. (2018) and Al-Shboul et al. (2020) show that greater supervisory power decreases banks' risk.

Therefore, we test the following hypothesis:

H3: Supervisory power has a positive or negative effect on banks' risk.

2.2. The effect of shareholders' and creditors' protection on banks' risk

The law and finance literature, which grew out of the seminal work of La Porta et al. (1997, 1998), had demonstrated that differences in the legal protection of investors (shareholders' and creditors' rights) are important for the financial development of a country through better contracting and enforcement mechanisms. Following this literature, several

studies have related investors' protection to bank risk-tasking behavior. Consistent with this view, we conjecture that the degree of protection of shareholders' and creditors' rights may play an important role in determining bank risk-taking behavior through different channels.

The economic theory suggests a positive effect of shareholder protection on banks' risk based on the argument that the amount of corporate resources diverted by corporate insiders or executives on a firm is reduced with better investors' protection (Shleifer and Wolfenzon, 2002). The executives of a firm may choose to pursue their self-interest, possibly by diverting corporate resources for personal benefits, at the expense of shareholders. Given that the amount of cash flow diversion is reduced when a company's cash flow is low, executives may even avoid some value-enhancing risky projects as a way to preserve their private benefits. Nevertheless, the amount of corporate resources diverted depends on the level of shareholders' protection, as a smaller diversion is expected with stronger investors' protection. Thus, with stronger shareholder protection the executives tend to make investment choices closer to the optimal choices. Supporting this theory, studying nonfinancial firms, John et al. (2008) find a positive association between shareholder protection and managers' incentives to undertake riskier but possibly more value-enhancing investments, while, for banks, Laeven and Levine (2009) show that banks with more powerful shareholders have a tendency to undertake more risks.

Concerning the effect of creditors' protection (rights) on banks' risk-taking behavior, there are at least two opposite channels discussed in the literature. On the one hand, Acharya et al. (2011) propose a "dark side" to stronger creditors' rights, whereby these rights lead managers to reduce corporate risk-taking. This theory posits that with stronger creditors' rights there is a higher chance for the lender to grab collateral or force repayment of the debtor that is in financial distress or even to force changes in the management of the debtor during a reorganization process, suggesting that borrowers are less willing to take risks when creditors

are better protected. For nonfinancial firms, Acharya et al. (2011) provide consistent international empirical evidence supporting this theory. As for banks, the theory is supported by the empirical evidence of Fang et al. (2014), who find that strengthened creditors' rights are likely to promote a higher degree of banking stability, Cole and Turk-Ariss (2018), who document that banks reduce their loan positions and consequently take on less risk when creditors' rights are stronger, and Biswas (2019), who show empirical evidence that stronger creditors' rights enhance bank stability, through the market power channel. On the other hand, the "bright side" literature, proposed by Houston et al. (2010), argues that strengthened creditors' rights can enhance greater bank risk, as stronger legal protections foster the confidence to lend to risky enterprises with poorer credit ratings. This relation finds support in the empirical evidence of Houston et al. (2010) and Teixeira et al. (2020a).

Based on the above arguments, we expect a positive relation between the level of shareholders' protection and banks' risk, and an either positive or negative relation between the level of creditors' protection and banks' risk.

Therefore, the following hypotheses are tested:

H4: The level of shareholders' protection has a positive or negative effect on banks' risk.

H5: The level of creditors' protection has a positive or negative effect on banks' risk.

2.3. The interplay between banking regulation and investors' protection

As stated by Fang et al. (2014), the way banks disclosure their financial information (transparency), monitor their borrowers' management, evaluate the risk of their clients, and so on, is conditional on the institutional environment where they operate. One strand of the institutional environment is the level of protection that investors (shareholders and creditors) benefit in each country, meaning that the effect of banking regulation reforms on banks' risk

may be conditional on the level of investors' protection, namely shareholders' and creditors' protection. In fact, although Teixeira et al. (2020a) document the importance of investors' protection on the bank regulation-risk channel, it is still pertinent to investigate whether investors' protection have a reinforcing or a mitigating effect on the overall effect that each banking regulation factor has on banks' risk.

The economic theory supports both effects (reinforcing and mitigating). On the one hand, a strand of the literature (e.g. Fang et al., 2014) defends that good institutional environments motivates financial stability and, consequently, a reduction on banks' risk. Since higher levels of investors' protection is perceived to contribute to better institutional environments, if banking regulation is efficient in reducing banks' risk, higher levels of investors' protection will reinforce this effect. Inversely, if banking regulation increases the risk of banks, the level of investors' protection is expected to mitigate this effect. On the other hand, high levels of investors' protection may be a limited downside of shareholders and creditors, motivating overconfidence and a willing to invest in riskier projects. Therefore, if the banking regulation in a specific country is being efficient in reducing banks' risk, this effect may become less efficient if the level of investors' protection on that country increases. In other words, shareholders' and creditors' protection may mitigate the negative effect of banking regulation on banks' risk. On the other side, if banking regulation is motivating an increase in banks' risk, this effect may be reinforced in environments of strongly protected investors.

To summarize, we test the following hypotheses:

H6: The effect of banking regulation on banks' risk is reinforced or mitigated by the level of shareholders' protection.

H7: The effect of banking regulation on banks' risk is reinforced or mitigated by the level of creditors' protection.

3. Data and methodology

3.1. Data and sample

The sample is organized in an unbalanced panel data since not all banks were active for the sample period. It is composed by 535 publicly traded commercial banks and bank-holding companies from OECD countries over the period 2004-2016. Banks with negative equity were excluded in the corresponding year. To ensure that results are not driven by outliers, we winsorize all bank-level variables at the 1% and 99% levels.

Different sources of data are used to build our sample. Banks' accounting data is obtained from the Bureau van Dijk's Bankscope database, which provides information in a standardized format, allowing comparisons between banks from different countries (Pasiouras et al., 2006). For this reason, this database is widely used in banking related literature (Gropp and Heider, 2010; Ashraf, 2017; Wang and Sui, 2019; among others). Banks' historical stock prices are from Thompson Reuters Datastream, while external and macroeconomic data comes from the OECD database, World Development Indicators (WDI) of World Bank and International Monetary Fund (IMF)'s World Economic Outlook database. Data for the quality of political institutions, measured by the democratic accountability variable (Dutra et al., 2020), is collected from the International Country Risk Guide (ICRG). Systemic banking crises data is collected from Leaven and Valencia (2018). We gather the data for the three banking regulation variables (activity restrictions, capital stringency and supervisory power), from the World Bank's Bank Regulation and Supervision Survey (BRSS). This banking regulation data is based on surveys conducted by Barth et al. (2008, 2013) and Anginer et al. (2019). They require information on how banks are regulated and supervised around the world, providing a unique source of comparable economy-level data. As in Ashraf (2017) and Wang and Sui (2019), the results from the survey conducted by Barth et al. (2008) in 2007 and by Barth et al. (2013) in 2012 are considered for the periods 2004-2007 and 2008-2011, respectively. For the

period 2012-2016, we consider the results from Anginer et al. (2019)'s survey conducted in 2019. Finally, the source of investors' protection variables is the World Bank's Doing Business Data Set and are described and explained in Caprio et al. (2007).

3.2. Model specification, variables and descriptive statistics

3.2.1. Estimation model

The model to empirically estimate the determinants of banks' risk follows the basic risk model of Lee et al. (2014), Pascual et al. (2015) and Dutra et al. (2020), where the dependent variable is a function of bank-specific, macroeconomic and external variables. As in Dutra et al. (2020), we add to the model extra variables related to our research focus, namely banking regulation and investors' protection variables.

The model is described as follows:

$$\begin{aligned} Risk_{i,j,t} = {} & \beta_0 + \beta_1 Risk_{i,t-1} + \beta_2 BankSpecific_{i,t} + \beta_3 External_{j,t} \\ & + \beta_4 BankingRegul_{j,t} + \beta_5 InvestProtect_{j,t} \\ & + \beta_6 (BankingRegul \times InvestProtect)_{j,t} + Year_t + \varepsilon_{i,j,t}, \end{aligned} \quad (1)$$

where i, j, t stand for bank i, in country j at year t. $Risk$ is the bank's risk measure and $BankSpecific$ is the vector of bank-specific variables. $External$ is the vector of macroeconomic and external variables. $BankingRegul$ is the vector of banking regulation variables, while $InvestProtect$ stands for the vector of investors' protection variables. The interaction between both variables is represented by the $(BankingRegul \times InvestProtect)$ term. To guarantee robustness (Baltagi, 2001) and capture the influence of aggregate (time-series) trends, time dummies ($Year$) are included in the model, as in Ashraff (2018), Alraheb et al. (2019) and Rezgallah (2019). The stochastic error is represented by ε.

We use a dynamic model with the one-period lagged value of the dependent variable as an explanatory variable because, as shown by Delis and Kouretas (2011), Louzis et al. (2012),

Castro (2013) and Pascual et al. (2015), banks' risk tends to persist over time due to sensitivity to macroeconomic shocks and informational opacity.

The $(BankingRegul \times InvestProtect)$ term incorporates a total of six interactions, since there are three banking regulation variables (activity restriction, capital stringency and supervisory power) and two investors' protection variables (shareholders' and creditors' protection/rights). These interaction terms capture the nonlinear effect of banking regulation on banks' risk through investors' protection. The overall effect of banking regulation on banks' risk is given by the sum of its individual effect and the indirect effect through the interaction term with investors' protection. This overall effect (individual + indirect) might be positive and/or negative, depending on the level of investors' protection, which influences the indirect effect (interaction term).

The overall effect of banking regulation on banks' risk is given by the following equation:

$$\frac{\partial Risk_{i,j,t}}{\partial BankingRegul_{j,t,m}} = \beta_{4,m} + \beta_{6,m,n} InvestProtect_{j,t,n}, \qquad (2)$$

where m equals 1, 2 or 3 if the banking regulatory variable is activity restriction, capital stringency and supervisory power, respectively. The parameter n takes the value of 1 or 2 depending on whether the investors' protection variable is shareholders' protection or creditors' protection.

The individual effect of banking regulation on banks' risk is given by the coefficient estimate β_4, while the indirect effect is given by the coefficient and interaction estimate β_6, conditional on the value of $InvestProtect$. Depending on the magnitude and sign of β_4 and β_6 and on the range of $InvestProtect$, the overall effect of banking regulation on banks' risk, *i.e.* $(\beta_{4,m} + \beta_{6,m,n} InvestProtect_{j,t,n})$, may be positive and/or negative.

The model is estimated using a two-step System Generalized Method of Moments (System GMM), suggested by Arellano and Bover (1995) and Blundell and Bond (1998), following recent studies by Liu et al. (2015), Alessandri and Nelson (2015), Luo et al. (2016), Borio et al. (2017), Quian et al. (2019) and Stef and Dimelis (2020). This estimation method is advisable for panel data sets with a small time dimension and a large number of countries (Roodman, 2009), as in our study. Also, this model is particularly well suited to handle autocorrelation and heterogeneity in panel data, the inconsistency caused by endogeneity, as well as in dealing with the bias produced by omitted variables in cross-sectional estimations (Bond et al., 2001). Furthermore, the system GMM provides stronger instruments and outperforms the Standard/Difference-GMM from Arellano and Bover (1995), according to Blundell and Bond (1998).[2]

For the system GMM estimation method, exogenous and endogenous variables have to be identified. This identification is driven by the existing literature and economic theory. If a variable x is correlated with past, contemporaneous or future error terms, then it should be considered endogenous. Instead, a variable x should be considered exogenous if it is uncorrelated with the error terms. Therefore, all the macroeconomic and external variables (vector $External$) of our sample are considered exogenous (as well as the time dummy variable) and all the other variables of our sample (the lag value of banks' risk, the bank-specific variables, the banking regulation and the investors' protection variables) are considered endogenous.

The system GMM estimation has two main concerns known as the proliferation of instruments and the serial autocorrelation of errors. Therefore, two diagnostic tests are executed to check the fitness of the estimated model. The first one is the Hansen test which tests if all

[2] In dynamic panel data models, the probability of the lagged dependent variable being correlated with the error term is high, which means that the strict exogeneity assumption may be violated. Then, methods such as OLS, Random Effects and/or Fixed Effects give inconsistent and biased estimations.

instruments are jointly exogenous, *i.e.*, the instruments used are not correlated with residuals. This null hypothesis should not be rejected. The second diagnostic test is the Arellano and Bond (1991) test for the second-order serial correlation in the error term, known as AR(2) test. The null hypothesis reflects the absence of the second-order serial correlation and should not be rejected.

3.2.2. Risk, banking regulation and investors' protection variables

Following Gropp and Heider (2010), Teixeira et al. (2014) and Teixeira et al. (2020a), we measure banks' risk by the standard deviation of asset returns, computed as the annualized standard deviation of daily stock price returns times the market value of equity, divided by the market value of the bank. This is a market-based measure instead of an accounting-based one, which means that it incorporates information of the banks' stock price volatility and, therefore, captures the total risk of the bank: idiosyncratic and market risk. There are alternative measures of banks' risk in the literature. For instance, Agoraki et al. (2011) and Danisman and Demirel (2019) use the non-performing loans, Laeven and Levine (2009), Houston et al. (2010), Ashraf (2017), Biswas (2019), Li (2019) and Ashraf et al. (2020) use the Z-score and Schuermann and Stiroh (2006) use banks' beta. To verify the robustness of our results, we decide to use the Z-score variable as an alternative measure of banks' risk. The results are analyzed in the robustness tests' section.

Regarding banking regulation, we use the well-known indices from BRSS dataset that are commonly used to capture information about banks' activity restrictions, banks' capital stringency and the power of supervisory agencies over banks in a specific country.

The overall restrictiveness index from the BRSS database is used as a measure for the restrictions on banks' activities, as in Wu et al. (2017, 2019), Danisman and Demirel (2019), Li (2019), Ashraf et. al (2020), Teixeira et al. (2020a) and Al-Shboul et al. (2020). This index

assumes values between 4 and 16 as a result from the sum of four different sub-indexes. Each sub-index takes values between 1 and 4, measuring how restrictive a bank is to operate in the respective activity: insurance (e.g., insurance underwriting and selling), securities market (e.g., underwriting, brokering, dealing, and all aspects of the mutual fund industry), real estate (e.g., real estate investment, development, and management) and owning non-financial firms.

The sum of the initial capital stringency index and the overall capital stringency index is used as a measure of banks' capital stringency, following Wu et al. (2017, 2019), Danisman and Demirel (2019), Li (2019), Ashraf et. al (2020), Teixeira et al. (2020a) and Al-Shboul et al. (2020). On the one hand, the initial capital stringency index provides information on whether the regulatory capital of banks can include assets other than cash, government securities, or borrowed funds, and whether the authorities verify the sources of these funds. One the other hand, the overall capital stringency index provides information on whether banks' regulatory capital incorporates certain risk elements, such as credit and market risks, and whether the calculation of the minimum amount of capital (regulatory capital requirements) considers or not certain market losses. In sum, the measure used for capital requirements takes into account not only the minimum capital that a bank should maintain (regulatory capital requirement), but also the regulatory requirements on the various components of this capital (nature and sources). It ranges from 0 to 10, with higher scores indicating greater capital stringency.

Finally, the supervisory power index of the BRSS is used to measure the power of supervisory agencies over banks, following Wu et al. (2017, 2019), Danisman and Demirel (2019) and Al-Shboul et al. (2020). It reflects the rights of supervisory agents to meet with auditors, demand information, and take legal action against them; to force a bank to change its internal organizational structure, management and/or directors; to oblige the bank to provision against potential losses and suspend dividends, bonuses, and management fees; and to supersede the rights of shareholders and intervene in a bank and/or declare a bank insolvent.

Overall, it reflects the authorities' supervisory power to take actions in order to prevent and correct inefficiencies in the banking industry, even against banks' decisions. Higher values of this index indicate more powerful supervisors, ranging from 0 to 14.

The investors' protection variables are proxied by two indexes from the World Bank Doing Business Data Set, as in Caprio et al. (2007) and Teixeira et al. (2020a). The shareholders' rights variable is proxied by the score-ease of shareholders suits index, while the creditors' rights variable is proxied by the score-strength of legal rights index. The former index measures how likely shareholders plaintiffs are to access internal corporate evidence and recover legal expenses, ranging on a scale from 0 to 100, where 0 represents the worst regulatory performance and 100 the best regulatory performance, *i.e.*, stronger shareholders' rights and protection. The latter index measures whether certain features that facilitate lending exist within the applicable collateral and bankruptcy laws, also ranging on a scale from 0 to 100, where 0 represents the worst regulatory performance and 100 the best regulatory performance, *i.e.*, stronger creditors' rights and protection.

3.2.3. Control variables

A set of bank-specific, macroeconomic and external variables are identified by the banking literature as determinants of banks' risk. We follow this literature, in particular Laeven and Levine (2009), Albertazzi and Gambacorta (2009), Pascual et al. (2015), Ashraf (2017), Wand and Sui (2019), Teixeira et al. (2020a), among others, in order to identify the controls variables of the risk model.

The bank-level factors that are included in our model to control for bank-specific characteristics are Leverage, Size, Profitability, Operational Efficiency (inverse of Cost-Income ratio), Credit Risk (inverse of Credit Quality), Income Diversity and Asset Diversity.

Even though most of the literature on banks' risk has identified these factors as statistically significant in explaining banks' risk-taking behavior, due to the differences in datasets, countries and time periods, their results on the sign of these effects are mixed.

Starting with leverage, the empirical results from the existing literature are mixed. Some authors, as Biase and Apolito (2012), argue that higher levels of debt are associated with more volatility of banks' profitability, higher default probability and, consequently, more risk. Other authors, like Mercieca et al. (2007) and Uhde and Heimeshoff (2009), show that banks feel more comfortable to take riskier investments when their capital ratios are high.

Regarding size, the empirical literature also finds mixed results. On the one hand, due to the "too big to fail" hypothesis (which provides extra government guarantees), larger banks have a greater competitive advantage compared to smaller banks (Pascual et al., 2015; Biase and Apolito, 2015). Moreover, larger banks have access to better funding sources and diversified investment channels (Afonso et al., 2014). On the other hand, banks of greater dimension are naturally more exposed to market deteriorations, assuming more risk (Jonghe, 2009; Altunbas et al., 2011).

In what concerns profitability, its effect on banks' risk is negative, as shown by most of the existing literature, as Biase and Apolito (2012) and Pascual et al. (2015), who argue that profits make banks more prepared to face unexpected events and market deteriorations.

The operational efficiency tends to have a positive effect on bank's risk. This variable is measured by the inverse of the cost-to-income ratio. Banks with low cost-to-income ratios, *i.e.*, with high operational efficiency, become more optimistic and less risk averse, assuming risky investments. Consequently, and as shown by Louzis et al. (2012), Pascual et al. (2015) and Wand and Sui (2019), greater cost-to-income ratios/lower operational efficiency have a negative effect on banks' risk.

Regarding the credit quality of banks, it is measured by the inverse of credit risk. Credit risk is proxied by the ratio of provisions for loan loss to total loans, where higher values of this ratio stand for lower credit quality. Intuitively, higher values of credit quality (lower values of the variable credit risk) represent a decrease in banks' risk (Lee et al., 2014).

The last two bank-level variables considered in our study are related to the bank's business model, which are proxied by the income and asset diversity variables (Luo et al, 2016). The former measures the diversification across different sources of income, while the latter measures the diversification across different types of assets. These two diversification effects on banks' risk can be mixed, according to the existing literature. While the portfolio theory states that diversifying the sources of revenue allow firms to reduce their risk (Demirguç-Kunt and Huizinga, 2010; Biase and Apolito, 2012), this diversification may provoke a focus dispersion of firms on their core activity, leading to unstable and inefficient financial systems (in the case of banks).

The macroeconomic and external factors included in our model as control variables are the GDP growth, the inflation rate, the level of interest rates, the slope of interest rates, the quality of political institutions, the market concentration and the systemic banking crisis period.

Starting with GDP growth, it captures the effect of business cycles on banks' risk. An increase in banks' risk happens if a country is not growing in what concerns GDP, as shown by most of the literature, like Albertazzi and Gambacorta (2009) and Pascual et al. (2015). Negative values of GDP growth lead to the deterioration of economic conditions and environment, affecting the loan quality and promoting credit losses and reduced profits.

The level of inflation is also recognized by the existing literature as an important determinant of banks' risk, with mixed effects. For instance, Uhde and Heimeshoff (2009) argue that the effect of inflation on banks' risk-taking behavior depends on how banks pass this inflation to its customers and whether they were expecting it or not. Caglayan and Xu (2016)

show evidence that the allocation of bank loans and therefore its risk are affected by inflation volatility, regardless of inflation being positive or negative. Other authors like Teixeira et al. (2020a) provide empirical evidence of a negative relationship between inflation and banks' risk.

Regarding the level of interest rates, the existing literature show mixed empirical evidence of its effect on banks' risk. On the one hand, banks' value is higher in low interest rates' environments, meaning that they prefer to avoid too much risk in order to preserve its value (Gizycki, 2001). On the other hand, when interest rates are low banks tend to make risky investments in order to obtain higher yields (Castro, 2013).

The last macroeconomic variable included in our model is the slope of interest rates. Even though the existing literature about the effect of this variable on banks' risk is scarce, Foos et al. (2017) and Teixeira et al. (2020a) show that banks' risk tends to increase as the yield curve gets steeper, although this effect is conditional on other bank-level characteristics.

According to Dutra et al. (2020), the quality of political institutions is statistically significant in explaining banks' risk. Therefore, in our model we control for the quality of political institutions across countries, proxied by the democratic accountability index from the International Country Risk Guide (ICRG), as in Ashraf (2017) and Wang and Sui (2019). This index measures the degree of democracy in a country, where higher scores stand for greater political competitiveness, leading to better political institutions. Nevertheless, there is mixed evidence on the effect of political institutions on banks' risk. While Ashraf (2017), Wang and Sui (2019), Rezgallah et al. (2019) and Udinn et al. (2020) find empirical evidence of a negative effect of the quality of political institutions on banks' risk, Bui and Bui (2019) and Al-Shboul et al. (2020) report an opposite effect.

Finally, we also control for market concentration and for the periods of systemic banking crisis. The primer reflects the level of competition in the banking industry and it is

measured by the ratio of total assets of the three largest commercial banks to total assets of all commercial banks of a country, as in Agoraki et al. (2011) and Luo et al. (2016). According to Agoraki et al. (2011), depending on the market power (market share) of each bank, the effect that market competition has on banks' risk varies. While banks with more market power do not need to take risks in order to gain market share and improve profits, the same does not happen with banks with less market power. Therefore, lower levels of competition usually mean less risk to banks with high levels of market share and more risk to banks with less market power. The latter is a dummy variable that equals 1 during the years of the systemic banking crisis and 0 otherwise, following Laeven and Valencia (2018). This is a generally accepted variable in the banking related literature, given that banks' risk tends to increase during the systemic banking crisis period when the uncertainty and volatility of the market conditions are higher.

A time dummy ($Year$) variable is also included in the model, guaranteeing robustness (see Baltagi, 2001) and capturing the influence of aggregate (time-series) trends.

Table 1 summarizes the definition of the variables.

[PLEASE INSERT TABLE 1 ABOUT HERE.]

3.2.4. Descriptive statistics

The sample descriptive statistics are reported in Table 2. The distribution of the dependent variable, graphically represented in Figure 1, has an annual mean value of 3.64% and an annual standard deviation of 2.51%, which shows variations in the level of risk across banks. Comparing these results with the ones reported by Teixeira et al. (2020a), we conclude that the banks of our sample have lower risk and lower standard deviation than their sample. From our analysis, we can justify this phenomenon by the fact that our sample is longer (2004-2016) than the one from Teixeira et al. (2020a), with two more years of data, (2004-2014), and

that since 2015 and 2016 were years characterized by more stability in the banking sector, which means lower levels of banks' risk and less volatility.

Regarding banking regulation and investors' protection variables, the results show relatively high mean values and low dispersion across countries (homogeneity), which is expected since only banks from OECD countries (developed countries) are considered in our sample. Interestingly, Turkey is the country from our sample that has the worst performance in what concerns investors' protection, while the United States of America is the country with the best performance in this field.

The annual mean value of banks' leverage is 88.20%, a relatively high leverage ratio, as in Gropp and Heider (2010). In what concerns banks' profitability, we report a mean value in line with Teixeira et al. (2020a, 2020b), rounding 1.19%. Regarding macroeconomic and external variables, we find that countries have grown (in terms of GDP) 1.89% per year, on average, from 2004 to 2016. This growth is followed by the inflation rate, with an annual mean of 1.95%. At last, the democratic accountability variable, which measures the quality of political institutions across countries, has a relatively high mean value and low standard deviation. Again, this happens because our sample is composed only by banks from OECD countries (developed countries).

[PLEASE INSERT TABLE 2 ABOUT HERE.]

[PLEASE INSERT FIGURE 1 ABOUT HERE.]

4. Empirical results

4.1. System GMM estimation

The estimation method used in our model is the two-step System GMM suggested by Arellano and Bover (1995) and Blundell and Bond (1998). As explained in section 3.2.1., this method guarantees consistency and efficiency of the results.

Three models are estimated to investigate the effect of banking regulation and investors' protection on banks' risk. In Model 1, we only examine the direct and linear effects of banking regulation and investors' protection on bank's risk-taking behavior. In Models 2 and 3, we include the non-linear and indirect effects of banking regulation on banks' risk through interaction terms with the investors' protection variables. The interaction between banking regulation and shareholders' protection is estimated in Model 2, while the interaction between banking regulation and creditors' protection is estimated in Model 3.

The estimation results are reported in Table 3.

[PLEASE INSERT TABLE 3 ABOUT HERE.]

We find that the coefficient of the lagged dependent variable is statistically significant at the 1% level across the three models. This means that there is a high persistence degree of banks' risk, justifying the choice of a dynamic model, as in Delis and Kouretas (2011), Louzis et al. (2012), Castro (2013), Lee et al. (2014), Pascual et al. (2015) and Teixeira et al. (2020a).

Focusing in Model 1, we find that the three banking regulation variables (activity restrictions, capital stringency and supervisory power) are statistically significant in explaining banks' risk. While activity restrictions and capital stringency have a positive effect on banks' risk, supervisory power has a negative effect. The positive effect of activity restrictions is in line with Barth et al. (2004), Laeven and Levine (2009), Ashraf (2017), Li (2019), Wu et al. (2017, 2019), Danisman and Demirel (2019), Al-Shboul et al. (2020) and Dutra et al. (2020), corroborating the theory that more restrictions on banks' activity leads to moral hazard and,

consequently, to an increase in banks' risk. Moreover, as banks face less restrictions on the activities they can operate, it is possible to diversify their income sources and reduce risk. On the contrary, as activity restrictions increase, banks are forced to choose riskier projects and loan operations (related to the banks' main activity) in order to maintain their profitability levels. Regarding the positive effect of capital stringency on banks' risk, it is aligned with the empirical evidence of Ashraf (2017), Li (2019), Al-Shboul et al. (2020) and Dutra et al. (2020). Since it is costly for banks to fulfill increases in the minimum regulatory capital, they will tend to assume more risk today with the goal of being capable to meet this requirement (Koehn and Santomero, 1980; Kim and Santomero, 1988; Blum, 1999). Finally, the negative effect of supervisory power on banks' risk is in line with the empirical evidence of Anginer et al. (2014), Garcia-Kuhnert et al. (2015), Mohsni and Otchere (2018), Clark et al. (2018), Al-Shboul et al. (2020) and Dutra et al. (2020), supporting the public interest view theory which states that as supervisory agencies have more power, the correction and improvement of banking market failures (e.g., information asymmetry) are more efficient.

Regarding the investors' protection variables, we document that both shareholders' and creditors' rights are statistically significant in explaining banks' risk. As expected, shareholders' protection has a positive effect on banks' risk, suggesting that the amount of corporate resources diverted by corporate insiders or executives on a firm is reduced with better investors' protection (Shleifer and Wolfenzon, 2002). With stronger shareholders' protection the executives tend to make investment choices closer to the optimal choices, undertaking riskier but possibly more value-enhancing investments. Our results are in line with the ones reported by John et al. (2008), Laeven and Levine (2009) and Teixeira et al. (2020a). On the contrary, we find a negative effect of creditors' protection on banks' risk, corroborating the "dark side" theory of Acharya et al. (2011). This theory posits that with stronger creditors' rights there is a higher chance for the lender to grab collateral or force repayment of the debtor

that is in financial distress or even to force changes in the management of the debtor during a reorganization process, suggesting that borrowers are less willing to take risks when creditors are better protected. Our results are aligned with the ones of Fang et al. (2014), Cole and Turk-Ariss (2018) and Biswas (2019).

Now, focusing in Model 2, we report statistically significant constitutive and interaction (with shareholders' protection) coefficient terms of the banking regulation variables, which allow us to conclude that the overall effect of activity restrictions, capital stringency and supervisory power on banks' risk is conditional on shareholders' protection. The reported individual effect of activity restrictions on banks' risk is negative while the individual effects of capital stringency and supervisory power are positive. Regarding the individual effect of shareholders' and creditors' protection, it is positive for the former and negative for the latter. Regarding the individual effects of the banking regulation variables, we document that some of these effects have different signs than the ones reported in Model 1, which is the case of activity restrictions and supervisory power. However, the individual coefficient signs should not be analyzed separately but jointly with the estimated coefficient of the interaction terms (interactions between the banking regulation variables and the shareholders' protection variable), giving us the overall effect. The overall effect of each banking regulation variable should be compared (instead of the individual effect) with the effects estimated in Model 1. For a better understanding, a graphical illustration of the marginal effects of banking regulation and shareholders' protection variables is presented in Figure 2.

[PLEASE INSERT FIGURE 2 ABOUT HERE.]

These graphical illustrations of the marginal effects were generated following Li and Tanna (2019), using the method of Brambor et al. (2006) and Berry et al. (2012), based on

Equation (2). For instance, the marginal effect of activity restrictions on banks' risk is calculated using:

$$\frac{\partial Risk_{i,j,t}}{\partial ActivityRestrict_{j,t}} = \beta_{4,1} + \beta_{6,1,1} ShareholdersProtect_{j,t}\,, \qquad (3)$$

evaluated at all values of the shareholders' protection variable, where $\beta_{4,1}$ stands for the estimated coefficient of the constitutive term of activity restrictions and $\beta_{6,1,1}$ for the estimated coefficient of the interaction term between activity restrictions and shareholders' protection.

Starting with activity restrictions, the overall effect of this variable on banks' risk is positive for the mean value (85.16) of the shareholders' protection variable. Interestingly, this effect assumes different signs depending on the magnitude of the shareholders' protection variable (see Figure 2), which ranges between 40 and 94.19 and where higher values represent greater protection and rights for shareholders. For high levels of shareholders' protection, the overall effect of activity restrictions on banks' risk is positive. As shareholders' rights deteriorate, the overall effect of activity restrictions on banks' risk decreases, achieving negative values in extreme cases (banks from countries with worse shareholders' rights). This turning point happens when the shareholders' protection variable assumes the value of 51.93. In our sample, 92.70% of the banks are from countries with a shareholders' protection variable greater than 51.93, which leads to a positive overall effect of activity restrictions on banks' risk. This result was expected given that our sample consists only of OECD countries, which are considered developed countries and, consequently, have relatively sound protection for shareholders. Based on this analysis, we conclude that shareholders' protection reinforces the positive effect of activity restrictions on the risk-taking behavior of banks. Relating these results with the theory, we conclude that the problems from restrictions on banks' activities, like moral hazard, loss of profitability (which encourages investments on risky projects) and lower diversification of banks' income sources, are magnified as the protection of shareholders increase. In other words, better shareholders' protection leads to less resources diverted by

banks' insiders or executives and, consequently, to an increase in the amount of banks' resources available to invest. This increase in the banks' available resources to invest, combined with high levels of activity restrictions, forces banks to make riskier investments.

Regarding capital stringency, the overall effect of this variable is always positive for the whole amplitude of shareholders' protection and it becomes higher as the latter assumes greater values, as shown in Figure 2. This means that environments of high levels of shareholders' protection reinforces the positive effect of capital stringency on banks' risk. Relating these results with the theory, we conclude that when taking into account the interplay between banking regulation and shareholders' protection, capital stringency in fact increases the risk of banks due to the cost of fulfilling higher capital requirements, being this effect reinforced by the managers' incentivizes to undertake riskier investments, associated with higher levels of shareholders' protection.

Finally, the overall effect of supervisory power on banks' risk is negative for the mean value of the shareholders' protection variable. Like activity restrictions, this effect also assumes different signs depending on the magnitude of the shareholders' protection variable (see Figure 2). For higher levels of shareholders' protection, the overall effect of supervisory power on banks' risk is negative. As shareholders' protection deteriorate, the overall effect of supervisory power on banks' risk increases, achieving positive values in extreme cases (banks from countries with worse shareholders' rights). This turning point happens when the shareholders' protection variable assumes the value of 60.35. In our sample, 83% of the banks are from countries with a shareholders' protection variable greater than 60.35, which leads to a negative overall effect of supervisory power on banks' risk. Based on this analysis, we conclude that shareholders' protection reinforces the negative effect of supervisory power on the risk-taking behavior of banks. Relating these results with the theory, we conclude that the effect of supervisory agencies on controlling banks' activities and fixing market failures is intensified

in the presence of higher levels of shareholders' protection (less corruption and diversion of banks' resources). In the opposite situation, where banks operate in countries with weak shareholders' rights (when the shareholders' protection variable assumes values lower than 60.35), banks' risk tends to increase as supervisory agencies have more power. In other words, for weak shareholders' protection, the supervisory power has a positive effect on banks' risk. Based on the theory, the weak protection of shareholders lead to diversion of banks' resources and corruption by banks' insiders and executives. With this scenario, supervisory authorities may have the wrong incentives to perform improvements and corrections on the banking industry but, instead, they are looking for the maximization of their welfare. In this environment of corruption and wrong incentives of the supervisory agencies, it is expected that higher supervisory power leads to an increase in banks' risk.

Regarding Model 3, both constitutive and interaction (with creditors' protection) coefficient terms of banking regulation variables are also statistically significant, meaning that the overall effect of activity restrictions, capital stringency and supervisory power on banks' risk is conditional on creditors' protection. The reported individual effects of activity restrictions and capital stringency on banks' risk are negative while the individual effect of supervisory power is positive. Regarding the individual effect of shareholders' and creditors' protection, it is positive for the former and negative for the latter, as in Model 2. While in Model 2 the sign of the individual effects of activity restrictions and supervisory power is different than the ones reported in Model 1, in Model 3 all the individual effects of the three banking regulation variables (activity restrictions, capital stringency and supervisory power) have different signs compared to the ones estimated in Model 1. Once again, the individual coefficient signs should not be analyzed separately but jointly with the estimated coefficient of the interaction terms (interactions between the banking regulation variables and the creditors' protection variable), giving us the overall effect. It is the overall effect of each banking

regulation variable that should be compared (instead of the individual effect) with the effects estimated in Model 1. The graphical illustration of the marginal effects of banking regulation and creditors' protection variables is presented in Figure 3.

[PLEASE INSERT FIGURE 3 ABOUT HERE.]

These marginal effects are calculated based on Equation (2). As an example, the marginal effect of activity restrictions on banks' risk is calculated using:

$$\frac{\partial Risk_{i,j,t}}{\partial ActivityRestrict_{j,t}} = \beta_{4,1} + \beta_{6,1,2} CreditorsProtect_{j,t}\,, \qquad (4)$$

evaluated at all values of the shareholders' protection variable, where $\beta_{4,1}$ stands for the estimated coefficient of the constitutive term of activity restrictions and $\beta_{6,1,2}$ for the estimated coefficient of the interaction term between activity restrictions and creditors' protection.

Regarding activity restrictions and capital stringency, the overall effect of these variables on banks' risk is positive for the mean value (77.29) of the creditors' protection variable. Remarkably, these effects assume different signs depending on the magnitude of the creditors' protection variable (see Figure 3), which ranges between 16.67 and 91.67 and where higher values represent greater protection and rights for creditors. For high levels of creditors' protection, the overall effect of activity restrictions and capital stringency on banks' risk is positive. As creditors' rights deteriorate, the overall effect of activity restrictions and capital stringency on banks' risk decrease, achieving negative values in extreme cases (banks from countries with worse creditors' rights). This turning point happens when the creditors' protection variable assumes the value of 46.08, in the case of activity restrictions, and the value of 50.92, in the case of capital stringency. In our sample, 84.44% of the banks are from countries with a creditors' protection variable greater than 46.08, which leads to a positive overall effect of activity restrictions on banks' risk. Regarding capital stringency, 79.34% of

the banks are from countries with a creditors' protection variable greater than 50.92, leading to a positive overall effect of capital stringency on banks' risk. As in Model 2, these results were expected given that our sample consists only of OECD countries, which are considered developed countries and, consequently, have relatively sound protection for creditors. Based on this analysis, we conclude that creditors' protection reinforces the positive effect of activity restrictions and capital stringency on the risk-taking behavior of banks. This suggests that the problems from restrictions on banks' activities and stringency on banks' regulatory capital, like the cost of fulfilling higher capital requirements, moral hazard, loss of profitability (which encourages investments on risky projects) and lower diversification of banks' income sources, are magnified as the protection of creditors increase. In other words, in environments of strong creditors' rights and legal protections, where banks are encouraged to lend to risky enterprises with poorer credit ratings, combined with high levels of activity restrictions and capital stringency which also motivates risky decisions, banks' risk tend to increase.

Finally, although the overall effect of supervisory power is always negative for the whole amplitude of creditors' protection, it becomes even more negative as the latter assumes higher values, as shown in Figure 3. This means that stronger legal protection to creditors reinforces the negative effect of supervisory power on banks' risk. This result leads to the conclusion that the effect of supervisory agencies on controlling banks' activities and fixing market failures is intensified in the presence of high levels of creditors' protection, which reflects more rights for creditors to grab collateral or force repayment of the debtor that is in financial distress or even to force changes in the management of the debtor during a reorganization process. With a close monitoring of both supervisory agencies and creditors over banks' activities, they are naturally less willing to take risks.

Both investors' protection variables, shareholders' and creditors' protection, are statistically significant in all three estimations (Model 1, 2 and 3), confirming their importance

in explaining banks' risk and in conditioning the effect of banking regulatory variables. Although the shareholders' protection variable and the creditors' protection variable ranges from 40 to 94.19 and from 16.67 to 91.67, respectively, the corresponding average in our sample is 85.16 and 77.30, respectively. This happens because our sample includes only banks from OECD countries, which are considered developed countries and, consequently, tend to present higher levels of investors' protection.

The estimated coefficients associated with the bank-specific variables reveal that leverage, size, profitability and cost-income ratio have a statistically significant negative effect on banks' risk. Regarding credit risk and income diversity, their effect on banks risk is positive and statistically significant. Finally, asset diversity has a negative effect on banks' risk, but it is statistically significant only in Models 1 and 2. Overall, these estimating results are aligned with the existing literature.

In what concerns country-specific variables, we find that banks' risk increases in countries with higher GDP growth, more inflation, steeper interest rates curve, better political institutions and higher concentration levels in the banking industry, whereas higher interest rates lead to a decrease in banks' risk. Note, however, that the estimated coefficient of concentration is not statistically significant at a 10% level in Model 3.

Finally, the estimated coefficient of the systemic banking crisis variable is positive, suggesting that during the period of the banking crisis there is an intensification of banks' risk-taking behavior. The time dummy variable has been found jointly statistically significant in all three estimations. Due to space constraints, they are not reported here but are available upon request.

The two-step system GMM estimation is correctly utilized since the Hansen test confirms the validity of instruments and the AR(2) test confirms the absence of second-order serial correlation in each model.

4.2. Additional tests and robustness checks

In this section, in addition to the robustness checks that validate the main results, we perform further tests that provide additional and interesting results on the effect of banking regulation on banks' risk.

First, we use an alternative estimation method, namely the one-step system GMM estimator, to validate the first order effects of the banking regulatory and investors' protection variables on banks' risk.[3] Model 4 re-estimates Model 1 but using the one-step system GMM estimator instead of the two-step system GMM estimator. The estimation results are reported in Table 4 and show that the main results of Model 1 do not change comparatively to the ones obtained in Model 4, documenting our initial conclusions about the direct effects of banking regulation and investors' protection on banks' risk.

Second, we use an alternative measure of banks' risk, namely the Z-Score to validate the results obtained in Models 2 and 3, *i.e.*, whether the effect of banking regulation on banks' risk is reinforced or mitigated by the level of investors' protection.[4] The corresponding results, from Models 5 and 6, are reported in Table 4. As in Models 2 and 3, activity restrictions and capital stringency have a positive effect on banks' risk (negative effect on Z-score) and supervisory power a negative effect on banks' risk (positive effect on Z-score). These effects are reinforced by higher levels of shareholders' and creditors' protection. All the remaining variables, both bank specific and macroeconomic/external variables, have the same effect on banks' risk as in Models 2 and 3, except for the level of interest rates. In Models 5 and 6, where

[3] According to Hwang and Sun (2018), the two-step system GMM estimator performs at least as well as the one-step estimator, since the latter is usually asymptotically inefficient.

[4] This measure is used by Laeven and Levine (2009), Cubillas and González (2014) and Luo et al. (2016) and it is calculated as the natural logarithm of $(ROA + E/A)/\sigma(ROA)$, where ROA represents the rate of return on assets, E stands for equity, A for assets and $\sigma(ROA)$ is the respective standard deviation of ROA. Z-score behaves inversely to the standard deviation of return on assets, *i.e.*, lower values of Z-score represent a higher probability of banks' default and, consequently, higher banks' risk.

the Z-score is used as a proxy for banks' risk, the level of interest rates has a positive effect on the risk taken by banks. Nevertheless, the economic theory supports both effects, as shown in section 3.2.

[PLEASE INSERT TABLE 4 ABOUT HERE.]

Third, an interesting analysis is to verify whether the effect of banking regulation on banks' risk channeled through investors' protection is similar in large banks compared to the smaller ones. Therefore, we split our sample into two halves, sorted by banks' size, based on the median of this variable. The first half has the largest banks of the original sample and the second half has the smallest ones. Then we re-estimate Models 2 and 3 for each subsample, generating Models 7, 8, 9 and 10 with the corresponding results presented in Table 5.

Models 7 and 8 stands for the re-estimation of Models 2 and 3, respectively, but only considering the subsample of the largest banks. We conclude that our main initial results hold for largest banks, *i.e.*, there is a positive effect of activity restrictions and capital stringency and a negative effect of supervisory power on the risk of the largest banks, and these effects are reinforced by higher levels of shareholders' and creditors' protection.

Models 9 and 10 correspond to the re-estimation of Models 2 and 3, respectively, but now considering the subsample of the smallest banks of our original sample. Interestingly, we obtain distinct results compared to the ones from Models 2, 3, 7 and 8, particularly in what concerns activity restrictions and supervisory power.

Regarding activity restrictions, as it becomes stricter, the risk of the smaller banks decreases, contrarily to what happens with larger banks. This positive effect between supervisory power and (smaller) banks' risk corroborates the theory of Boyd et al. (1998), who argue that banks have more opportunities to take more risk if they are allowed to engage in

more activities, and validates the empirical evidence of Fernandez and Gonzalez (2005), Pasiouras et al. (2006), Agoraki et al. (2011), Wang and Sui (2019) and Teixeira et al. (2020a). These results suggest that activity restrictions have different effects on banks' risk, depending on the level of banks' size. On the one hand, since larger banks have already invested much more on their core activity than smaller banks, they face pressure to invest their available funds on different activities, in order to diversify their risk, obtain different income sources, increase profitability and reduce risk. Therefore, any increase on activity restrictions leads to an increase in the risk of the largest banks. On the other hand, since smaller banks still have space to invest and grow on the banking activity, they must concentrate on their core business rather than incurring in more risk by investing in different activities where banks' managers are not expert.

The results of the interaction effect between activity restrictions and investors' protection of the smaller banks show that the negative effect of activity restrictions on banks' risk is mitigated by the level of shareholders' protection (Model 9) and reinforced by the level of creditors' protection (Model 10).

According to the economic theory, the mitigating effect of shareholders' rights on the negative relationship between activity restrictions and banks' risk can be explained by the fact that higher levels of shareholders' protection originates overconfidence and an increasing willing to invest on risky projects, since the downside for shareholders of a bad investment is limited. This means that if the regulation in a specific country is being effective in reducing banks' risk by restricting the range of activities they can operate, this effectiveness is mitigated by an increasing willing to invest in risky projects.

In what concerns the reinforcing effect of creditors' rights on the negative relationship between activity restrictions and banks' risk, it is justified by the fact that banking regulatory policies are more efficient in reducing banks' risk in the presence of good institutional environments. Since high levels of creditors' protection promote better institutional

environments, a reinforcing effect on reducing banks' risk by restricting their activities should be expected.

As far as supervisory power is concerned, as it becomes stronger, the risk of the smaller banks' also increases, in line with the private interest view. This view, supported by Boot and Thakor (1993) and Quintyn and Taylor (2002), suggests that supervisory agents may not have the right incentives when performing their duty, increasing the probability of mistakes and bad decisions with a negative impact on banks' risk. Pasiouras et al. (2009), Wu et al. (2017, 2019) and Danisman and Demirel (2019) present empirical evidence with similar results. From these results it follows that supervisory power has different effects on banks' risk, depending on the level of banks' size. On the one hand, since supervisory agencies are more worried on the risk taken by larger banks, which have a greater impact in the economy, it is normal that the effectiveness of their supervisory work on reducing the risk of these banks is higher. On the other hand, when dealing with smaller banks with a lower preponderance in the economy and financial system, the probability of not correctly supervising these banks is higher. According to Boot and Thakor (1993) and Quintyn and Taylor (2002), supervisory agents may not have the right incentives when performing their duty, but instead the intention of using their power to maximize their own welfare, leading to mistakes, bad decisions, corruption and, consequently, higher levels of smaller banks' risk.

The aforementioned positive effect of supervisory power on (smaller) banks' risk is reinforced by higher levels of shareholders' and creditors' protection. This interception effect is justified by the fact that high levels of investors' protection may be seen as a limited downside of shareholders and creditors, motivating overconfidence and a willing to invest on riskier projects. Therefore, if supervisory power is leading to an increase in banks' risk, it is expected that this positive effect is reinforced in environments of highly protected investors with a limited downside and an increasing willing to make risky investments.

[PLEASE INSERT TABLE 5 ABOUT HERE.]

At last, we investigate whether the direct effects of banking regulation on banks' risk were more or less intense during the systemic banking crisis period. According to Beltratti and Stulz (2012), changes in the banking regulatory environment are more likely to happen during the systemic banking crisis period. In Model 11, we re-estimate Model 1 but now including interaction terms between the three banking regulatory variables and the systemic banking crisis dummy variable. The corresponding results are depicted in Table 6 and show that the positive effects of activity restrictions and capital stringency on banks' risk are magnified during the systemic banking crisis period, corroborating the evidence of Beltratti and Stulz (2012). Regarding supervisory power, we document that its effect on reducing banks' risk is less efficient during the systemic banking crisis period. In sum, if the regulatory variable generally leads to an increase in banks' risk, this effect is magnified during the systemic banking crisis period, whereas if the regulatory variable generally leads to a decrease in banks' risk, this effect is less efficient during the systemic banking crisis period.

[PLEASE INSERT TABLE 6 ABOUT HERE.]

5. Conclusion

In this study we analyze the effect of banking regulation and investors' protection on banks' risk-taking behavior and whether the overall effect of banking regulation on banks' risk is channeled through investors' protection. As banking regulatory factors we consider activity restrictions, capital stringency and supervisory power, whereas investors' protection is measured by shareholders' and creditors' rights. The paper aims to investigate whether

shareholders' and creditors' rights reinforce or mitigate the effect of each banking regulatory factor on banks' risk. We also examine how the effect of banking regulation on banks' risk is intensified during the systemic banking crisis period and whether this effect is different for larger banks compared to smaller ones.

This paper uses annual data for a sample of 535 OECD publicly traded banks, organized in a panel format, over the 2004-2016 period, and all models are estimated using the two-step system GMM.

The results indicate that the three banking regulation variables (activity restrictions, capital stringency and supervisory power) are statistically significant in explaining banks' risk, with a positive effect of activity restrictions and capital stringency, and a negative effect of supervisory power. Moreover, we argue that the individual effect of shareholders' protection on banks' risk is positive, whereas higher levels of creditors' protection lead to lower values of banks' risk. More importantly, when accounting for the interplay between banking regulation and investors' protection, we find that both shareholders' and creditors' rights reinforce each individual effect of the banking regulation variables on banks' risk. It reinforces the positive effect of activity restrictions and capital stringency and the negative effect of supervisory power. These results are robust to an alternative estimation method and to an alternative measure of banks' risk.

Additional robustness tests reveal that the main results hold for the largest banks, *i.e.*, there is a positive effect of activity restrictions and capital stringency and a negative effect of supervisory power on the risk of the largest banks, and these effects are reinforced by higher levels of shareholders' and creditors' protection. However, when considering smaller banks, we find distinct results, particularly in what concerns activity restrictions and supervisory power. For smaller banks, their risk decreases as activity restrictions become stricter, with this effect being mitigated by higher levels of shareholders' protection and reinforced by higher

levels of creditors' protection. Regarding supervisory power, the empirical evidence shows a positive effect of supervisory power on banks' risk, with this effect being reinforced by higher levels of both shareholders' and creditors' protection. Finally, when analyzing how banking regulation impacts banks' risk during the systemic banking crisis period, we show that the positive effects of activity restrictions and capital stringency on banks' risk are magnified during this period, whereas the negative effect of supervisory power on banks' risk is less pronounced in this period.

The results have potential banking regulatory, policy and management implications. In addition to provide to regulatory and political entities information on how banking regulation influences banks' risk, our results also provide a set of factors that determine banks' risk, helping banks' managers in their strategic decisions.

Finally, we believe that further work on this matter should focus on emerging markets, where banking regulation and investors' protection variables vary more than in developed countries; analyse the interplay between banking regulation and financial freedom in explaining banks' risk; and to investigate the interaction between banking regulation and investors' protection on banks' profitability.

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Table 1
Variable sources and definitions

Variable	Description	Source
Banks' risk		
Asset Risk	Annualized standard deviation of daily stock price returns times the market value of equity over the market value of the bank.	Thompson Reuters Datastream, Bankscope database and authors' calculations
Z-score	Natural logarithm of (ROA + E/A)/σ(ROA). ROA represents the rate of return on assets, E/A is the equity-to-assets ratio and σ(ROA) is the standard deviation of the rate of return on assets. A higher score suggests a lower probability of bank insolvency and, therefore, less risk.	Bankscope database and authors' calculations
Banking regulatory variables		
Activity restrictions	Overall Restrictiveness Index from the World Bank's Bank Regulation and Supervision Survey (BRSS) database. This index measures the extent to which banks are restricted to engage in the following non-lending activities: insurance activities, securities market activities, real estate activities and/or owning non-financial firms. Each of the previous activities originates an individual index that ranges from 1 to 4, where 1 means that there is no restriction on banks to operate the respective activity and 4 means that the activity cannot be developed by banks at all. The overall index takes values between 4 and 16, with higher values of this variables meaning higher activity restrictions.	World Bank's Bank Regulation and Supervision Survey (BRSS) database
Capital stringency	Capital Stringency Index from the World Bank's Bank Regulation and Supervision Survey (BRSS) database. This index measures whether regulatory capital requirements for banks in a country respect Basel accords. The capital requirements index ranges from 0 to 10, where higher scores reflect greater capital stringency.	World Bank's Bank Regulation and Supervision Survey (BRSS) database
Supervisory power	Supervisory Power Index from the World Bank's Bank Regulation and Supervision Survey (BRSS) database. This index measures the rights of the supervisory agencies to meet with, demand information from, and take legal action against auditors; to force a bank to change its internal organizational structure, management, directors, etc.; to oblige the bank to provision against potential losses and suspend dividends, bonuses, and management fees; and to supersede the rights of shareholders and intervene in a bank and/or declare a bank insolvent. The index ranges from 0 to 14, where higher values indicate more powerful supervisors.	World Bank's Bank Regulation and Supervision Survey (BRSS) database
Investors' protection variables		
Shareholders' rights	Score-Ease of shareholder suits index from the World Bank Doing Business Data Set. The ease of shareholder suits index measures how likely shareholders plaintiffs are to access internal corporate evidence and recover legal expenses. It ranges from 0 to 100, where 0 represents the worst regulatory performance and 100 the best regulatory performance, *i.e.*, stronger shareholders' rights and protection.	World Bank Doing Business Data Set
Creditors' rights	Score-Strength of legal rights index from the World Bank Doing Business Data Set. The strength of legal rights index measures whether certain features that facilitate lending exist within the applicable collateral and bankruptcy laws. It ranges from 0 to 100, where 0 represents the worst regulatory performance and 100 the best regulatory performance, *i.e.*, stronger creditor's rights and protection.	World Bank Doing Business Data Set
Bank specific variables		
Leverage	Book value of total liabilities over total assets, measured in market terms, *i.e.*, as the sum of the market value of equity and the book value of total liabilities.	Bankscope database and authors' calculations
Size	Natural logarithm of the book value of total assets.	Bankscope database and authors' calculations
Profitability	Profit after interest expenses over the book value of assets.	Bankscope database and authors' calculations
Cost-income ratio	Operating costs or non-interest costs over net operating income.	Bankscope database and authors' calculations
Credit risk	Provisions for loan losses to total loans.	Bankscope database and authors' calculations
Income diversity	Measures the diversification across different sources of income and is given by 1-[(net interest income-other operating income)/(total operating income)]	Bankscope database and authors' calculations
Asset diversity	Measures the diversification across different types of assets and is given by 1-[(net loans-other earnings assets)/(total earnings assets)].	Bankscope database and authors' calculations
External variables		
GDP growth	Annual percentage change of Gross Domestic Product (GDP).	IMF's database
Inflation	Annual percentage change in the Consumer Price Index (CPI).	IMF's database
Level of interest rates	10-year yield rate on government bonds.	OECD database
Slope of interest rates	Difference between the 10-year yield rate and the 1-year yield rate on government bonds.	OECD database
Democratic accountability	Democratic accountability index from International Country Right Guide database. This index measures the type of the government in a country (*i.e.*, alternative democracy, dominated democracy, de-facto one-party state, de-jure one-party state and autarchies) and responsiveness of the government to its people. This index ranges from 1 to 6, where higher values represent democratic forms of government (alternative democracies) and lower values represent autarchies.	International Country Right Guide database
Concentration	Measures the level of market competition in the banking sector and is given by the fraction of the assets of the three largest banks over the assets of all commercial banks in a country.	World Bank database
Crisis	Dummy variable that assumes the value 1 in the years of systemic banking crisis and 0 otherwise.	Laeven and Valencia (2018)

Table 2
Descriptive statistics

						Distribution		
	N	Mean	St. Dev.	Min.	Max.	10th	50th	90th
Banks' risk								
Asset risk (%)	4230	3.644	2.509	0.000	26.393	1.161	3.150	6.526
Z-score	4230	1.856	1.350	-5.540	8.031	0.063	1.937	3.432
Banking regulatory variables								
Activity restrictions	4230	9.822	2.416	4.000	14.000	6.000	9.000	13.000
Capital stringency	4230	7.013	1.139	3.000	10.000	6.000	7.000	8.889
Supervisory power	4230	12.212	1.755	5.000	14.500	10.000	12.000	14.500
Investors' protection variables								
Shareholders' rights	4230	77.292	24.313	16.667	91.667	33.333	91.667	91.667
Creditors' rights	4230	85.162	14.634	40.000	94.186	60.000	94.186	94.186
Bank specific variables								
Leverage (%)	4230	88.199	6.101	53.477	99.867	80.412	88.539	85.817
LOG Size	4230	8.397	2.149	4.281	14.733	6.089	7.936	11.489
Profitability (%)	4230	1.190	0.685	-6.008	7.277	0.394	1.154	2.002
Cost-income ratio	4230	33.489	7.651	5.638	87.705	23.678	33.768	41.932
Credit risk	4230	0.517	1.150	-2.134	56.848	0.017	0.295	1.278
Income diversity	4230	0.914	0.325	0.041	1.907	0.515	0.891	1.367
Asset diversity	4230	0.576	0.294	0.022	1.931	0.271	0.518	0.964
External variables								
GDP growth (%)	4230	1.885	1.950	-8.075	25.163	-0.137	1.967	3.513
Inflation (%)	4230	1.948	1.634	-2.097	11.874	0.038	1.640	3.515
Level of interest rates (%)	4230	3.067	1.381	-0.362	10.054	1.803	2.786	4.629
Slope of interest rates (%)	4230	1.530	1.154	-2.074	9.834	-0.362	1.520	2.711
Democratic accountability	4230	5.936	0.280	3.708	6.000	6.000	6.000	6.000
Concentration	4230	43.750	17.913	28.060	98.627	32.796	35.120	75.571
Crisis	4230	0.306	0.461	0	1	0	0	1

Table 3

Banks' risk model with banking regulatory and investors' protection variables.

The dependent variable, bank's asset risk, is given by the annualized standard deviation of daily stock price returns times the market value of equity over the market value of the bank. Model 1 is given by Equation (1) with $\beta_6 = 0$, *i.e.* with no interaction terms between banking regulation and investors' protection variables, whereas Model 2 and Model 3 expand Model 1 by including the interactions terms between banking regulation and shareholders' and creditors' protection, respectively. The reported coefficients and their robust standard errors (in parentheses) clustered at country levels are obtained using the Arellano and Bover (1995) and Blundell and Bond (1998) two-step System GMM estimator. ***, ** and * represent statistical significance at 1%, 5% and 10% levels, respectively. The null hypothesis of the Hansen test states that all instruments are jointly exogenous and that the instruments used are not correlated with residuals. The null hypothesis of the autoregressive (AR) test states that there is not second-order serial correlation in the error term.

Dependent variable: asset risk	**Model 1**	**Model 2**	**Model 3**
Lagged dependent variable	0.226***	0.221***	0.220***
	(0.001)	(0.002)	(0.002)
Banking regulatory variables			
Activity restriction	0.037***	-0.065***	-0.247***
	(0.001)	(0.007)	(0.005)
Capital stringency	0.059***	0.000***	-0.059***
	(0.002)	(0.015)	(0.006)
Supervisory power	-0.031***	0.218***	0.002***
	(0.002)	(0.007)	(0.006)
Investors' protection variables			
Shareholders' rights	0.005***	0.031***	0.001***
	(0.000)	(0.002)	(0.000)
Creditors' rights	-0.003***	-0.002***	-0.041***
	(0.000)	0.000	(0.001)
Interaction variables			
Activity restriction x Shareholders' rights		0.001***	
		(0.000)	
Capital stringency x Shareholders' rights		0.001***	
		(0.000)	
Supervisory power x Shareholders' rights		-0.004***	
		(0.000)	
Activity restriction x Creditors' rights			0.005***
			(0.000)
Capital stringency x Creditors' rights			0.001***
			(0.000)
Supervisory power x Creditors' rights			-0.002***
			(0.000)
Bank specific variables			
Leverage	-0.288***	-0.284***	-0.279***
	(0.001)	(0.001)	(0.001)
LOG Size	-0.083***	-0.076***	-0.051***
	(0.002)	(0.003)	(0.002)
Profitability	-0.260***	-0.228***	-0.219***
	(0.006)	(0.008)	(0.005)
Cost-income ratio	-0.014***	-0.013***	-0.012***
	(0.001)	(0.001)	(0.001)
Credit risk	0.434***	0.439***	0.419***
	(0.005)	(0.008)	(0.006)
Income diversity	0.938***	0.953***	0.591***
	(0.020)	(0.023)	(0.024)
Asset diversity	-0.090***	-0.096***	-0.008
	(0.015)	(0.023)	(0.022)
External variables			
GDP growth	0.069***	0.060***	0.071***
	(0.002)	(0.002)	(0.001)
Inflation	0.072***	0.069***	0.105***
	(0.002)	(0.003)	(0.003)
Level of interest rates	-0.188***	-0.171***	-0.105***
	(0.004)	(0.005)	(0.004)
Slope of interest rates	0.192***	0.218***	0.155***
	(0.004)	(0.004)	(0.003)
Democratic Accountability	-0.181***	-0.257***	0.026***
	(0.009)	(0.010)	(0.011)
Concentration	0.003***	0.002***	0.000
	(0.000)	(0.000)	(0.000)
Crisis	0.499***	0.420***	0.011***
	(0.009)	(0.010)	(0.009)
Year dummies	Yes	Yes	Yes
p-value of AR(2) test	0.157	0.160	0.149

p-value of Hansen test	0.241	0.338	0.296

Table 4
Robustness checks

Robustness tests: a different estimation method (Model 4) and an alternative proxy for banks' risk (Models 5 and 6). In Model 4, we re-estimate Model 1 but using the one-step System GMM estimator instead of the two-step System GMM estimator. In Models 5 and 6 we re-estimate Models 2 and 3 but using the Z-score as proxy for banks' risk. The reported coefficients and their robust standard errors (in parentheses) clustered at country levels are obtained using the Arellano and Bover (1995) and Blundell and Bond (1998) System GMM estimator. ***, ** and * represent statistical significance at 1%, 5% and 10% levels, respectively.

Dependent variable: asset risk	**Model 4**	**Model 5**	**Model 6**
Lagged dependent variable	0.225***		
	(0.014)		
Lagged dependent variable (Z-Score)		0.518***	0.525***
		(0.003)	(0.002)
Banking regulatory variables			
Activity restriction	0.037**	0.051***	0.022***
	(0.021)	(0.006)	(0.003)
Capital stringency	0.062**	0.134***	0.037***
	(0.027)	(0.012)	(0.006)
Supervisory power	-0.032**	-0.051***	-0.047***
	(0.020)	(0.007)	(0.003)
Investors protection variables			
Shareholders rights	0.006	-0.017***	-0.011***
	(0.005)	(0.001)	(0.000)
Creditors rights	-0.002	0.004***	0.008***
	(0.003)	0.000	(0.001)
Interaction variables			
Activity restriction x Shareholders rights		-0.001***	
		(0.000)	
Capital stringency x Shareholders rights		-0.002***	
		(0.000)	
Supervisory power x Shareholders rights		0.001***	
		(0.000)	
Activity restriction x Creditors rights			-0.001***
			(0.000)
Capital stringency x Creditors rights			-0.000***
			(0.000)
Supervisory power x Creditors rights			0.001***
			(0.000)
Bank specific variables			
Leverage	-0.288***	0.004***	0.003***
	(0.008)	(0.001)	(0.001)
LOG Size	-0.081***	0.013***	0.021***
	(0.018)	(0.001)	(0.002)
Profitability	-0.263***	0.544***	0.518***
	(0.062)	(0.007)	(0.008)
Cost-income ratio	-0.015***	0.012***	0.013***
	(0.005)	(0.001)	(0.000)
Credit risk	0.438***	-0.294***	-0.296***
	(0.046)	(0.004)	(0.005)
Income diversity	0.946***	-.117***	-0.089***
	(0.164)	(0.020)	(0.019)
Asset diversity	-0.103	0.273***	0.235***
	(0.124)	(0.013)	(0.012)
External variables			
GDP growth	0.071***	-.018***	-0.018***
	(0.020)	(0.001)	(0.001)
Inflation	0.072**	-0.034***	-0.038***
	(0.030)	(0.002)	(0.002)
Level of interest rates	-0.188***	-0.115***	-0.120***
	(0.033)	(0.003)	(0.003)
Slope of interest rates	0.192***	-.047***	-0.047***
	(0.041)	(0.003)	(0.003)
Democratic Accountability	-0.180	0.052***	0.014*
	(0.154)	(0.007)	(0.008)
Concentration	0.003	-0.004***	-0.005***
	(0.003)	(0.000)	(0.000)
Crisis	0.499***	-0.139***	-0.115***
	(0.116)	(0.010)	(0.009)
Year dummies	Yes	Yes	Yes

Table 5
Additional tests

Additional tests: the original sample is divided into two subsamples by banks' size. The subsample of the largest banks is used to estimate Models 7 and 8, whereas the subsample of the smallest banks is used to estimate Models 9 and 10. Models 7 and 9 re-estimate Model 2, whereas Models 8 and 10 re-estimate Model 3. All models are given by Equation (1) and estimated using two-step System GMM. The reported coefficients and their robust standard errors (in parentheses) clustered at country levels are obtained using the Arellano and Bover (1995) and Blundell and Bond (1998) System GMM estimator. ***, ** and * represent statistical significance at 1%, 5% and 10% levels, respectively.

Dependent variable: asset risk	**Model 7**	**Model 8**	**Model 9**	**Model 10**
Lagged dependent variable	0.224***	0.215***	0.260***	0.257***
	(0.001)	(0.001)	(0.001)	(0.001)
Banking regulatory variables				
Activity restriction	-0.159***	-0.284***	-0.978***	-0.170
	(0.007)	(0.006)	(0.140)	(0.162)
Capital stringency	0.045***	-0.104***	-1.013***	-0.742***
	(0.005)	(0.006)	(0.234)	(0.161)
Supervisory power	0.394***	0.092***	-0.828***	-0.921***
	(0.009)	(0.005)	(0.117)	(0.092)
Investors protection variables				
Shareholders rights	0.057***	-0.004***	-0.179***	0.062***
	(0.002)	(0.000)	(0.034)	(0.006)
Creditors rights	-0.007***	-0.044***	0.004*	-0.192***
	(0.001)	0.001	(0.002)	(0.020)
Interaction variables				
Activity restriction x Shareholders rights	0.003***		0.007***	
	(0.000)		(0.002)	
Capital stringency x Shareholders rights	0.001***		0.014***	
	(0.000)		(0.004)	
Supervisory power x Shareholders rights	-0.006***		0.009***	
	(0.000)		(0.002)	
Activity restriction x Creditors rights		0.007***		-0.006**
		(0.000)		(0.003)
Capital stringency x Creditors rights		0.002***		0.012***
		(0.000)		(0.003)
Supervisory power x Creditors rights		-0.003***		0.014***
		(0.000)		(0.002)
Bank specific variables				
Leverage	-0.281***	-0.278***	-0.269***	-0.272***
	(0.001)	(0.001)	(0.002)	(0.003)
LOG Size	-0.032***	-0.006*	0.155***	0.158***
	(0.005)	(0.003)	(0.011)	(0.014)
Profitability	-0.345***	-0.316***	-0.213***	-0.212***
	(0.009)	(0.008)	(0.014)	(0.015)
Cost-income ratio	-0.022***	-0.021***	-0.012***	-0.011***
	(0.001)	(0.001)	(0.002)	(0.002)
Credit risk	0.249***	0.201***	0.375***	0.389***
	(0.006)	(0.008)	(0.012)	(0.015)
Income diversity	0.614***	0.366***	0.781***	0.855***
	(0.024)	(0.024)	(0.057)	(0.058)
Asset diversity	0.210***	0.168***	-0.323***	-0.309***
	(0.028)	(0.022)	(0.041)	(0.042)
External variables				
GDP growth	0.062***	0.078***	-0.028***	-0.011
	(0.001)	(0.001)	(0.008)	(0.009)
Inflation	0.117***	0.166***	-0.127***	-0.128***
	(0.003)	(0.002)	(0.010)	(0.009)
Level of interest rates	-0.142***	-0.064***	0.462***	0.188***
	(0.003)	(0.003)	(0.024)	(0.029)
Slope of interest rates	0.197***	0.117***	0.270***	0.495***
	(0.004)	(0.004)	(0.024)	(0.028)
Democratic Accountability	-0.033***	0.308***	-2.781***	-2.890***
	(0.012)	(0.009)	(0.102)	(0.140)
Concentration	0.004***	0.002***	0.031***	0.018***
	(0.000)	(0.000)	(0.002)	(0.002)
Crisis	0.660***	0.156***	2.181***	3.021***
	(0.008)	(0.013)	(0.252)	(0.302)
Year dummies	Yes	Yes	Yes	Yes

Table 6
Additional tests

Additional test: risk model with interaction between banking regulation variables and crisis dummy variable. The reported coefficients and their robust standard errors (in parentheses) clustered at country levels are obtained using the Arellano and Bover (1995) and Blundell and Bond (1998) System GMM estimator. ***, ** and * represent statistical significance at 1%, 5% and 10% levels, respectively.

Dependent variable: asset risk	**Model 11**
Lagged dependent variable	0.218***
	(0.002)
Banking regulatory variables	
Activity restriction	0.041***
	(0.002)
Capital stringency	0.012***
	(0.002)
Supervisory power	-0.066***
	(0.002)
Investors protection variables	
Shareholders rights	0.008***
	(0.000)
Creditors rights	-0.004***
	(0.000)
Interaction variables	
Activity restriction x Crisis	0.156***
	(0.003)
Capital stringency x Crisis	0.004
	(0.003)
Supervisory power x Crisis	0.026***
	(0.003)
Bank specific variables	
Leverage	-0.286***
	(0.001)
LOG Size	-0.059***
	(0.003)
Profitability	-0.203***
	(0.008)
Cost-income ratio	-0.006***
	(0.001)
Credit risk	0.489***
	(0.006)
Income diversity	0.717***
	(0.024)
Asset diversity	-0.058***
	(0.022)
External variables	
GDP growth	0.079***
	(0.002)
Inflation	0.119***
	(0.003)
Level of interest rates	-0.126***
	(0.004)
Slope of interest rates	0.191***
	(0.003)
Democratic Accountability	-0.024*
	(0.012)
Concentration	0.003***
	(0.000)
Crisis	-1.812***
	(0.043)
Year dummies	Yes

Fig. 1.
Distribution of the dependent variable (banks' risk).

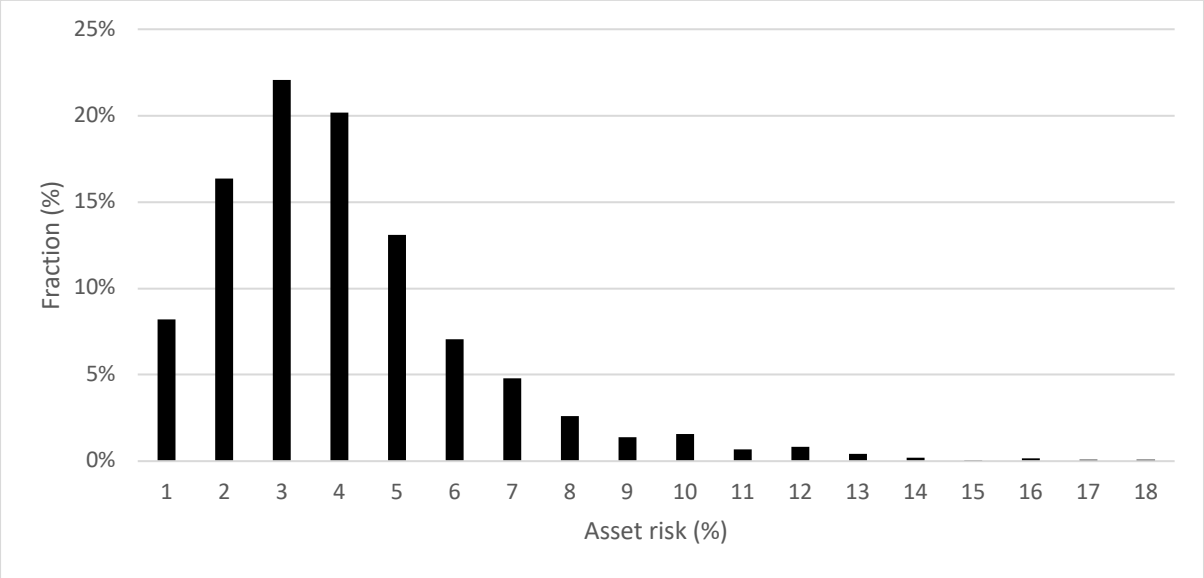
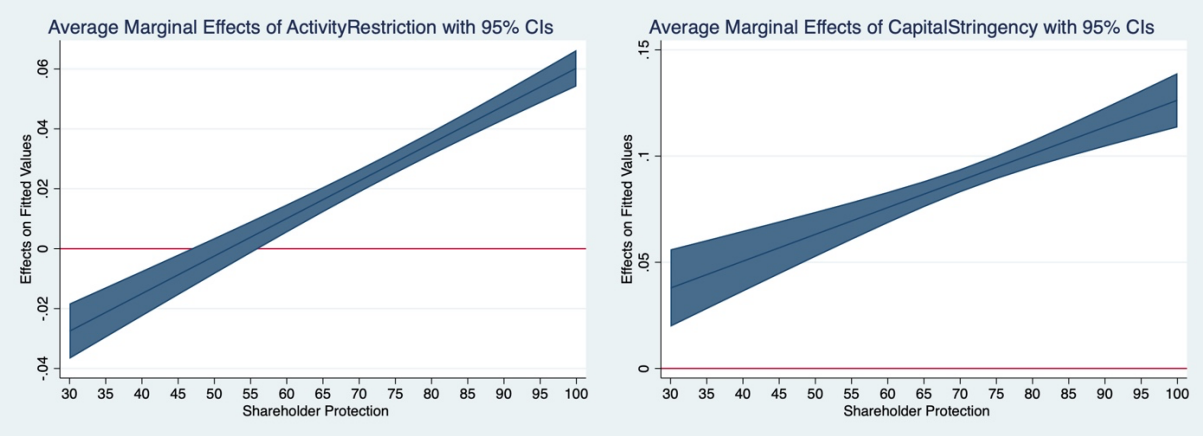


Fig. 2.
Marginal effects of banking regulation variables on shareholders' protection
Marginal effects of activity restrictions, capital stringency and supervisory power on banks' risk, evaluated at all values of the shareholders' protection variable. These marginal effects are calculated based on the results of Model 2, using the method of Brambor et al. (2006) and Berry et al. (2012), *i.e.*, using Equation (2) evaluated at all values of the shareholders' protection variable. $\beta_{4,m}$ stands for the estimated coefficient of the constitutive term and $\beta_{6,m,n}$ for the estimated coefficient of the interaction term with investors' protection. m assumes value 1 if the banking regulatory variable is activity restriction, 2 for capital stringency and 3 for supervisory power and n assumes the value 1 if the investors' protection variables is the shareholders' protection and 2 for the creditors' protection. The dashes lines provide the 95% confidence intervals.



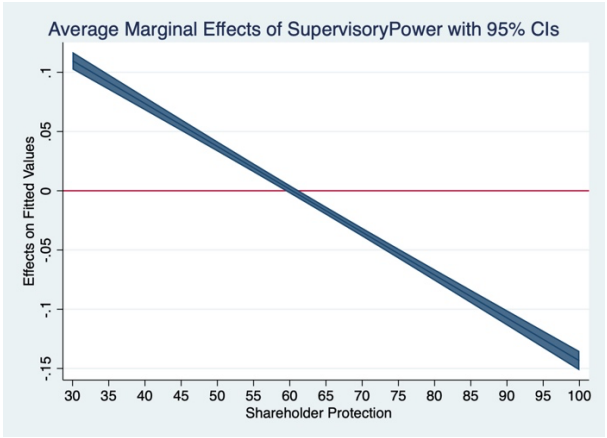


Fig. 3.

Marginal effects of banking regulation variables on creditors' protection

Marginal effects of activity restrictions, capital stringency and supervisory power on banks' risk, evaluated at all values of the creditors' protection variable. These marginal effects are calculated based on the results of Model 2, using the method of Brambor et al. (2006) and Berry et al. (2012), *i.e.*, using Equation (2) evaluated at all values of the creditors' protection variable. $\beta_{4,m}$ stands for the estimated coefficient of the constitutive term and $\beta_{6,m,n}$ for the estimated coefficient of the interaction term with investors' protection. m assumes value 1 if the banking regulatory variable is activity restriction, 2 for capital stringency and 3 for supervisory power and n assumes the value 1 if the investors' protection variables is the shareholders' protection and 2 for the creditors' protection. The dashes lines provide the 95% confidence intervals.