



Institutional mechanisms, ownership and bank risk-taking during crises[☆]

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ABSTRACT

Previous studies indicate that prior period investor protection, quality of government/institution and ownership have little to no influence on bank risk-taking around crisis periods. Using contemporaneous data for 40 countries, we show that institutional mechanisms, investor protection, bank regulation and supervision (BRS) rules, and ownership, reduced bank risk-taking around the Global Financial Crisis (GFC) and the Eurozone Crisis/Sovereign Debt Crisis periods. Institutional mechanisms have the strongest risk-reducing impacts on bank risk-taking, whereas foreign and government ownership have the weakest impacts. The greater the distance from bank default the lower the likelihood of crisis regimes. Investor protection increased (decreased) the likelihood of the GFC (Eurozone Crisis) regimes. Government ownership increased (decreased) the likelihood of the GFC (Eurozone Crisis) regimes. Using a generalized bivariate copula function, we untangle the relation between crisis regimes and bank risk-taking by showing that higher risk-taking increases the likelihood of crisis regimes.

1. Introduction

Since La Porta et al. (1997; 1998), several studies have examined the influences of institutional mechanisms on economic growth, financial market development and risk-taking.¹ These studies show that the strength of institutional mechanisms has economic consequences for countries. Despite the considerable influences of institutional mechanisms (see, e.g., La Porta et al., 1997; Wurgler, 2000), previous studies show that prior period investor protection, ownership, and institutional mechanisms, have little to no influence

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¹ By institutional mechanisms we mean the different laws and legal enforcement rules in countries that influence ownership concentration, investor and creditor rights protection, financial system development, and property rights. The level of investor protection reflects the strength of institutional mechanisms and ownership rights in countries (La Porta et al., 1999). When we refer to governance mechanisms, we sometimes include legal/institutional mechanisms and ownership structure.

on bank risk-taking during crisis periods (Beltratti & Stulz, 2012; Erkens et al., 2012; Hoque et al., 2015). Specifically, Beltratti & Stulz (2012) report that prior period investor protection levels only predict stock returns of non-U.S. banks and the strength of bank regulation and supervision (BRS) rules is unrelated to stock price performance during crisis periods, except for large banks in countries with more restrictions, and banks with more shareholder-friendly boards. Hoque et al. (2015) provide related results. They show that investor protection and quality of government do not jointly influence bank performance, nor does ownership robustly influence bank risk-taking during crisis periods. These results are surprising since they imply that legal and regulatory mechanisms are ineffective in averting financial crises or mitigating crisis events. These prior results also suggest that banks that perform well during crisis periods may have done so due to their risk culture or business model (Fahlenbrach et al., 2012), thus supporting the view that certain legal and BRS rules may be revocable, by banks adopting their own provisions and governance practices (Klapper & Love, 2004). However, despite this view, prior evidence is mixed on the role of bank-level governance in mitigating risk-taking around crisis periods (Abid et al., 2021; Erkens et al., 2012; Fernandes et al., 2021; Minton et al., 2014; Vallascas et al., 2017).

Motivated by the above considerations, we examine whether institutional mechanisms, as well as ownership, investor protection, and BRS rules, influence the risk-taking behavior of commercially listed banks, headquartered in 40 countries. Since institutional mechanisms, ownership, and BRS rules influence bank risk-taking during tranquil periods (Angkinand & Wihlborg, 2010; Barth et al., 2004; Laeven & Levine, 2009), we test whether they also influence risk-taking around crisis periods. We undertake a multi-country study since prior studies show that the effects of institutional mechanisms, investor protection, and BRS rules vary across countries and, in turn, influence ownership structures and financial market development (La Porta et al., 1997, 1998; Laeven & Levine, 2009). Indeed, the effects of BRS rules on risk-taking depend on the strength of investor protection (Teixeira et al., 2020) as well as the comparative powers of bank owners (Laeven & Levine, 2009).² Furthermore, higher risk-taking is associated with expropriation of minority shareholders which tends to be more pronounced around crisis periods, particularly when investor protection and bank regulations are weak and asset values are expected to fall (Boyd & Hakenes, 2014; Johnson et al., 2000). Thus, collectively, we expect our measures to influence risk-taking around crisis periods. Unlike Beltratti & Stulz (2012), Erkens et al. (2012), and Hoque et al. (2015), we use the *contemporaneous* values of our measures since they aim to maintain market discipline during both tranquil and crisis periods. We separately analyze each crisis period since crisis events are unique and have different origins (Kaminsky & Reinhart, 1999).³ We therefore ask: How do institutional mechanisms, investor protection, ownership, and BRS rules shape risk-taking around crisis periods? Do these mechanisms predict the likelihood of crisis regimes?

Using the standard deviation of return on bank assets (ROA), hereinafter, RISK, and the natural logarithm of Z-score, we find results that contrast with those of prior studies (i.e., Beltratti & Stulz, 2012; Erkens et al., 2012; Hoque et al., 2015).⁴ Specifically, we find that institutional mechanisms, ownership, investor protection, and BRS rules reduce risk-taking around the Global Financial Crisis (GFC) and Eurozone Crisis periods. We attribute the difference between our results and those of prior studies to our research design and the hypotheses we test. We also find that institutional mechanisms and investor protection have the largest decreasing impacts on risk-taking, whereas ultimate foreign and government ownership have the smallest decreasing impacts. The effects of macroeconomic variables are also weak. The stronger influence of institutional mechanisms on risk-taking compared to macroeconomic variables is in line with the view that institutions are more effective in achieving economic outcomes compared to macroeconomic policy (Acemoglu et al., 2003). Our results are robust to an alternative risk-taking proxy, alternative sub-sample estimations, and difference-in-difference (DID) regression estimates.

We use the Bussiere & Fratzscher (2006) post-crisis bias test to predict the likelihood of crisis regimes. Using this test, we find that bank risk-taking predicts the pre-crisis regimes more strongly than the crisis/post-crisis regimes. This result suggests that governmental and regulatory actions aimed at mitigating crisis events are likely to be more effective during pre-crisis regimes. Furthermore, the greater the distance from bank default, the lower the likelihood of a crisis regime. This result re-enforces the view that the strength of ex-ante bank balance sheet stability is critical in ensuring that banks withstand liquidity shocks associated with crisis events (see Kapan & Minoiu, 2018). Stronger investor protection reduced the likelihood of crisis regimes in countries during the 2005–2009 period but increased the likelihood of crisis regimes during the 2009–2019 period. The latter result does not call for self-regulation, since institutional mechanisms and investor protection tend to constrain expropriation by controlling investors, especially when investment returns are expected to fall (Johnson et al., 2000). That is, self-regulation would only incentivize greater expropriation and risk-taking around crisis periods.⁵ Thus, even if bank consolidation reduces regulatory constraints, it is still necessary to ensure legal rules, and prudential and BRS rules are effective (Mishkin, 1999).

² Too strong a level of supervisory power is associated with corruption in lending (Beck et al., 2006b). However, reforms of legal institutions, corporate governance, and bank liberalization increase banking stability (Fang et al., 2014).

³ The sample periods are the years: i) 2005–2009, which include the Global Financial Crisis (GFC) of 2007–2008, in line with prior studies (Beltratti & Stulz, 2012; Erkens et al., 2012; Hoque et al., 2015); and ii) 2009–2019, which include the Eurozone Crisis of 2010–2018. 2009 is a common year in both sample periods since we want to predict the non-crisis years of each sample period and since the two crises are not far apart in years. The Eurozone Crisis is considered to have started May 2, 2010, after the first Greek bailout (<https://www.reuters.com/article/us-eurozone/>, accessed, Nov. 9, 2018) and ended August 2018, following the European leaders' declaration (Brunsdon & Khan, 2018). Joseph et al. (2020) also use 2010–2018 as the Eurozone Crisis period. Our results are robust using alternative years for the Eurozone Crisis period.

⁴ Explanations for crisis events include asset bubbles, panic, external shocks, and contagion (Corsetti et al., 1999; Krugman, 1998). The severity of a financial crisis often reflects the strength of institutional mechanisms and BRS rules, and the types of ownership in countries (see Johnson et al., 2000).

⁵ Dominant insiders of complex organizations may siphon off cash from low cash flow rights units to high cash flow rights units, thereby causing dominant insiders to take more risk in low cash flow rights units (John et al., 2008).

We contribute to prior research in the following ways. First, we contribute to prior research on the collective roles of institutional mechanisms, ownership, investor protection, and BRS rules in shaping bank risk-taking around crisis periods. Unlike prior studies that use an alternative research design (see Beltratti & Stulz, 2012), we show that institutional mechanisms have the largest mitigating impacts on risk-taking. Second, our focus on crisis periods allows us to assess the effectiveness of institutional and regulatory mechanisms in periods when controlling investors and managers are more likely to expropriate (Johnson et al., 2000). For example, Laeven & Levine (2009) find that, during tranquil periods, bank risk-taking varies under different bank regulatory conditions, depending on the comparative powers of shareholders. We show that, around crisis periods, institutional mechanisms, investor protection, and BRS rules have stronger mitigating effects on bank risk-taking than foreign and government ownership. Thus, while Iannotta et al. (2013) show that government ownership induces higher operational risk compared to privately held banks, failure to account for the effects of institutional mechanisms, investor protection, and BRS rules suggests that their reported effects for ownership may have been overestimated. We do not endogenize board characteristics since board governance may be counter-productive around crisis events (Beltratti & Stulz, 2012; Van Essen et al., 2013).⁶ Indeed, board-level governance practices do not substitute for institutional mechanisms or BRS rules (Klapper & Love, 2004), meaning that, if bank-level governance practices fail, there is no recourse for investors except through existing legal and regulatory channels. Third, unlike prior studies (Beck et al., 2006a; Demirgüç-Kunt & Detragiache, 2002), we estimate the likelihood of: i) the tranquil regime, when economic conditions are largely sound; ii) the pre-crisis regime; and, iii) the crisis/post-crisis regime, when economic fundamentals go through adjustments. Using this approach, we address the weak and, perhaps, unconvincing view that lax institutional mechanisms, weak investor protection, and BRS rules incentivize excessive risk-taking that in turn increases the likelihood of crisis events (Bebchuk & Spamann, 2010; Kirkpatrick, 2009). We statistically link the relation between higher risk-taking and crisis regimes using a generalized bivariate copula function. We believe we are the first to directly test the relation between risk-taking and crisis events.

The next section reviews prior studies and presents our hypotheses. Section 3 presents our models and data. Sections 4 and 5 present the results and we conclude in Section 6.

2. Background and hypothesis development

While the strength of investor protection may influence controlling shareholders' behavior, legal rules determine how property rights are protected (John et al., 2008). Legal rights vary across countries and predict differences in ownership structure and financial development (La Porta et al., 1998). Laws and bank regulations determine bank capital requirements, ownership, and foreign bank entry (Barth et al., 2013). BRS rules also influence risk-taking behavior (Laeven & Levine, 2009). Our hypotheses are developed from these perspectives. Fuller definitions of our variables are in WEB Appendix A.

2.1. Institutional mechanisms and investor protection

Countries that lack sound governance mechanisms are more prone to corruption, poor legal enforcement, and ineffective governments (La Porta et al., 1998). Weak institutional mechanisms incentivize expropriation by managers and controlling investors (Shleifer & Vishny, 1997). Johnson et al. (2000) show that agency conflicts in countries with weak legal systems make these countries more vulnerable, when market prices are likely to decline. The enforceability of investors' intrinsic rights depends on a country's rule of law and government effectiveness (La Porta et al., 1998). Caprio et al. (2007) report that higher cash flow rights reduce the negative effects of poor investor protection. However, shareholders may tolerate excessive risk-taking if they stand to benefit substantially from up-side risk and losses are borne by governments and society (Bebchuk & Spamann, 2010). As such, strong investor protection rules create less fear of managerial expropriation and less of a need for dominant shareholders to direct investment policy (Burkart et al., 2003). If a decline in the power of the dominant shareholder allows managers to have more discretion to pursue conservative policies, this may lead to a negative relation between investor protection and risk-taking. However, John et al. (2008) suggest that investor protection and risk-taking may be positively related, since riskier investments generate higher returns, if such investments pay off. Given these conflicting perspectives, we hypothesize that,

H1A. *Stronger institutional mechanisms and investor protection reduce bank risk-taking around crisis periods.*

H1B. *Stronger institutional mechanisms and investor protection increase bank risk-taking around crisis periods.*

We measure the strength of institutional mechanisms using four of the six institutional mechanisms of the standardized Worldwide Governance Indicators (WGIs) of Kaufmann et al. (2011).⁷ We use the components of Rule of Law, Control of Corruption, Regulatory Quality, and Government Effectiveness. Since 2002, the WGIs have been updated yearly by the World Bank. Following Houque et al. (2012), we use the aggregated six dimensions of the WIGs, called the Quality of Government. Beltratti & Stulz (2012) and Hoque et al. (2015) also use the six dimensions of the WIGs, which they call *Institution*. We measure Investor Protection using the Spamann (2010)

⁶ There is substantial debate about whether firm-level governance is more effective in enhancing firm performance than institutional mechanisms and investor protection (Chhaochharia & Laeven, 2009; Klapper & Love, 2004).

⁷ For simplicity, we refer to the WGI measures as institutional mechanisms/arrangements in line with what Beltratti & Stulz (2012) and Hoque et al. (2015) and others call *Institution*. Erkens et al. (2012) also use the WGIs, which they interchangeably refer to as Institution, legal institutions, country-level governance mechanisms, country-level legal institutions, and country-level governance.

corrected Anti-Director Rights Index (ADRI). This measure is supplemented with the Djankov et al. (2008) revised ADRI for six countries, i.e., China, Kazakhstan, Ukraine, Russia, Poland, and Tunisia, due to missing data under the corrected ADRI. Since both ADRI measures are highly correlated (Spearman rank correlation, $r_s = 0.69$; p -value ≤ 0.01), there is little loss of information using the revised ADRI.

2.2. Ultimate foreign and government ownership

Various forms of ownership impose different levels of discipline on firms (see Aggarwal et al., 2011; Ferreira & Matos, 2008). Huang et al. (2022) argue that foreign ownership substitutes for country-level governance. They suggest that foreign ownership promotes risk-taking in countries with weak institutional governance. Arguably, government ownership helps prevent market failure and promotes socially desirable projects. Prior evidence on the relation between ownership and bank performance is mixed (see Cull et al., 2017, for a review). Government ownership tends to increase risk-taking due to government protection from bank default (Iannotta et al., 2013). Large voting and cash flow rights give shareholders more power and incentive to shape investment policy (La Porta et al., 1998). Thus, Laeven & Levine (2009) show that banks with owners that have larger voting and control rights take more risk. Very few studies examine the competing influences of government and foreign ownership on bank risk-taking. An exception is the study by Angkinand & Wihlborg (2010). They report that institutional mechanisms and ownership shape risk-taking in the presence of deposit insurance schemes. Yeyati & Micco (2007) indicate that banks with foreign ownership undertake higher risk-taking than domestic banks. Beltratti & Stulz (2012) measure ownership using the largest ultimate shareholder and find that ownership increases risk-taking. Given these perspectives, we hypothesize that,

H2A. Both government and foreign ownership decrease bank risk-taking around crisis periods.

H2B. Both government and foreign ownership increase bank risk-taking around crisis periods.

By government and foreign ownership, we mean part ownership of banks by governments and foreign investors, respectively. We measure ownership using the percentage of ultimate foreign corporate and ultimate government ownership available in BankFocus for our listed banks, headquartered in the 40 countries. Specifically, ownership is the percentage of bank shares held by foreign corporate and government owners of the commercial banks in our sample.

2.3. Bank regulation and supervision (BRS)

Due to the complexity of banks' operations (Morgan, 2002), institutional mechanisms and investor protection may be ineffective in thwarting expropriation or controlling excessive risk-taking. BRS rules may supersede investor protection arrangements or even render them superfluous (Caprio et al., 2007). As stated before, bank risk-taking varies under different bank regulatory regimes, depending on the comparative powers of shareholders (Laeven & Levine, 2009). Given these conditions, BRS rules may interact with institutional mechanisms and investor protection to influence risk-taking. Indeed, theory predicts that BRS rules enhance social welfare in the presence of higher risk-taking incentives (Boyd et al., 1998). However, while, empirically, generous deposit insurance exacerbates moral hazard and increases banking fragility (Demirgüç-Kunt & Detragiache, 2002), bank supervision incentivizes greater disclosure and private monitoring, while also reducing the moral hazard of deposit insurance (Barth et al., 2004). Cihák & Tieman (2008) report, however, that tighter official supervisory power and capital regulation increase banking system fragility (see also Demirgüç-Kunt & Detragiache, 2011). Thus, we hypothesize that,

H3A. Stronger BRS rules reduce bank risk-taking around crisis periods.

H3B. Stronger BRS rules increase bank risk-taking around crisis periods.

We measure BRS rules using Capital Regulation, Overall Restrictions on Banking, Independence of Supervisory Authority (Political), Limitations on Foreign Bank Entry, and No Explicit Deposit Insurance Scheme. We use these measures since they are commonly used in prior studies (Barth et al., 2013; Beltratti & Stulz, 2012; Cihák & Tieman, 2008; Hoque et al., 2015). Independence of Supervisory Authority (Political) and No Explicit Deposit Insurance Scheme are measured using dummy variables.

2.4. Predicting crisis regimes

Prior studies show that weaknesses in legal and regulatory mechanisms contribute to crisis events (Bebchuk & Spamann, 2010; Kirkpatrick, 2009). Beck et al. (2006a) suggest that regulatory systems that thwart bank competition, increase banking systems' fragility and intensify risk-taking. For example, deposit insurance schemes exacerbate moral hazard in banking by disincentivizing depositors to monitor banks, further encouraging excessive risk-taking. Thus, Demirgüç-Kunt & Detragiache (2002) find that deposit insurance schemes increase the likelihood of banking crises. While BRS rules aim to curb excessive managerial incentives, their effectiveness depends on the quality of the legal environment. Indeed, weak investor protection in countries increases the severity of crisis events (Johnson et al., 2000). Poor market discipline is associated with excessive risk-taking and increases the likelihood of banking crises (Anginer et al., 2014; Barth et al., 2004). Since economic fundamentals are largely sound and sustainable during tranquil periods but undergo an adjustment process during the crisis/post-crisis periods, we hypothesize that,

H4A. Stronger institutional mechanisms, investor protection, and BRS rules decrease the likelihood of pre-crisis and crisis/post-crisis regimes.

H4B. Stronger institutional mechanisms, investor protection, and BRS rules increase the likelihood of pre-crisis and crisis/post-crisis regimes.

Unlike prior studies (see Demirgüç-Kunt & Detragiache, 2002), we use the Bussiere & Fratzscher (2006) post-crisis bias test to predict crisis regimes. The model estimates the likelihood of the tranquil regime, the pre-crisis regime, and the crisis/post-crisis regime (see Section 3.1). The post-crisis bias test is more powerful than the binary logit or probit models since these models do not sufficiently discriminate among the phases of the crisis regimes (Bussiere & Fratzscher, 2006). We identify the crisis year(s) for each country using the Laeven & Valencia (2018) database. We extend their crisis years(s) to the more recent period. We adopt this approach since all countries did not necessarily experience a crisis in the same year. H4A and H4B are tested for each crisis period.

3. Model specification and the data**3.1. Model specification**

We measure risk-taking using $RISK_{i,t}$ and $Z-score_{i,t}$. These measures, and especially $Z-score_{i,t}$, are often used to capture risk-taking (Berger & Bouwman, 2009; Houston et al., 2010; John et al., 2008; Laeven & Levine, 2009). Following John et al. (2008) and Faccio et al. (2016), we estimate $RISK_{i,t}$ for bank i in year t , using the standard deviation of $DE_{i,t}$ from t to $t+4$, where $DE_{i,t}$ is the deviation of a bank's return on assets (ROA) from our global sample average, over 5-year overlapping windows. Hence, $DE_{i,t} = ROA_{i,t} - \overline{ROA}_t$ where $\overline{ROA}_t$ is the global average of ROA for our sample banks in 40 countries, in year t . ROA is the ratio of bank profit before tax to total assets. Thus, $RISK_{i,t}$ for bank i at year t in a country, is computed as,

$$RISK_{i,t} = \sqrt{\frac{1}{4} \sum_{j=0}^4 \left(DE_{i,t+j} - \frac{1}{5} \sum_{k=0}^4 DE_{i,t+k} \right)^2}, \quad (1a)$$

requiring five years of observations and removing bank-year observations, if unavailable over the window. We denote $RISK_{i,t}$ as RISK, as appropriate. Arguably, since we use the sample average $\overline{ROA}_t$, RISK may not be significantly affected by differences across countries. We therefore estimate another RISK measure, which we call $RISK^*$, using the standard deviation of each bank's ROA over 5-year

overlapping windows. Thus, $RISK^*_{i,t} = \sqrt{\frac{1}{4} \sum_{j=0}^4 \left(ROA_{i,t+j} - \frac{1}{5} \sum_{k=0}^4 ROA_{i,t+k} \right)^2}$. Both RISK and $RISK^*$ are profit volatility measures in line with our risk-taking focus. They are likely to capture banks' risky assets whose downside is realized at default. Since both risk measures generate similar results, we focus on the results using RISK as the dependent variable.

Following Laeven & Levine (2009) and Houston et al. (2010), we estimate $Z-score_{i,t}$ for bank i in a country at year t as,

$$Z-score_{i,t} = \ln((ROA_{i,t} + CAR_{i,t}) / \sigma ROA_{i,t}). \quad (1b)$$

In Eq. (1b), $ROA_{i,t}$ is the return on total assets, as defined before. $CAR_{i,t}$ is the equity to total assets ratio. $\sigma(ROA)$ is the standard deviation of $ROA_{i,t}$ which gives $Z-score_{i,t}$ a risk-taking interpretation. We use $Z-score_{i,t}$ and Z-score interchangeably. Z-score compares a bank's buffer (capitalization and returns) with the volatility of its return on assets, i.e., $\sigma(ROA)$. A higher Z-score indicates stronger balance sheet stability. Ahrend & Goujard (2015) show that bilateral bank flows significantly decrease when creditors' bank assets are hit by negative exogenous shocks, suggesting that Z-score is economically meaningful. Since Z-score is highly skewed (Anginer et al., 2014; Laeven & Levine, 2009), we follow prior studies by using the natural logarithm of the raw Z-score value. This approach enables us to compare our results with prior related studies.

Using our risk-taking measures, our baseline equation is:

$$RISK_{i,t} \text{ or } Z-score_{i,t} = \alpha + \rho_1 DLoans_{i,t} + \sum_l \beta_l Legal_{l,j,t} + \sum_m \beta_m Control_{m,i,t} + \sum_k \theta_k IncomeLevel_k + \sum_t \gamma_t Year_t + \varepsilon_{i,t}. \quad (2)$$

In Eq. (2), $RISK_{i,t}$ and $Z-score_{i,t}$ are risk-taking measures for bank i in year t , defined earlier. $DLoans_{i,t}$ are the deviation of bank loans to total assets of bank i , from the average country-level bank loans to total assets. Using bank loans scaled by total assets is likely to be a source of endogeneity since bank loans to total assets and risk-taking may be jointly determined. Furthermore, bank executives can increase risk-taking during tranquil periods and decrease the level of risk-taking during crisis periods, depending on their risk tolerance. A change of board structure can also cause risk-taking to be correlated with bank loans. Thus, in Eq. (2), we instrument $DLoans_{i,t}$ since we assume that an individual bank's $DLoans_{i,t}$ are unlikely to influence total country bank loans in year t (absence of simultaneity).⁸ We address the selection of our instrumental variables (IVs) below.

In Eq. (2), $Legal_{l,j,t}$ is a set of legal/institutional measures l in country j in year t . $Control_{m,i,t}$ is a set of m macroeconomic and financial control variables that influence crisis events and economic and financial development (Frankel & Saravelos, 2012; Johnson et al., 2000; La Porta et al., 1997). The m control variables include real GDP Growth to capture business cycle conditions (De Bruyckere et al., 2013) and the ratio of Market Capitalization by country to GDP to proxy for the state of financial development (see Wurgler, 2000). Higher financial market development improves capital allocation (Wurgler, 2000). Stronger legal and regulatory environments

⁸ Laeven & Levine (2009) use a related approach for their variables but based on their mean values.

improve financial market development (La Porta et al., 1997). $Income\ Level_k$ and $Year_t$ capture country income group and year fixed effects, respectively. Both aim to mitigate model misspecification due to potential missing variables and capture unobservable country development effects. For example, income level explains differences in the quality of BRS and economic development (Cihák & Tie-man, 2008). $\varepsilon_{i,t}$ is an error term. Our explanatory and control variables are not lagged since we want to relate them to risk-taking in the same sample period.

Since ownership and BRS rules may also influence risk-taking (see Caprio et al., 2007; Laeven & Levine, 2009), we extend Eq. (2) such that our full model is,

$$RISK_{i,t} \text{ or } Z\text{-score}_{i,t} = \alpha + \rho_1 DLoans_{i,t} + \sum_l \beta_l Legal_{l,j,t} + \sum_w \beta_w Ownership_{w,i,t} + \sum_r \beta_r Regulation_{r,j,t} + \sum_m \beta_m Control_{m,i,t} + \sum_k \theta_k Income\ Level_k + \sum_t \gamma_t Year_t + \varepsilon_{i,t}. \quad (3)$$

Here, $Ownership_{w,i,t}$ captures ultimate foreign corporate and government ownership w , for bank i at year t . $Regulation_{r,j,t}$ captures a set of BRS rules, r , in country j in year t . $Legal_{l,j,t}$ and $Regulation_{r,j,t}$ are likely to be exogenous since management cannot control their levels. However, $Ownership_{w,i,t}$ may be a source of endogeneity if innovations in $Ownership_{w,i,t}$ affect risk-taking. We suggest that this is unlikely, since the percentages of foreign and government ownership are relatively small (see Table 1) and appear to cluster at low levels of risk-taking (see Fig. 2).

Since Eqs. (2) and (3) are estimated using IV-GMM, we now consider our IVs. An IV should be correlated with the endogenous variable, (say), $DLoans_{i,t}$, and affect risk-taking *only* through its effect on $DLoans_{i,t}$. As such, we use various combinations of macro-economic variables including Private Credit to GDP, Domestic Credit to Private Sector to GDP, GDP per Capita and Gross National Product per Capita, since they are likely to affect $DLoans_{i,t}$ through their effects on economic conditions. For example, GDP per capita appears to be a valid IV since GDP per capita is likely to vary by country and influence $DLoans_{i,t}$. However, our IVs are likely to be invalid (i.e., the exclusion principle) if they simultaneously proxy for variables that affect the outcome variable. We report several diagnostic tests to validate our IVs. We find no evidence that our IVs are invalid.

Finally, we predict the crisis regimes using the Bussiere & Fratzscher (2006) post-crisis bias test. This test provides an early warning signal of the likelihood of: i) the tranquil year(s)/regime ($Y_{i,t} = 0$), when economic conditions are largely sound; ii) the pre-crisis year (s)/regime ($Y_{i,t} = 1$), when economic conditions are subject to adjustments; and iii) the crisis/post-crisis year(s)/regime ($Y_{i,t} = 2$), when economic adjustment occurs before achieving stability. Thus,

$$\begin{aligned} \Pr(Y_{i,t} = 0) &= \frac{1}{(1 + e^{X_{i,t}\beta^1} + e^{X_{i,t}\beta^2})}, \\ \Pr(Y_{i,t} = 1) &= \frac{e^{X_{i,t}\beta^1}}{(1 + e^{X_{i,t}\beta^1} + e^{X_{i,t}\beta^2})}, \\ \Pr(Y_{i,t} = 2) &= \frac{e^{X_{i,t}\beta^2}}{(1 + e^{X_{i,t}\beta^1} + e^{X_{i,t}\beta^2})}. \end{aligned} \quad (4)$$

In Eq. (4), $X_{i,t}$ is a vector of country-level explanatory variables including RISK or Z-score. For example, β^1 captures the effect of a change in $X_{i,t}$ on the probability of being in (say) a pre-crisis regime, relative to the probability of being in a tranquil regime. ($Y_{i,t} = 2$) captures a part of ($Y_{i,t} = 0$), as in standard binary models, but splits the sample into the crisis/post-crisis regime and the new tranquil regime. Thus,

$$Y_{i,t} = \begin{cases} 1 & \text{if } \exists k = 1, \dots, n, \text{ year(s) s.t. } CE_{i,t+k} = 1, \\ 2 & \text{if } \exists k = 0, \dots, p, \text{ s.t. } CE_{i,t-k} = 1, \\ 0, & \text{otherwise.} \end{cases} \quad (5)$$

In Eq. (5), $CE_{i,t}$ is the crisis event/year, which has a value of 1 in year t if country i is hit by a crisis; 0, otherwise.

3.2. The data

Our regression results are based on two sub-periods, estimated independently: i) the years 2005–2009, which span the GFC of 2007–2008; and, ii) the years 2009–2019, which span the 2010–2018 Eurozone Crisis period. As stated before, 2009 is a common year in both sample periods since we want to predict the crisis years in each period. We follow Beltratti & Stulz (2012), Erkens et al. (2012),

Table 1

Descriptive statistics for our main variables.

Panel A: Summary statistics of bank-specific variables						
RISK, RISK* and bank Z-score are risk-taking proxies at bank level. RISK is the standard deviation of the deviation of bank ROA from the global sample average ROA for all banks, using fixed 5-year moving windows. RISK* is the standard deviation of each bank's ROA over a similar window. Z-score is estimated as $\ln((CAR + ROA)/\sigma(ROA))$, where CAR is the capital-to-asset ratio, ROA is bank return on assets, and $\sigma(ROA)$ is standard deviation of bank ROA. Government Ownership and Foreign Ownership are government ultimate ownership and foreign ultimate corporate ownership, respectively. Bank Deposits are scaled by bank total assets. $DLoans_{i,t}$ are the deviation of the ratio of each bank's total loans to bank total assets in a country from the average ratio of all bank loans to total assets. Tangible Equity is shareholder equity minus intangible assets to total assets. Funding Fragility is the ratio of the sum of deposits from other banks, other deposits, and short-term borrowing, to the sum of total deposits, money market and short-term funding. Variable definitions are in WEB Appendix A .						
Variable	N	Mean	Median	Min	Max	Std. Dev.
RISK (%)	3224	0.713	0.305	0.0004	84.866	2.744
RISK* (%)	3224	0.724	0.259	0.0001	84.953	2.731
Bank Z-score (natural log)	3207	3.581	3.655	-3.218	15.444	1.318
Foreign Ownership (%)	2362	12.522	7.15	0	49	16.574
Government Ownership (%)	2362	4.136	0.42	0	94.9	13.996
Tangible Equity (%)	3224	9.832	8.134	0.063	110.0188	11.231
Deviation of Bank Loans (%)	3221	2.208	-1.952	-132.358	2378.806	69.189
Bank Deposits (%)	3224	79.915	74.780	20.442	3233.157	92.677
Bank Size/Total asset (in logs)	3224	16.397	15.822	13.819	22.028	2.032
Funding Fragility (%)	3224	13.145	8.898	0.0004	75.958	13.888
Non-performing loans (%)	3833	3.2249	1.65	0	80	6.4118
Panel B: Summary statistics of country-level variables						
RISK, RISK*, Z-Score, Foreign Ownership and Government Ownership are at country level. ADRI is the Spamann (2010) ADRI for investor protection. The Djankov et al. (2008) revised ADRI is used for China, Kazakhstan, Ukraine, Russia, Poland and Tunisia due to unavailable Spamann (2010) ADRI data. Quality of Government is the aggregate of the six dimensions of the Worldwide Governance Indicators (WGIs). The other variables are from Global Financial Development, the Popular Indicators Database of World Bank and the World Bank Surveys.						
Variable	N	Mean	Median	Min	Max	Std. dev.
RISK (%)	310	0.741	0.394	0.004	21.334	2.139
RISK* (%)	310	0.623	0.183	0.001	21.997	2.211
Bank Z-score (natural log)	307	3.761	3.756	-0.447	9.012	1.301
ADRI (Investor Protection)	310	3.932	4	1	6	0.924
Rule of Law	310	0.699	0.705	-1.016	2.014	0.993
Control of Corruption	310	0.698	0.630	-1.132	2.470	1.153
Regulatory Quality	310	0.761	0.946	-0.957	1.984	0.865
Government Effectiveness	310	0.846	0.989	-0.877	2.437	0.927
Quality of Government	310	3.622	0.988	-7.069	11.334	5.490
Real GDP Growth (%)	310	-0.931	-0.433	-24.147	9.637	4.025
Foreign Ownership (%)	310	27.957	25.262	0	49	19.266
Government Ownership (%)	310	9.920	0.852	0	98.609	17.713
Capital Regulatory Index	308	6.905	7	1	10	1.963
Overall Restrictions on Banking	308	6.822	7	3	12	2.041
Limit. on Foreign Bank Entry	310	3.772	4	0	4	0.610
Bank Concentration (%)	310	63.117	62.348	20.846	100	20.232
Government Expend Growth (%)	302	3.179	2.248	-7.404	48.324	4.923
Broad Money Growth (%)	305	6.566	6.249	-54.965	60.537	11.830
Terms of Trade (%)	310	99.205	99.592	57.777	169.312	18.840
Market Capitalization to GDP (%)	305	100.994	64.411	6.532	1086.340	153.121
Stock Market Turnover Ratio	310	72.520	66.893	1.151	292.615	52.691
Bank Capital to Total Assets (%)	305	7.826	7	3	15.2	2.875
Stock Market Return (%)	308	8.439	7.332	-46.866	378.825	32.059
Bank Deposit to GDP (%)	297	77.01	64.453	15.739	320.766	51.414
Gross National Income Growth (%)	305	2.972	2.787	-15.722	19.503	4.038
Domestic Credit to Private Sector divided by GDP (%)	305	98.191	96.202	11.910	218.16	50.984

and Hoque et al. (2015) and use similar years for the GFC period. We use 2010 as the start of the Eurozone Crisis period since May 2010 is the date of the first Greek bailout by the European Central Bank and IMF (see also, Joseph et al., 2020). We use 2018 as the end of the Eurozone Crisis period since European leaders declared the crisis to be over in August 2018 (Brunsdén & Khan, 2018).⁹ Our sub-samples include the years outside the crisis periods since we also want to predict the crisis regimes. Our full sample contains 686 listed commercial banks, headquartered in 40 countries, after removing bank subsidiaries, banks with loans-to-asset ratios of less than 10%, banks with deposits-to-assets ratios of less than 20% (see Beltratti & Stulz, 2012), and banks with total assets of less than US\$1 billion. These restrictions are likely to limit our sample to mainly deposit-taking banks (Beltratti & Stulz, 2012). Since we need to have at least three banks in a country to compute the Bank Concentration proxy (see Beltratti & Stulz, 2012), this further limits the number of countries we examine. The number of countries in our study is comparable to those of Laeven & Levine (2009) and Beltratti & Stulz (2012) but we have a larger number of listed banks (see Appendix 1).¹⁰

Our data sources include the World Bank Global Financial Development (2019), the World Bank, and Bank Focus. The BRS rules are from World Bank Surveys on the Bank Regulation database. The U.K. and U.S. economies are treated as affected by the Eurozone Crisis since their sovereign bond yields declined during the period (De Santis & Zimic, 2018). However, we test the sensitivity of our results to the assumption that only Eurozone banks were affected by the Eurozone Crisis. The largest and smallest 1% of the observations are winsorized variable by variable before estimation.

3.3. Descriptive statistics, correlations and plots

Table 1 shows the descriptive statistics for the main variables used to estimate our regressions. RISK and RISK* have non-zero means of 0.71% and 0.72%, respectively, using bank-level data (Panel A). The mean of log (Z-score) is 3.58 at bank level. These risk-taking values are not too different from those of the country-level data in terms of their means and standard deviations (see Panels A and B, Table 1). Foreign Ownership and Government Ownership have means of 12.52 and 4.14%, respectively (Panel A). The Foreign Ownership percentage is larger than the Government Ownership percentage (see Table 1, Panel A). The large percentage of Foreign Ownership is unexpected since foreign ownership tends to decrease around crisis events and government ownership tends to increase (Cull et al., 2017). However, Claessens & Van Horen (2014) show that, as the overall number of domestic banks decreased during the 2007 to 2013 period, foreign bank share increased and ownership shifted away from OECD to non-OECD countries. This may partly explain the larger percentage of Foreign Ownership compared to the percentage of Government Ownership.

RISK and RISK* are positively correlated ($r_s = 0.80$; p -value ≤ 0.01), in untabulated results. Thus, using RISK or RISK* would not systematically alter our results. RISK and RISK* are negatively correlated with the institutional mechanisms, whereas Z-score has the expected positive relationship (p -value ≤ 0.10). Since the correlations do not imply causality, we test for causality effects using our regressions.

Fig. 1 plots the relationships between RISK (at country level) and Investor Protection, and RISK (at country level) and Quality of Government for 2008 and 2010. Fig. 1 shows that, except for the U.S. (USA) in terms of Investor Protection, developed countries tend to have the highest levels of Investor Protection and Quality of Government. Their values align with low to moderate RISK levels in both years. China (CHN) has the lowest Investor Protection value, followed by the U.S. (USA). The U.S. (USA) has high values for Quality of Government in both years, against a relatively low value of RISK. Pakistan (PAK) has the lowest Quality of Government score followed by Russia (RUS). Ukraine (UKR) has the highest RISK value in 2008, even if the U.S. is the source of the GFC (Panel A of Fig. 1). In contrast, Greece (GRC) has the highest RISK value in 2010, with moderate Investor Protection and Quality of Government values (Panel B of Fig. 1). While Greece (GRC) is regarded as the source of the Eurozone Crisis, it is Ukraine (UKR) that has the highest RISK value in 2008 (Panels A and B). Hence, the plots suggest that higher risk-taking does not clearly correlate with crisis events.

Fig. 2 plots RISK (at country level) against both government and foreign ownership in 2008 and 2010. Ownership varies across countries in both years. The trend lines for Foreign and Government Ownership are downward sloping in 2008 but upward sloping in 2010. For both years, low to moderate levels of Foreign Ownership are concentrated at low levels of RISK (Panels A and B). In contrast, low to moderate levels of Government Ownership are concentrated at higher levels of RISK, in line with the view that government ownership is associated with higher risk-taking (Iannotta et al., 2013). We find related patterns using the Z-score plots which are available on request.

⁹ Prior studies use different sample periods for the Eurozone Crisis. Ongena et al. (2019) use 2009–2012 for the Eurozone Crisis period, whereas Acharya et al. (2018) use the 2010–2012 period. For both studies, the crisis year end is 2012 although Ongena et al. (2019) extended their sample to 2013. Hoque et al. (2015) use 2010–2011 to examine risk-taking around the Eurozone Crisis period. 2011 appears to be the end of their sample period. Using the 2011, 2012 or 2013 as the end of the Eurozone Crisis period ignores several other Eurozone Crisis episodes, including the bailout of Italian banks in mid-2016, and Spain's bank recapitalization programs between 2012 and 2014, and its deleveraging in late 2016 (see Gandrud & Hallerberg, 2014; Lehmann, 2017). Gandrud & Hallerberg (2014) provide a list of 15 Asset Management Companies (AMCs) created by 12 E.U. countries for some 37 failing banks during 2008–2014. Even so, we re-run the estimation for the 2009–2012 period. These additional results are consistent with our reported findings (see WEB Appendix B).

¹⁰ Our sample compares favourably with prior studies. Laeven & Levine (2009) use 279 publicly listed banks from 48 countries. Beltratti & Stulz (2012) use 387 banks from 32 countries. Using 5-year overlapping windows to compute RISK further reduces the number of observations in our sample.

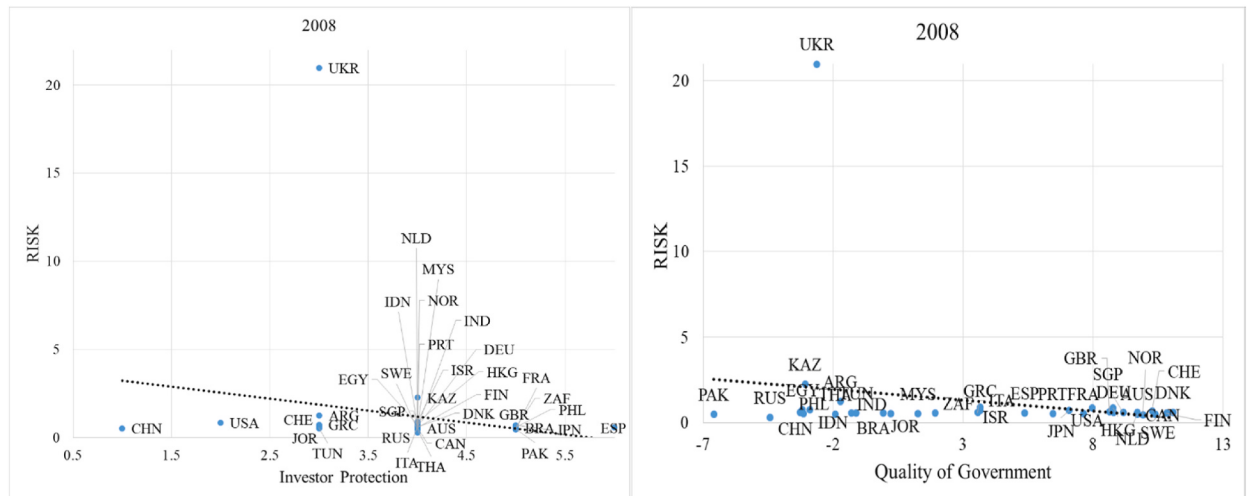
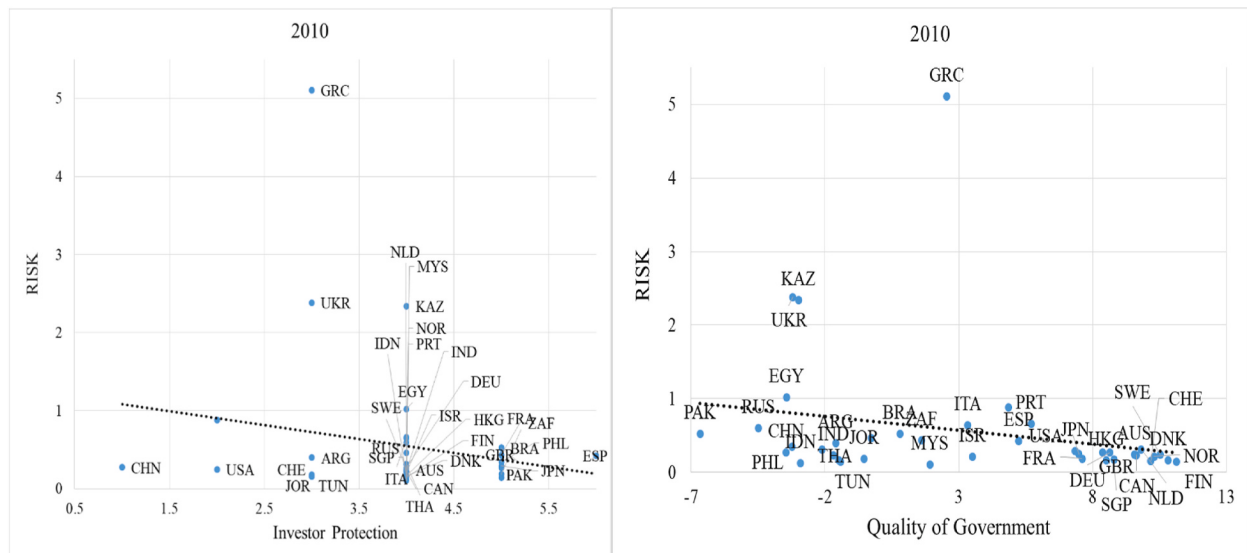
Panel A: Plots of Global Financial Crisis year of 2008**Panel B: Plots of Eurozone Crisis year of 2010**

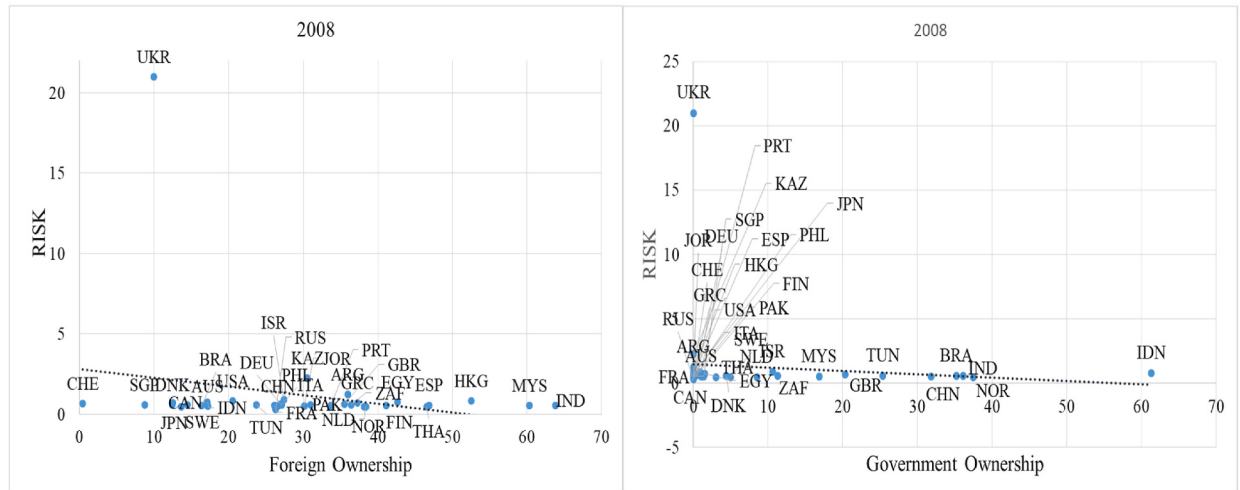
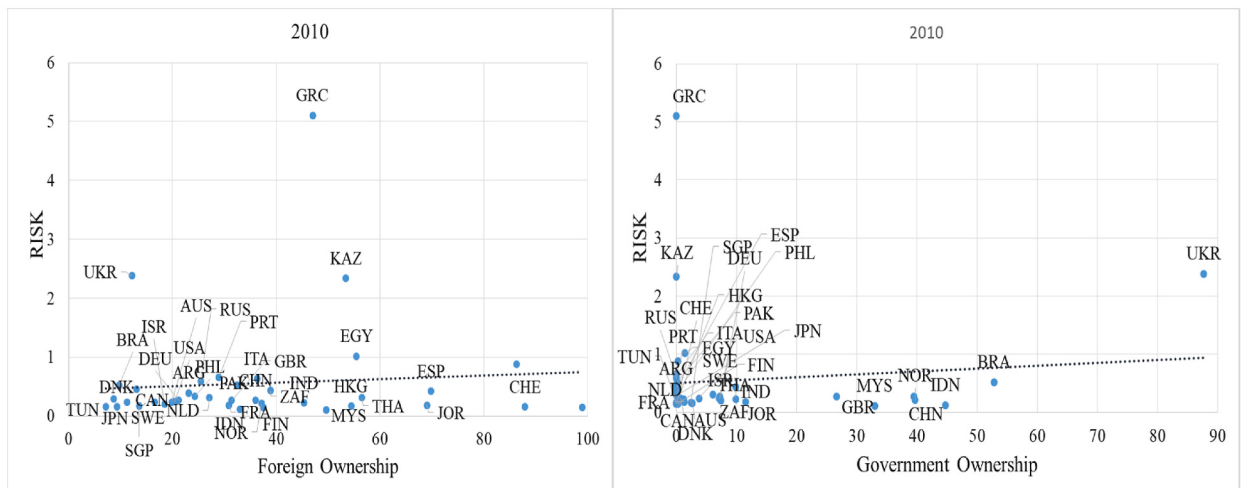
Fig. 1. Plots of RISK, investor protection and quality of government for 2008 and 2010.

This figure shows the plots for investor protection and Quality of Government against RISK at country level. Investor protection is based on the Spamann (2010) corrected ADRI. The corrected ADRI is unavailable for China, Kazakhstan, Ukraine, Russia, Poland and Tunisia. We therefore use the Djankov et al. (2008) revised ADRI for these countries. Low scores indicate stronger directors' rights. Quality of Government Index is based on the aggregate of the six operationalized dimensions of Worldwide Governance Indicators (WGIs) available at the World Bank. A high score indicates high government quality. RISK is based on the standard deviation of the deviation of each country's average bank ROA from the global average ROA over 5-year overlapping windows and aggregated to country level.

4. Empirical results

4.1. Institutional mechanisms, investor protection and risk-taking

Tables 2a–2b show the IV-GMM regression coefficients after regressing RISK or Z-score on institutional mechanisms, Investor Protection (ADRI), and the control variables. The IV-GMM regressions include country income and year fixed effects to control for unobservable confounding effects. We do not show the coefficients for fixed effects and most control variables to save space. The tables show that the Hayashi C statistic for endogeneity and Hansen J-statistic for over-identifying restrictions are insignificant (p -value ≥ 0.10). The robust F -statistic of the first-stage regression is significant, indicating that our IVs are not weak (p -value ≤ 0.10). Based on

Panel A: Plots of Global Financial Crisis year of 2008**Panel B: Plots of Eurozone Crisis year of 2010****Fig. 2.** Plots of RISK and ownership for 2008 and 2010.

The figure shows plots of the average weighted percentage of foreign and government ownership against RISK at country level. Foreign corporate ultimate ownership is the average of foreign corporate ultimate ownership in a country weighted by bank total assets. Government ownership is the average of government ultimate ownership in a country weighted by bank total assets. RISK is based on the standard deviation of the deviation of each country's average bank ROA from the global average ROA over 5-year overlapping windows and aggregated to country level.

these tests, there does not appear to be endogeneity concerns. However, we do not suggest that we have addressed all sources of endogeneity.

Tables 2a–2b show that ADRI (Investor Protection) and institutional mechanisms reduce risk-taking in the baseline equations (see Eq. (2)) for both sample periods. They do so using both RISK and Z-score as dependent variables (p -value ≤ 0.10). Thus, we reject **H1B** in favor of **H1A** to support the view that Investor Protection and institutional mechanisms reduce risk-taking. Using RISK as the dependent variable, the negative ADRI coefficients are in the range of -0.58 (p -value ≤ 0.01) to -0.26 (p -value ≤ 0.05) for the 2005–2009 period, which contains the GFC period (see Panel A of Table 2a). The coefficients have a wider range for the 2009–2019 period, which contains the Eurozone Crisis period (p -value ≤ 0.10 ; Panel B of Table 2a). As expected, the sensitivity of these variables varies across the sample periods since they are affected by crisis events that have different origins.

As indicated above, the coefficients for institutional mechanisms and investor protection are large in absolute terms. Furthermore, the coefficients for institutional mechanisms are much larger than those of Investor Protection in absolute terms. For example, when significant, the coefficients for institutional mechanisms are up to seven (five) times larger than those of ADRI, using RISK (Z-score) as the dependent variable for the 2005–2009 period. We find related results for the 2009–2019 period, but here, the magnitudes of the

Table 2a

IV-GMM coefficients for institutional mechanisms using RISK as the dependent variable.

The IV-GMM coefficients are for 686 banks in 40 countries. RISK is the dependent variable at bank level. In Panel A, the sample period is 2005–2009 and contains the 2007–2008 GFC period. In Panel B, the sample period is 2009–2019 and contains the 2010–2018 Eurozone Crisis period. ADRI is the Spamann (2010) investor protection. The Djankov et al. (2008) revised ADRI is used for China, Kazakhstan, Ukraine, Russia, Poland and Tunisia due to unavailable Spamann (2010) ADRI data. IM denotes Institutional Mechanism in terms of Rule of Law, Control of Corruption, Regulatory Quality, Government Effectiveness and Quality of Government. Bank Deposit, Bank Size, Tangible Equity, Funding Fragility, Real GDP Growth, Government Expenditure Growth, Broad Money Growth, Terms of Trade, Market Capitalization to GDP and Stock Market Turnover Ratio are control variables. Most control variables are not shown to save space. $DLoans_{i,t}$ are the deviation of bank loans to total assets of bank i , from the average country-level bank loans to total assets. $DLoans_{i,t}$ are instrumented with Private Credit to GDP and GDP per capita. Variable definitions are in WEB Appendix A. Hayashi C statistic, J -statistic and First Stage Robust F -statistic are tests for endogeneity, over-identifying restriction and weak instruments, respectively. The Wald χ^2 statistic tests whether all the coefficients, besides the constant are significant. Robust standard errors are in parentheses. ^a, ^b, and ^c denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Estimates for the 2005–2009 period										
Variable	Rule of Law		Control of Corruption		Regulatory Quality		Govt. Effectiveness		Quality of Government	
ADRI (Investor protection)	−0.472 ^a (0.082)	−0.300 ^a (0.101)	−0.373 ^a (0.049)	−0.258 ^a (0.057)	−0.580 ^a (0.103)	−0.245 ^b (0.118)	−0.403 ^a (0.071)	−0.257 ^b (0.114)	−0.416 ^a (0.097)	−0.324 ^a (0.104)
Institutional Mechanism (IM)	−2.061 ^a (0.442)	−1.861 ^a (0.408)	−1.785 ^a (0.289)	−1.801 ^a (0.290)	−2.257 ^a (0.504)	−1.888 ^a (0.479)	−1.386 ^a (0.287)	−1.206 ^a (0.288)	−0.361 ^a (0.087)	−0.349 ^a (0.077)
High_ADRI × IM		−0.007 (0.071)		−0.272 ^a (0.067)		−0.115 (0.103)		−0.057 (0.097)		0.001 (0.013)
Low_ADRI × IM		0.435 ^a (0.133)		0.015 (0.086)		0.583 ^a (0.176)		0.210 ^b (0.097)		0.035 (0.022)
Bank Concentration	0.010 ^a (0.004)	0.010 ^a (0.003)	0.016 ^a (0.004)	0.014 ^a (0.004)	0.002 (0.003)	0.002 (0.003)	0.005 ^b (0.003)	0.005 ^c (0.003)	0.003 (0.003)	0.006 ^b (0.003)
Constant	0.285 (0.730)	0.580 (0.803)	−0.593 (0.700)	−1.161 ^c (0.686)	2.982 ^a (0.752)	2.025 ^c (1.207)	2.198 ^b (0.913)	1.637 ^c (0.984)	0.361 (0.814)	0.122 (0.719)
Observations	1037	1052	1037	1037	1037	1052	1052	1052	1054	1052
R-squared	0.134	0.138	0.158	0.140	0.123	0.132	0.111	0.118	0.021	0.097
Wald χ^2 statistic	166.58 ^a	227.10 ^a	275.91 ^a	297.37 ^a	197.80 ^a	296.21 ^a	340.46 ^a	402.33 ^a	248.87 ^a	253.79 ^a
Hayashi C statistic	2.291	1.114	0.001	0.471	2.221	0.118	0.656	0.324	0.430	0.610
Hansen J -statistic	1.893	0.097	0.358	1.848	1.069	0.0002	1.306	0.083	1.480	1.380
First Stage F -statistic	5.959 ^a	9.311 ^a	5.915 ^a	8.248 ^a	5.761 ^a	14.872 ^a	13.797 ^a	13.867 ^a	3.214 ^a	10.232 ^a
Panel B: Estimates for the 2009–2019 period										
ADRI (Investor Protection)	−0.408 ^a (0.151)	−0.224 ^c (0.134)	−0.313 ^c (0.175)	−0.338 ^b (0.160)	−0.498 ^c (0.262)	−0.324 ^c (0.169)	−0.181 ^b (0.084)	−0.275 ^b (0.108)	−0.691 ^a (0.234)	−0.459 ^b (0.227)
Institutional Mechanism (IM)	−1.000 ^a (0.286)	−0.809 ^c (0.450)	−0.829 ^a (0.289)	−0.899 ^a (0.324)	−0.647 ^b (0.317)	−1.337 ^c (0.718)	−0.660 ^c (0.361)	−0.038 (0.236)	−0.152 ^a (0.057)	−0.092 (0.067)
High_ADRI × IM		−0.484 (0.445)		−0.022 (0.359)		−0.694 (0.456)		−0.497 ^c (0.280)		0.019 (0.081)
Low_ADRI × IM		−0.154 (0.683)		0.068 (0.562)		−0.203 (0.598)		−0.322 (0.298)		0.100 (0.112)
Bank Concentration	−0.001 (0.010)	−0.001 (0.018)	0.005 (0.018)	−0.004 (0.024)	−0.016 (0.015)	−0.003 (0.012)	0.010 (0.011)	−0.009 (0.009)	−0.017 (0.017)	−0.028 (0.019)
Constant	3.432 ^c (1.988)	2.388 (3.696)	2.161 (2.979)	3.818 (4.239)	5.784 (3.936)	2.920 (2.196)	−0.056 (1.829)	2.994 (2.053)	8.120 ^c (4.259)	7.511 (5.646)
Observations	2283	2244	2261	2244	2283	2074	2261	2283	2283	2275
R-squared	0.080	0.088	0.045	0.048	0.081	0.089	0.110	0.112	0.114	0.115
Wald χ^2 statistic	79.49 ^a	106.31 ^a	88.92 ^a	64.84 ^a	49.44 ^a	48.40 ^a	98.16 ^a	49.39 ^a	73.66 ^a	65.68 ^a
Hayashi C statistic	2.163	0.406	0.408	2.355	2.374	2.339	2.014	1.813	1.584	1.458
Hansen J -statistic	0.780	0.783	0.550	0.934	0.774	0.007	2.198	1.606	0.494	0.687
First Stage F -statistic	5.696 ^a	4.685 ^a	9.010 ^a	5.155 ^a	8.008 ^a	4.216 ^a	6.376 ^a	2.710 ^c	2.412 ^c	2.519 ^c

institutional mechanisms and ADRI coefficients are generally smaller. In general, laws relating to institutional mechanisms dominate ADRI in reducing risk-taking. This may be due to investor protection rules largely being drawn from legal rules, as well as the origin of legal rules (La Porta et al., 1998).

For the 2005–2009 period, Investor Protection is in the range of 0.28 (p -value ≤ 0.01) to 0.60 (p -value ≤ 0.01), when significant, after controlling for Control of Corruption and Regulatory Quality, respectively (see Panel A, Table 2b) and using Z-score as the dependent variable. Based on these coefficients, a one standard deviation increase of 0.92 for Investor Protection, is associated with a change in Z-score in the range of 6.85% ($=0.28 \times 0.92/3.76$) to 14.68% ($=0.60 \times 0.92/3.76$), when Z-score has a mean of 3.76, and Investor Protection has a standard deviation of 0.92 in *untabulated* results. Given the large decreasing effects of institutional mechanisms and Investor Protection on risk-taking, it is questionable whether increases in their stringency could have prevented the crises, since more stringent rules could be detrimental to well-governed banks (Bruno & Claessens, 2010). However, it can be argued that weaknesses in institutional mechanisms and investor protection may have increased the severity of the crises once the crises took effect. Johnson et al.'s (2000) results appear to support this view. Our results contrast with those of Beltratti & Stulz (2012) and Hoque et al. (2015), who test an alternative hypothesis. In a subsequent section, we replicate the Beltratti & Stulz (2012) and Hoque et al.

Table 2b

IV-GMM coefficients for institutional mechanisms using Z-score as the dependent variable.

The IV-GMM coefficients are for 686 banks in 40 countries. Z-score is the dependent variable at bank level. In Panel A, the sample period is 2005–2009 and contains the 2007–2008 GFC period. In Panel B, the sample period is 2009–2019 and contains the 2010–2018 Eurozone Crisis period. ADRI is the Spamann (2010) investor protection. The Djankov et al. (2008) revised ADRI is used for China, Kazakhstan, Ukraine, Russia, Poland and Tunisia due to unavailable Spamann (2010) ADRI data. IM denotes Institutional Mechanism in terms of Rule of Law, Control of Corruption, Regulatory Quality, Government Effectiveness and Quality of Government. Bank Deposit, Bank Size, Tangible Equity, Funding Fragility, Real GDP Growth, Government Expenditure Growth, Broad Money Growth, Terms of Trade, Market Capitalization to GDP and Stock Market Turnover Ratio are control variables. Most control variables are not shown to save space. $DLoans_{i,t}$ are the deviation of bank loans to total assets of bank i , from the average country-level bank loans to total assets. $DLoans_{i,t}$ are instrumented with Private Credit to GDP and GDP per capita. Variable definitions are in WEB Appendix A. Hayashi C statistic, J -statistic and First Stage Robust F -statistic are tests for endogeneity, over-identifying restriction and weak instruments, respectively. Wald χ^2 statistic tests whether all the coefficients, besides the constant are significant. Robust standard errors are in parentheses. ^a, ^b, and ^c denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Estimates for the 2005–2009 period										
Variable	Rule of Law		Control of Corruption		Regulatory Quality		Govt. Effectiveness		Quality of Government	
ADRI (Investor Protection)	0.462 ^a (0.135)	0.330 ^a (0.096)	0.424 ^a (0.109)	0.279 ^a (0.081)	0.597 ^a (0.178)	0.095 (0.105)	0.507 ^a (0.118)	0.340 ^a (0.094)	0.515 ^a (0.153)	0.309 ^a (0.093)
Institutional Mechanism (IM)	1.417 ^a (0.314)	1.654 ^a (0.280)	1.409 ^a (0.175)	1.478 ^a (0.172)	1.538 ^a (0.409)	1.852 ^a (0.300)	1.341 ^a (0.214)	1.403 ^a (0.205)	0.323 ^a (0.068)	0.287 ^a (0.050)
High_ADRI × IM		0.308 ^c (0.166)		0.480 ^a (0.157)		0.755 ^a (0.228)		0.370 ^b (0.178)		0.038 (0.030)
Low_ADRI × IM		−0.164 (0.137)		−0.006 (0.113)		−0.460 ^a (0.170)		−0.039 (0.123)		−0.006 (0.025)
Bank Concentration	−0.001 (0.004)	−0.001 (0.003)	−0.009 ^a (0.003)	−0.003 (0.003)	0.006 (0.005)	0.007 ^c (0.004)	−0.001 (0.005)	0.002 (0.004)	0.003 (0.005)	0.001 (0.003)
Constant	4.097 ^a (1.195)	4.694 ^a (0.976)	5.173 ^a (0.952)	5.065 ^a (1.005)	1.708 (1.696)	4.331 ^a (1.042)	2.816 ^c (1.683)	3.374 ^a (1.021)	3.973 ^a (1.462)	5.283 ^a (0.942)
Observations	1046	1029	1029	1029	1046	1029	1044	1029	1046	1029
R-squared	0.108	0.109	0.072	0.122	0.100	0.103	0.115	0.115	0.111	0.111
Wald χ^2 statistic	181.17 ^a	218.91 ^a	270.81 ^a	288.32 ^a	127.65 ^a	219.45 ^a	179.54 ^a	211.95 ^a	156.94 ^a	245.20 ^a
Hayashi C statistic	0.164	0.057	0.459	2.373	1.663	0.592	0.505	0.576	1.343	0.019
Hansen J -statistic	1.767	14.579	0.502	0.001	0.708	0.778	0.123	0.377	0.553	2.492
First Stage F -statistic	4.258 ^a	14.579 ^a	15.012 ^a	7.620 ^a	4.599 ^b	14.977 ^a	3.194 ^b	8.620 ^a	3.579 ^b	15.391 ^a
Panel B: Estimates for the 2009–2019 period										
ADRI (Investor Protection)	0.228 ^b (0.099)	0.148 ^c (0.087)	0.208 ^c (0.117)	0.100 (0.109)	0.232 ^b (0.117)	0.116 (0.106)	0.207 ^a (0.078)	−0.116 (0.132)	0.219 ^b (0.102)	0.216 ^b (0.100)
Institutional Mechanisms (IM)	0.812 ^a (0.178)	0.653 ^a (0.163)	0.889 ^a (0.158)	0.778 ^a (0.150)	0.920 ^a (0.312)	0.452 ^b (0.224)	0.918 ^a (0.166)	0.556 ^a (0.202)	0.130 ^a (0.033)	0.082 ^b (0.035)
High_ADRI × IM		0.310 ^a (0.116)		0.232 (0.170)		0.505 ^a (0.167)		0.715 ^a (0.236)		0.051 ^b (0.023)
Low_ADRI × IM		0.234 ^c (0.136)		0.271 ^c (0.147)		0.381 ^b (0.193)		0.444 ^b (0.183)		0.096 ^a (0.032)
Bank Concentration	0.008 (0.005)	0.008 ^b (0.004)	0.004 (0.007)	0.002 (0.004)	0.009 ^b (0.004)	0.011 ^b (0.006)	0.008 ^c (0.004)	0.007 ^c (0.004)	0.009 ^c (0.005)	0.005 (0.006)
Constant	2.833 ^b (1.213)	3.835 ^a (0.740)	2.815 ^c (1.496)	4.666 ^a (1.373)	3.182 ^b (1.305)	5.622 ^a (0.919)	2.921 ^a (0.958)	6.490 ^a (1.707)	4.403 ^a (1.188)	5.612 ^a (1.078)
Observations	2272	2272	2250	2272	2272	2020	2272	2272	2020	2020
R-squared	0.168	0.179	0.177	0.188	0.163	0.176	0.171	0.183	0.167	0.179
Wald χ^2 statistic	268.50 ^a	330.33 ^a	278.92 ^a	500.45 ^a	278.92 ^a	332.97 ^a	372.04 ^a	323.43 ^a	255.93 ^a	387.30 ^a
Hayashi C statistic	1.892	1.599	2.287	0.038	1.169	0.746	0.230	2.306	2.023	0.470
Hansen J -statistic	0.534	2.107	2.107	2.269	0.324	0.040	0.766	2.609	1.545	2.199
First Stage F -statistic	2.566 ^c	3.256 ^b	2.870 ^c	9.830 ^a	8.640 ^a	3.809 ^b	4.552 ^b	6.055 ^a	6.684 ^a	4.851 ^a

(2015) approach and find support for their claims.

4.2. Strength of investor rights protection and risk-taking

Cross-country differences in financing and investments levels are attributed to heterogeneity in investor protection and legal rules (La Porta et al., 1997, 2002). Higher ownership concentration is associated with poorer investor protection in countries (La Porta et al., 1999). Thus, while we find that institutional mechanisms and investor protection reduce risk-taking, it is possible that the extent of risk mitigation depends on the strength of investor protection in countries. As such, we test the effects of variation in the strength of investor protection by attributing a value of 1 to the highest 30% of the ADRI scores by country, denoted High_ADRI; 0, otherwise. Conversely, countries with the lowest 30% of ADRI scores, denoted Low_ADRI, are attributed a value of 1; 0, otherwise. We then separately interact High_ADRI and Low_ADRI with each institutional mechanism (IM) to determine their combined effects. While these cut-off points are arbitrary, they enable us to test conditions that relate to theoretical and empirical predictions. For example, La Porta et al. (1999) show that very few firms are widely held except in countries with strong investor protection, implying that the absence of

dominant shareholders is likely to reduce risk-taking. In the [Stulz \(2005\)](#) model, private appropriation benefits vary across countries and stronger investor protection makes it more costly for insiders to expropriate from outsiders. These perspectives suggest that banks in high investor protection countries are likely to experience a decrease in risk-taking, whereas those in low investor protection countries are likely to experience an increase in risk-taking.

[Tables 2a–2b](#) show the coefficients based on the interaction terms, i.e., $\text{High_ADRI} \times \text{IM}$ and $\text{Low_ADRI} \times \text{IM}$. The tables show that high Investor Protection countries experienced lower risk-taking, whereas low Investor Protection countries experienced higher risk-taking ($p\text{-value} \leq 0.10$) during the 2005–2009 period. This result is in line with the view that greater (weaker) Investor Protection, given the institutional environment, enhances (reduces) stock valuation and investment opportunities. High Investor Protection also reduces the private benefits of controlling investors on account of greater property rights ([La Porta et al., 1997, 2002; Nenova, 2003; Wurgler, 2000](#)). Conversely, low Investor Protection, given the institutional environment, increases risk-taking, if controlling shareholders stand to gain more cash flow rights in poor investor protection countries (see [Shleifer & Vishny, 1997](#)). Thus, fear of expropriation is likely to be much higher in countries with weak investor protection and weak legal enforcement ([Giannetti & Simonov, 2006](#)).

For the 2009–2019 period, only one coefficient is negative and significant for the interaction terms, when RISK is the dependent variable ($p\text{-value} \leq 0.10$). The remaining coefficients are insignificant. However, using Z-score as the dependent variable, both high and low Investor Protection countries experienced lower risk-taking for the 2009–2019 period. The risk reduction effect of $\text{Low_ADRI} \times \text{IM}$ is unexpected. If moral suasion caused many Eurozone banks to increase their exposure to sovereign risk (see [Weidmann, 2013](#)), then low investor protection countries should also experience an increase in risk-taking. This is not what we find. However, under the Basel III arrangements, banks are required to maintain higher capital requirements. This suggests that Basel III requirements may provide an explanation for low risk-taking in both high and low investor protection countries. It is worth noting that not all the banks in our sample are headquartered in a Eurozone member state. We therefore note ahead of [Section 5](#), that re-estimating the regressions using only Eurozone banks does not alter our main results.

4.3. Financial and macroeconomic variables

Prior evidence relating to the influence of bank charter/franchise value on bank financial performance is mixed ([Beltratti & Stulz, 2012; Keeley, 1990](#)). Banks with valuable charter are predicted to take less risk to avoid bankruptcy or loss of their valuable charter. [Beltratti & Stulz \(2012\)](#) hypothesize that a more concentrated banking system allows banks to earn monopoly rent. However, they find no support for their prediction. Like [Houston et al. \(2010\)](#) and [Beltratti & Stulz \(2012\)](#), we measure bank charter value using the total assets of the three largest commercial banks in a country, relative to the total assets of all banks in that country. We call this measure Bank Concentration. Panel A of [Table 2a](#) shows that Bank Concentration increased risk-taking during the 2005–2009 period ($p\text{-value} \leq 0.10$), although we find mixed evidence when Z-score is used as the dependent variable for the same sample period ($p\text{-value} \leq 0.10$; Panel A, [Table 2b](#)). Bank Concentration is insignificant for the 2009–2019 period, using RISK as the dependent variable ([Table 2a](#), Panel B). However, Bank Concentration decreased risk-taking using Z-score for the same period ($p\text{-value} \leq 0.10$; [Table 2b](#), Panel B). As such, a one standard deviation increase of 26.92% for Bank Concentration is associated with an increase in Z-score of between 0.054% ($= 0.008 \times 26.92/4.00$) and 0.074% ($= 0.011 \times 26.92/4.00$), when Bank Concentration has a standard deviation of 26.92% and Z-score has a mean of 4.00 (in untabulated results). Thus, the percentage reduction in default risk due to charter value is small. The coefficient values for macroeconomic variables are also small. We do not show them to save space. However, institutional mechanisms followed by Investor Protection had economically more pronounced influences on risk-taking compared to macroeconomic factors. [Johnson et al. \(2000\)](#) report related results for the relative importance of institutional mechanisms and macroeconomic variables around the Asian Financial Crisis period.

4.4. How do ultimate ownership and investor protection influence risk-taking?

Theoretical models predict that government ownership is associated with adverse economic outcomes, in contrast to the public interest view that government ownership mitigates market failure and exploits market externalities. There are countervailing economic costs associated with ownership. Large controlling shareholders have more incentives to monitor managers compared to minority shareholders. Furthermore, foreign ownership helps improve firm-level governance, especially if foreign owners are from strong investor protection countries ([Aggarwal et al., 2011](#)). Since the strength of investor protection influences the extent to which controlling shareholders expropriate minority shareholders ([Johnson et al., 2000](#)), it is worthwhile to explore the effects of ownership on risk-taking. For this estimation, we include Investor Protection and Quality of Government in the IV-GMM regressions since they may influence the level of ownership ([La Porta et al., 1998](#)). We do not appear to have problems with endogeneity based on our diagnostic tests.

[Tables 3a–3b](#) show that Quality of Government and Investor Protection still reduce risk-taking in the presence of ownership effects ($p\text{-value} \leq 0.10$). They do so for both sample periods. The coefficients for Quality of Government and Investor Protection are, however, larger in absolute value compared to those of ownership. Thus, Quality of Government and Investor Protection have stronger effects on

Table 3a

IV-GMM coefficients for institutional mechanisms and ownership, using RISK as the dependent variable.

The IV-GMM coefficients are for 686 banks in 40 countries. RISK is the dependent variable at bank level. In Panel A, the sample period is 2005–2009 and contains the 2007–2008 GFC period. In Panel B, the sample period is 2009–2019 and contains the 2010–2018 Eurozone Crisis period. ADRI is the Spamann (2010) investor protection. The Djankov et al. (2008) revised ADRI is used for China, Kazakhstan, Ukraine, Russia, Poland and Tunisia due to unavailable Spamann (2010) ADRI data. Quality of Government is the aggregate of the six operationalized dimensions of the WGI. Bank Deposit, Bank Size, Tangible Equity, Funding Fragility, Real GDP Growth, Government Expenditure Growth, Broad Money Growth, Terms of Trade, Market Capitalization to GDP and Stock Market Turnover Ratio are control variables. Most control variables are not shown to save space. $DLoans_{i,t}$ are the deviation of bank i loans to total assets of bank i , from the average country-level bank loans to total assets. $DLoans_{i,t}$ are instrumented with Gross National Product per Capita, Private Credit to GDP. Variable definitions are in WEB Appendix A. The Hayashi C statistic, J -statistic and First Stage Robust F -statistic are tests for endogeneity, over-identifying restriction and weak instruments, respectively. The Wald χ^2 statistic tests whether all the coefficients, besides the constant are significant. Robust standard errors are in parentheses. ^a, ^b, and ^c denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Variable	Estimates for the 2005–2009 period					Estimates for the 2009–2019 period						
ADRI (Investor Protection)	−0.401 ^a (0.062)	−0.332 ^a (0.091)	−0.383 ^a (0.065)	−0.346 ^a (0.101)	−0.399 ^a (0.062)	−0.380 ^a (0.098)	−0.178 ^a (0.049)	−0.192 ^b (0.095)	−0.1946 ^a (0.0567)	−0.411 ^a (0.124)	−0.205 ^a (0.059)	−0.163 ^c (0.088)
Quality of Government	−0.397 ^a (0.075)	−0.390 ^a (0.076)	−0.384 ^a (0.074)	−0.377 ^a (0.076)	−0.394 ^a (0.075)	−0.387 ^a (0.075)	−0.118 ^a (0.033)	−0.165 ^a (0.040)	−0.1247 ^a (0.0331)	−0.187 ^a (0.049)	−0.135 ^a (0.035)	−0.168 ^a (0.042)
High_ADRI × Quality of Government		−0.030 ^c (0.017)		−0.022 (0.019)		−0.023 (0.017)		0.038 (0.029)		0.069 (0.042)		0.014 (0.026)
Low_ADRI × Quality of Government		0.002 (0.030)		0.003 (0.027)		−0.006 (0.029)		0.042 (0.027)		0.051 (0.051)		0.032 (0.045)
Foreign Ownership	−0.003 ^b (0.001)	−0.008 ^a (0.002)			−0.003 ^b (0.001)	−0.008 ^a (0.002)	−0.003 ^c (0.002)	−0.004 ^b (0.002)			−0.002 (0.002)	−0.004 ^c (0.002)
High_ADRI × Foreign Ownership		−0.001 (0.003)				−0.001 (0.003)		−0.003 (0.003)				−0.004 (0.003)
Low_ADRI × Foreign Ownership		0.006 ^b (0.003)				0.006 ^b (0.003)		0.006 ^b (0.003)				0.007 ^b (0.003)
Government Ownership			0.002 (0.002)	0.001 (0.002)	0.001 (0.002)	−0.001 (0.002)			0.003 (0.002)	−0.009 ^b (0.005)	0.003 (0.003)	−0.006 ^c (0.003)
High_ADRI × Government Ownership				0.005 (0.005)		0.007 (0.004)				0.013 ^b (0.005)		0.007 ^b (0.003)
Low_ADRI × Government Ownership				−0.032 (0.024)		−0.025 (0.023)				0.018 ^b (0.009)		0.009 (0.008)
Constant	−0.150 (0.864)	0.139 (0.963)	−0.096 (0.872)	−0.137 (0.909)	−0.094 (0.861)	0.384 (0.947)	−0.482 (0.667)	0.812 (1.017)	0.209 (0.899)	2.673 (1.841)	0.207 (0.940)	0.922 (1.071)
Observations	690	690	690	690	690	690	1714	1713	1728	1728	1714	1728
R-squared	0.133	0.183	0.100	0.111	0.137	0.190	0.197	0.230	0.075	0.226	0.228	0.233
Wald χ^2 statistic	149.85 ^a	206.47 ^a	143.63 ^a	155.53 ^a	150.81 ^a	209.80 ^a	202.73 ^a	97.67 ^a	190.39 ^a	342.98 ^a	179.31 ^a	284.97 ^a
Hayashi C statistic	0.586	0.059	0.836	0.705	0.536	0.003	0.185	1.293	0.337	0.003	0.470	0.004
Hansen J -statistic	1.127	1.324	1.110	1.506	1.321	1.820	1.915	1.594	0.033	0.164	0.124	0.068
First Stage F -statistic	8.624 ^a	7.077 ^a	8.642 ^a	7.874 ^a	8.575 ^a	6.506 ^a	7.055 ^a	6.866 ^a	5.153 ^a	2.349 ^c	3.228 ^b	2.623 ^c

Table 3b

IV-GMM coefficients for institutional mechanisms and ownership using bank level Z-score as the dependent variable.

The IV-GMM coefficients are for 686 banks in 40 countries. Z-score is the dependent variable at bank level. In Panel A, the sample period is 2005–2009 and contains the 2007–2008 GFC period. In Panel B, the sample period is 2009–2019 and contains the 2010–2018 Eurozone Crisis period. ADRI is the [Spamann \(2010\)](#) investor protection. The [Djankov et al. \(2008\)](#) revised ADRI is used for China, Kazakhstan, Ukraine, Russia, Poland and Tunisia due to unavailable [Spamann \(2010\)](#) ADRI data. Quality of Government is the aggregate of the six operationalized dimensions of the WGI. Bank Deposit, Bank Size, Tangible Equity, Funding Fragility, Real GDP Growth, Government Expenditure Growth, Broad Money Growth, Terms of Trade, Market Capitalization to GDP and Stock Market Turnover Ratio are control variables. Most control variables are not shown to save space. $DLoans_{i,t}$ are the deviation of bank i loans to total assets of bank i , from the average country-level bank loans to total assets. $DLoans_{i,t}$ are instrumented with Gross National Product per Capita, Private Credit to GDP. Variable definitions are in [WEB Appendix A](#). The Hayashi C statistic, J -statistic and First Stage Robust F -statistic are tests for endogeneity, over-identifying restriction and weak instruments, respectively. The Wald χ^2 statistic tests whether all the coefficients, besides the constant are significant. Robust standard errors are in parentheses. ^a, ^b, and ^c denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Variable	Estimates for the 2005–2009 period					Estimates for the 2009–2019 period						
ADRI (Investor Protection)	0.422 ^a (0.071)	0.325 ^a (0.094)	0.405 ^a (0.073)	0.279 ^b (0.120)	0.418 ^a (0.072)	0.279 ^b (0.114)	0.126 ^c (0.071)	0.232 ^c (0.132)	0.175 ^c (0.103)	0.381 ^a (0.141)	0.245 ^b (0.097)	0.154 ^c (0.093)
Quality of Government	0.313 ^a (0.041)	0.311 ^a (0.042)	0.303 ^a (0.041)	0.295 ^a (0.044)	0.312 ^a (0.041)	0.307 ^a (0.043)	0.151 ^a (0.033)	0.216 ^a (0.043)	0.098 ^b (0.042)	0.154 ^a (0.055)	0.171 ^a (0.037)	0.137 ^a (0.033)
High_ADRI × Quality of Government		0.027 (0.021)		0.036 (0.026)		0.038 (0.024)		−0.032 (0.034)		−0.011 (0.043)		0.027 (0.023)
Low_ADRI × Quality of Government		−0.013 (0.033)		−0.016 (0.030)		−0.019 (0.034)		−0.029 (0.042)		0.033 (0.053)		0.038 (0.030)
Foreign Ownership	0.002 ^b (0.001)	0.006 ^b (0.003)			0.002 ^b (0.001)	0.006 ^b (0.003)	−0.001 (0.002)	−0.001 (0.003)			−0.004 (0.003)	−0.001 (0.002)
High_ADRI × Foreign Ownership		0.005 (0.005)				0.004 (0.005)		0.007 (0.005)				0.003 (0.003)
Low_ADRI × Foreign Ownership		−0.005 ^c (0.003)				−0.005 ^c (0.003)		−0.006 (0.004)				−0.0001 (0.003)
Government Ownership			−0.002 (0.003)	−0.006 (0.004)	−0.002 (0.003)	−0.004 (0.004)			0.004 (0.004)	−0.002 (0.006)	−0.005 (0.003)	−0.002 (0.004)
High_ADRI × Government Ownership				0.007 (0.007)		0.005 (0.006)				0.004 (0.010)		−0.008 ^b (0.004)
Low_ADRI × Government Ownership				0.008 (0.026)		0.002 (0.028)				0.002 (0.009)		0.005 (0.007)
Constant	5.174 ^a (0.953)	5.035 ^a (1.026)	5.108 ^a (0.945)	5.532 ^a (0.994)	5.115 ^a (0.947)	5.195 ^a (1.067)	4.241 ^a (1.073)	3.372 ^a (1.230)	6.675 ^a (1.810)	3.769 ^b (1.734)	3.190 ^b (1.402)	5.222 ^a (0.808)
Observations	684	684	684	684	684	684	1693	1722	1551	1551	1722	1708
R-squared	0.163	0.121	0.167	0.167	0.165	0.140	0.169	0.223	0.169	0.180	0.228	0.181
Wald χ^2 statistic	230.27 ^a	262.91 ^a	228.83 ^a	255.40 ^a	231.50 ^a	276.06 ^a	263.11 ^a	390.82 ^a	238.98 ^a	202.30 ^a	179.31 ^a	417.95 ^a
Hayashi C statistic	0.073	0.510	0.008	0.020	0.050	0.246	0.061	0.053	0.138	1.532	0.470	0.344
Hansen J -statistic	0.536	0.545	0.444	0.635	0.635	0.626	1.600	2.555	2.009	0.043	0.124	2.530
First Stage F -statistic	8.813 ^a	7.492 ^a	8.940 ^a	8.288 ^a	8.878 ^a	6.999 ^a	2.914 ^a	9.255 ^a	2.457 ^c	2.965 ^c	3.228 ^b	8.826 ^a

risk-taking compared to ownership. Many governments imposed regulatory constraints on capital and liquidity flows during the GFC period, particularly where foreign banks constituted a substantial part of the banking system.¹¹ However, while our findings are in line with the implications of studies that show that foreign ownership enhances firm-level governance (Aggarwal et al., 2011), our estimates show that the effects of Foreign Ownership on risk-taking are economically small. Thus, for the 2005–2009 period, Foreign Ownership decreased RISK by -0.003 (p -value ≤ 0.05) in the baseline regressions and by up to -0.008 (p -value ≤ 0.01) in the regressions with interaction terms (Table 3a). For the 2005–2009 period, a one standard deviation increase of 22.28% for Foreign Ownership at bank level is associated with a decrease in RISK of -0.069% ($= -0.003 \times 22.28/0.97$), using the coefficient value of -0.003 , when Foreign Ownership has a standard deviation of 22.28% and RISK has a mean of 0.97% in untabulated results. We find related results for the 2009–2019 period.

For the 2005–2009 period, the coefficients for Government Ownership are insignificant, using both RISK and Z-score as dependent variables. However, Government Ownership has negative and significant coefficients for the 2009–2019 period (p -value ≤ 0.10), using RISK as the dependent variable. Government Ownership is insignificant using Z-score as the dependent variable. While we find some support of H2A, this support only holds for the 2009–2019 period, when RISK is the dependent variable. The significant coefficients are economically small, indicating that Government Ownership has relatively weak effects on risk-taking across our sample periods.¹²

The tables also show that Foreign Ownership increased risk-taking in low Investor Protection countries (p -value ≤ 0.10) for both sample periods. Investors in poor investor protection countries have higher information disadvantage and higher monitoring costs, which in turn disincentivize foreign investment (Leuz et al., 2010). Thus, our finding of higher risk-taking in low Investor Protection countries may be due to the dominance of foreign institutional investors (FIIs) in decision-making in some countries. Alternatively, since foreign investors are likely to hold diversified portfolios, they may temporarily tolerate poor performance that is associated with higher risk-taking in some countries (Ederer & Manso, 2013; Luong et al., 2017). These factors may explain our result. Huang et al. (2022) show, however, that FIIs promote risk-taking in countries with weak governance and that their presence substitutes for weak country-level governance. However, we find that the High_ADRI $\times$ Foreign Ownership coefficients are insignificant, even if financial information is more credible in high Investor Protection countries and investments are better protected (see Bae et al., 2006).¹³ We also find that Government Ownership increased risk-taking in both high and low Investor Protection countries during the 2009–2019 period (p -value ≤ 0.05). Government ownership may incentivize greater risk-taking due to moral hazard (Iannotta et al., 2013). Government Ownership had insignificant effects in both high and low Investor Protection countries during the 2005–2009 period.

4.5. What are the effects of bank regulation and supervision on risk-taking?

Laeven & Levine (2009) report that bank risk-taking varies according to the comparative powers of bank owners and the effects of BRS rules. Thus, ignoring BRS effects may lead to incorrect conclusions regarding the effects of institutional mechanisms, investor protection, and ownership on risk-taking. Barth et al. (2004) also argue that there are severe shortcomings in empirical studies that examine BRS effects without regard to government ownership. In the Boyd & Hakenes (2014) model, capital regulation increases looting and risk-shifting, which in turn increases the severity of crisis events. Given these arguments, we examine whether BRS rules influence risk-taking in the presence of ownership, Investor Protection, and Quality of Government. We focus on four BRS rules that are commonly tested in empirical work.¹⁴ We report the results where RISK is used as the dependent variable. Using Z-score as the dependent variable generated related results, which are available on request.

Table 4 shows the IV-GMM results. Our diagnostic tests do not suggest concerns over endogeneity, using our tests. The table shows two notable findings. First, both Investor Protection and Government Ownership have insignificant coefficients for the 2009–2019 period, when we control for Independence of Supervisory Authority (political) and include interaction terms in the regression. Government Ownership is insignificant in the same regression for the 2005–2009 period. Otherwise, Investor Protection, and government and foreign ownership decreased risk-taking during both sample periods. Second, Foreign Ownership increased risk-taking in both high and low Investor Protection countries during the 2005–2009 period (p -value ≤ 0.10). Foreign Ownership increased risk-taking but only in low Investor Protection countries during the 2009–2019 period (p -value ≤ 0.10). Otherwise, our prior results remain robust after controlling for BRS effects.

Table 4 also shows that BRS rules reduce risk-taking (p -value ≤ 0.10). The only exception is No Explicit Deposit Insurance (a dummy variable), which increased risk-taking during the 2005–2009 period (p -value ≤ 0.10). The increase in risk-taking associated with No Deposit Insurance Scheme is in line with prior results (see Barth et al., 2004; Demirgüç-Kunt & Detragiache, 2002). While the coefficients for No Explicit Deposit Insurance are positive for the 2005–2009 period, they do not fully eliminate the negative effects of Investor Protection. In contrast, No Explicit Deposit Insurance reduced risk-taking for the 2009–2019 period (p -value ≤ 0.01). This may be due to greater information disclosure by official supervisors which may have increased private monitoring and mitigated the moral

¹¹ Asset share of foreign banks exceeds 80% of the financial banking system in some countries (see Cull et al., 2017).

¹² Boubakri et al. (2013) report a positive (negative) relation between risk-taking and foreign (government) ownership for non-financial firms during 1981–2007. They ignore the 1998 Asian Financial Crisis period.

¹³ Governments in poor investor protection countries are more likely to impose restrictions on the flow of international funds during crisis periods. Improved investor protection enhances international investment flows in countries (Shleifer & Wolfenzon, 2002).

¹⁴ To save space, we do not show the results for Limitations on Foreign Bank Entry. The coefficients for Limitations on Foreign Bank Entry are negative, suggesting that increases in competition reduced risk-taking. Prior evidence on the influence of bank competition and bank risk-taking is mixed (Boyd & De Nicoló, 2005).

Table 4

IV-GMM coefficients for institutional mechanisms, ownership and bank regulation and supervision, using RISK as the dependent variable. The IV-GMM coefficients are for 686 banks in 40 countries. RISK is the dependent variable at bank level. In Panel A, the sample period is 2005–2009 and contains the 2007–2008 GFC period. In Panel B, the sample period is 2009–2019 and contains the 2010–2018 Eurozone Crisis period. ADRI is the Spamann (2010) investor protection. The Djankov et al. (2008) revised ADRI is used for China, Kazakhstan, Ukraine, Russia, Poland and Tunisia due to unavailable Spamann (2010) ADRI data. Quality of Government is the aggregate of the six operationalized dimensions of the WGLs. Bank Deposit, Bank Size, Tangible Equity, Funding Fragility, Real GDP Growth, Government Expenditure Growth, Broad Money Growth, Terms of Trade, Market Capitalization to GDP and Stock Market Turnover Ratio are control variables. Most control variables are not shown to save space. $DLoans_{i,t}$ are the deviation of bank loans to total assets of bank i , from the average country-level bank loans to total assets. $DLoans_{i,t}$ are instrumented with Domestic Credit to Private Sector over GDP and Gross National Product per Capita. Variable definitions are in WEB Appendix A. The regressors include year and country income level fixed effects. Hayashi C statistic, J -statistic and First Stage Robust F -statistic are tests for endogeneity, over-identifying restriction and weak instruments, respectively. Wald χ^2 statistic tests whether all the coefficients, besides the constant are significant. Robust standard errors are in parentheses. ^a, ^b, and ^c denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Estimates for the 2005–2009 period								
Variable	Capital regulatory index		Overall Restrictions on Banking		Independence of Supervisory Authority (political)		No Explicit Deposit Insurance	
ADRI (Investor Protection)	−0.496 ^a (0.082)	−0.470 ^b (0.187)	−0.455 ^a (0.086)	−0.554 ^a (0.126)	−0.397 ^a (0.098)	−0.239 ^c (0.131)	−0.437 ^a (0.077)	−0.526 ^a (0.119)
Bank Regulation and Supervision	−0.090 ^b (0.035)	−0.067 ^c (0.040)	−0.088 ^b (0.042)	−0.040 (0.048)	−0.292 ^c (0.152)	−0.405 ^a (0.147)	0.203 ^c (0.122)	0.307 ^b (0.143)
Quality of Government	−0.337 ^a (0.064)	−0.119 ^a (0.041)	−0.301 ^a (0.064)	−0.290 ^a (0.064)	−0.256 ^a (0.074)	−0.168 ^b (0.075)	−0.305 ^a (0.058)	−0.308 ^a (0.064)
High_ADRI × Quality of Government		0.074 ^a (0.028)		0.029 (0.020)		−0.016 (0.023)		0.043 ^c (0.023)
Low_ADRI × Quality of Government		0.053 (0.049)		0.023 (0.038)		0.105 ^b (0.047)		0.066 ^c (0.040)
Foreign Ownership	−0.003 ^b (0.001)	−0.011 ^b (0.005)	−0.004 ^b (0.002)	−0.013 ^a (0.003)	−0.005 ^b (0.002)	−0.018 ^a (0.005)	−0.004 ^b (0.002)	−0.015 ^a (0.003)
High_ADRI × Foreign Ownership		−0.002 (0.004)		0.010 ^b (0.004)		0.017 ^a (0.006)		0.010 ^b (0.005)
Low_ADRI × Foreign Ownership		0.011 ^c (0.006)		0.010 ^a (0.004)		0.013 ^a (0.005)		0.012 ^a (0.003)
Government Ownership	−0.001 (0.002)	−0.010 ^b (0.004)	0.002 (0.002)	−0.003 (0.004)	0.003 (0.003)	0.008 (0.011)	0.001 (0.002)	−0.004 ^c (0.002)
High_ADRI × Government Ownership		0.006 (0.005)		0.005 (0.005)		−0.005 (0.011)		0.006 (0.004)
Low_ADRI × Government Ownership		0.020 (0.046)		−0.046 (0.036)		−0.079 ^c (0.045)		−0.033 (0.027)
Constant	2.305 ^a (0.859)	3.554 ^c (1.837)	1.766 ^c (1.047)	2.272 ^b (1.065)	1.523 (1.230)	1.645 (1.332)	0.714 (0.912)	1.445 (1.007)
Observations	697	703	697	697	698	684	698	698
R-squared	0.197	0.130	0.193	0.196	0.192	0.196	0.190	0.092
Wald χ^2 statistic	219.40 ^a	127.75 ^a	131.90 ^a	165.15 ^a	116.39 ^a	132.57 ^a	138.71 ^a	169.42 ^a
Hayashi C statistic	0.019	1.362	0.878	0.293	0.458	1.743	1.997	0.504
Hansen J -statistic	1.539	1.511	2.536	0.743	0.451	0.528	1.271	0.148
First Stage F -statistic	5.415 ^a	6.358 ^a	6.302 ^a	3.749 ^b	4.578 ^b	3.534 ^b	6.879 ^a	5.391 ^a
Panel B: Estimates for the 2009–2019 period								
Variable	Capital regulatory index		Overall Restrictions on Banking		Independence of Supervisory Authority (political)		No Explicit Deposit Insurance	
ADRI (Investor Protection)	−0.264 ^b (0.114)	−0.319 ^a (0.094)	−0.200 ^a (0.053)	−0.292 ^a (0.103)	−0.143 ^a (0.040)	−0.074 (0.138)	−0.199 ^a (0.045)	−0.173 ^b (0.080)
Bank Regulation and Supervision	−0.054 ^b (0.027)	−0.114 ^a (0.027)	−0.074 ^b (0.031)	−0.091 ^a (0.033)	−0.293 ^a (0.098)	−0.350 ^a (0.136)	−0.389 ^a (0.099)	−0.455 ^a (0.099)
Quality of Government	−0.168 ^a (0.044)	−0.045 ^c (0.026)	−0.121 ^a (0.032)	−0.129 ^a (0.037)	−0.099 ^a (0.028)	−0.157 ^a (0.052)	−0.114 ^a (0.031)	−0.138 ^a (0.038)
High_ADRI × Quality of Government		0.023 (0.026)		−0.0001 (0.013)		0.026 (0.047)		−0.007 (0.014)
Low_ADRI × Quality of Government		−0.014 (0.033)		−0.054 (0.034)		0.037 (0.043)		−0.006 (0.030)
Foreign Ownership	−0.003 (0.002)	−0.004 ^b (0.002)	−0.003 ^c (0.002)	−0.007 ^a (0.002)	−0.003 ^c (0.002)	−0.004 ^c (0.002)	−0.003 ^c (0.002)	−0.005 ^a (0.002)
High_ADRI × Foreign Ownership		0.002 (0.002)		0.0001 (0.002)		−0.004 (0.003)		−0.001 (0.002)
Low_ADRI × Foreign Ownership		0.004 ^c (0.002)		0.007 ^a (0.002)		0.006 ^b (0.003)		0.006 ^a (0.002)
Government Ownership	−0.002 (0.003)	−0.010 ^b (0.004)	0.0003 (0.003)	−0.005 ^a (0.002)	0.004 ^c (0.002)	−0.003 (0.004)	0.001 (0.002)	−0.005 ^b (0.002)
High_ADRI × Government Ownership		0.008 ^b		0.005 ^b		0.008		0.007 ^a

(continued on next page)

Table 4 (continued)

		(0.004)		(0.002)		(0.005)		(0.003)
Low_ADRI × Government Ownership		0.016 ^b		0.009		0.011		0.010 ^c
		(0.008)		(0.006)		(0.008)		(0.006)
Constant	−0.673	1.306	−0.118	1.056	−0.023	0.832	−0.351	0.205
	(0.607)	(1.171)	(0.613)	(0.778)	(0.690)	(1.437)	(0.666)	(0.616)
Observations	1468	1699	1713	1728	1715	1713	1715	1728
R-squared	0.079	0.223	0.231	0.221	0.214	0.239	0.233	0.241
Wald χ^2 statistic	175.02 ^a	161.17 ^a	148.64 ^a	296.38 ^a	266.95 ^a	201.57 ^a	269.97 ^a	272.41 ^a
Hayashi C statistic	0.774	0.686	2.296	0.150	0.104	0.478	0.019	0.034
Hansen J-statistic	0.721	0.358	0.066	0.136	0.014	1.766	0.052	0.088
First Stage F-statistic	11.357 ^a	3.873 ^b	11.465 ^b	21.306 ^a	8.235 ^a	5.517 ^a	8.163 ^a	9.409 ^a

hazard associated with deposit insurance (Demirgüç-Kunt & Detragiache, 2002).¹⁵ Overall, our results are more in line with H3A, thereby allowing us to reject H3B. It is also useful to note that BRS rules have more pronounced effects on risk-taking compared to ownership.

4.6. Post-crisis bias test

In this section, we present the results of the Bussiere & Fratzscher (2006) post-crisis bias test. This test jointly estimates the likelihood of a pre-crisis year by country (denoted, $Y = 1$), a crisis/post-crisis year by country (denoted, $Y = 2$), and a tranquil year/regime by country (denoted, $Y = 0$), in line with Eqs. (4) and (5). This approach allows us to relate our tests to the specific economic conditions in a country since all countries did not experience a crisis in the same year. Country-fixed effects are excluded from the estimation, since countries with no crisis would drop out of the estimation, if country-fixed effects are also captured (Demirgüç-Kunt & Detragiache, 2002). We include Quality of Government and BRS rules in the regressions, since the strength of a country's institutional mechanisms reflects the quality of its legal environment (La Porta et al., 1998), and the legal environment influences the relationship between BRS rules and financial stability (see Ashraf, 2017; Demirgüç-Kunt & Detragiache, 2002). Ownership is also included in the regressions since Laeven & Levine (2009) show that the relationship between bank risk-taking and BRS rules depends on banks' ownership structure. Finally, we include RISK and Z-score since prior studies argue that higher risk-taking increases the likelihood of crisis events (Bebchuk & Spamann, 2010). We believe that we are first to directly test the link between risk-taking and crisis events. Our results are presented below.

4.6.1. Does higher risk-taking increase the likelihood of crisis regimes?

Panel A of Table 5a shows that RISK has positive and significant coefficients for the 2005–2009 pre-crisis and crisis/post-crisis regimes, relative to the tranquil regime (p -value ≤ 0.10). Only one coefficient is insignificant. In Panel A of Table 5b, Z-score is negative and significant for all pre-crisis and crisis/post-crisis coefficients of the same period (p -value ≤ 0.05). Both results indicate that risk-taking increased the likelihood of the pre-crisis and crisis/post-crisis regimes, after controlling for BRS rules. However, the magnitude of the coefficients depends on the BRS rule. Furthermore, both RISK and Z-score have the largest coefficient values (in absolute terms) during the pre-crisis regime. If banks increased risk-taking in the run-up to the GFC period (Minton et al., 2014), then our results suggest that this strategy increased the likelihood of the pre-crisis regime much more strongly than the likelihood of the crisis/post-crisis regime. Our results show that RISK and Z-score are more consistent predictors of the crisis regimes compared to BRS rules or ownership (for the period).

In contrast to the 2005–2009 regimes, only one RISK coefficient is significant for the 2009–2019 period (p -value ≤ 0.05 ; Panel B of Table 5a). Panel B of Table 5b shows that all pre-crisis Z-score coefficients are significant. However, all crisis/post-crisis Z-score coefficients are insignificant (Panel B of Table 5b). Based on the coefficient sign of the significant cases, risk-taking increased the likelihood of the 2009–2019 pre-crisis regime. Collectively, risk-taking is a stronger predictor of the likelihood of the pre-crisis regimes than the crisis/post-crisis regimes. To illustrate, RISK has coefficients of 2.98 (p -value ≤ 0.01) and 1.05 (p -value ≤ 0.01) for the pre-crisis and crisis/post-crisis regimes of the 2005–2009 period, respectively, after controlling for No Explicit Deposit Insurance (Table 5a, Panel A). The log-odds based on these coefficients are $e^\beta = 19.68$ and $e^\beta = 2.85$ for the pre-crisis and crisis/post-crisis regimes, respectively. In this case, the log-odds for the pre-crisis regime are 6.9 times larger than those of the crisis/post-crisis regime, indicating the pre-crisis risk-taking levels are a stronger predictor. The associated average marginal effects (AMEs) are significant for both estimates (p -value ≤ 0.10) in untabulated results.¹⁶ Furthermore, the pre-crisis Z-score coefficients are larger (in absolute value) than those of the crisis/post-crisis coefficients, indicating that the greater the distance from default, the larger the decrease in the likelihood of the pre-crisis regime relative to the crisis/post-crisis regime, especially for the 2005–2009 period. As such, the stronger the balance sheets of banks are, ex-ante, the more likely they will withstand economic shocks during crisis periods (Kapan & Minoiu, 2018). Since higher risk-taking during the pre-crisis regime is a stronger predictor of crisis events than risk-taking during the

¹⁵ In a separate analysis, we find that Private Monitoring increases risk-taking (p -value ≤ 0.10). Under the private monitoring view, supervisory policies that promote information disclosure and distort the adverse effects of deposit insurance, stabilize banking systems. Private monitoring is more effective in well-functioning institutional systems (Beck et al., 2006b).

¹⁶ The AMEs are partial effects for each observation averaged across all the observations of each variable.

Table 5a

Multinomial logistic regression using crisis regimes as dependent variables and RISK, legal and bank regulation at country level.

The post-crisis bias test for 686 banks in 40 countries, where the crisis year is determined by country using the [Laeven & Valencia \(2018\)](#) database and extended to the more recent period. In Panel A, the sample period is 2005–2009 which contains the 2007–2008 GFC period. In Panel B, the sample period is 2009–2019 which contains the 2010–2018 Eurozone Crisis period. (Y = 1) is the pre-crisis regime/year(s). (Y = 2) is the crisis/post-crisis regime/year(s). (Y = 0) is the tranquil regime/year(s). The regressions include Quality of Government, Investor Protection, ownership and bank regulation and supervision (BRS) rules. The BRS variables, i.e., Capital Regulatory Index, Overall Restrictions on Banking, Independence of Supervisory Authority (political) and No Explicit Deposit Insurance Scheme are from World Bank Surveys on Bank Regulation database. ADRI is the [Spamann \(2010\)](#) investor protection. The [Djankov et al. \(2008\)](#) revised ADRI is used for China, Kazakhstan, Ukraine, Russia, Poland and Tunisia due to unavailable [Spamann \(2010\)](#) ADRI data. The control variables are according to [Table 2a](#) or [2b](#). Some of the control variables are not shown to save space. RISK, Foreign and Government Ownership are aggregated at country level (see Panel B, [Table 1](#)). Variable definitions are in the [WEB Appendix A](#). Robust standard errors are in parentheses. ^a, ^b, and ^c denote significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Estimates for the 2005–2009 period								
Variable	Capital regulatory index		Overall Banking on Restrictions		Independence of Supervisory Authority (political)		No Explicit Deposit Insurance	
	Y = 1	Y = 2	Y = 1	Y = 2	Y = 1	Y = 2	Y = 1	Y = 2
RISK	2.713 (1.996)	1.009 ^b (0.460)	1.513 ^c (0.902)	0.772 ^c (0.403)	4.420 ^a (0.596)	1.092 ^a (0.317)	2.982 ^a (0.845)	1.050 ^a (0.318)
ADRI (Investor Protection)	-2.713 ^b (1.077)	-2.149 ^a (0.756)	-6.894 ^a (0.742)	-1.606 ^c (0.838)	-3.993 ^a (0.877)	-1.657 ^c (0.853)	-7.645 ^a (0.549)	-1.654 ^b (0.725)
Quality of Government	-1.366 ^a (0.223)	-0.205 ^a (0.053)	-1.132 ^a (0.059)	-0.228 ^a (0.054)	-1.239 ^a (0.050)	-0.203 ^a (0.045)	-1.018 ^a (0.043)	-0.185 ^a (0.044)
Foreign Ownership	0.631 (0.389)	-0.029 (0.342)	2.934 ^a (0.329)	0.320 (0.363)	0.659 (0.683)	-0.086 (0.364)	1.238 ^a (0.364)	0.027 (0.394)
Government Ownership	0.656 ^a (0.072)	0.117 ^a (0.044)	1.271 ^a (0.064)	0.109 ^c (0.056)	1.029 ^a (0.055)	0.094 ^a (0.031)	1.272 ^a (0.066)	0.104 ^b (0.041)
Bank Regulation and Supervision	4.535 ^a (1.044)	0.377 (0.306)	-6.829 ^a (0.500)	-0.806 ^c (0.475)	1.980 (1.891)	-0.768 (0.724)	-4.092 ^a (1.496)	-0.506 (1.119)
Constant	56.825 ^a (9.276)	10.764 ^c (5.579)	29.112 ^a (10.498)	16.060 ^a (5.878)	16.438 ^b (7.437)	10.561 (6.689)	22.455 ^a (8.377)	9.394 (5.968)
Observations	144	144	144	144	146	146	145	145
Pseudo R ²	0.845 ^a		0.857 ^a		0.843 ^a		0.840 ^a	
Panel B: Estimates for the 2009–2019 period								
RISK	0.757 (0.471)	0.557 (0.427)	0.644 ^b (0.327)	0.057 (0.287)	0.573 (0.377)	-0.152 (0.420)	0.483 (0.324)	0.097 (0.311)
ADRI (Investor Protection)	3.281 ^b (1.341)	3.105 ^b (1.311)	2.961 ^b (1.307)	1.572 (0.980)	3.450 ^a (1.012)	3.481 ^a (0.958)	1.834 ^a (0.704)	1.451 ^b (0.599)
Quality of Government	2.126 ^a (0.574)	1.846 ^a (0.486)	1.570 ^a (0.430)	1.092 ^a (0.256)	1.678 ^a (0.452)	1.375 ^a (0.266)	1.369 ^a (0.388)	0.998 ^a (0.203)
Foreign Ownership	0.140 ^a (0.031)	0.117 ^a (0.030)	0.130 ^a (0.029)	0.095 ^a (0.024)	0.135 ^a (0.028)	0.106 ^a (0.025)	0.120 ^a (0.025)	0.087 ^a (0.023)
Government Ownership	-0.328 ^a (0.078)	-0.347 ^a (0.084)	-0.225 ^a (0.055)	-0.216 ^a (0.061)	-0.241 ^a (0.061)	-0.296 ^a (0.055)	-0.203 ^a (0.053)	-0.220 ^a (0.053)
Bank Regulation and Supervision	1.505 ^b (0.629)	1.353 ^a (0.405)	0.257 (0.553)	-0.367 (0.555)	-2.582 ^b (1.310)	-4.125 ^a (0.971)	-15.442 ^a (1.602)	-17.538 ^a (1.350)
Constant	-26.514 ^b (10.929)	-25.972 ^b (10.135)	-22.849 ^b (11.347)	-9.816 (11.008)	-19.100 ^b (7.815)	-17.963 ^a (6.698)	-15.916 ^a (5.989)	-15.098 ^a (4.931)
Observations	186	186	186	186	186	186	186	186
Pseudo R ²	0.646 ^a		0.642 ^a		0.610 ^a		0.631 ^a	

crisis/post-crisis regime, regulators should focus on the level of risk-taking during the pre-crisis regime as it would be difficult to curb the crisis once it is set in motion.

4.6.2. Do investor protection and ownership decrease the likelihood of crisis regimes?

The panels in [Table 5a–5b](#) show that, for the 2005–2009 period, higher Investor Protection decreased the likelihood of the crisis regimes (p -value ≤ 0.10). Quality of Government had related effects for the 2005–2009 period, but their effects are not as pronounced compared to those of Investor Protection (p -value ≤ 0.05). Specifically, for the 2005–2009 period, Investor Protection has log-odds of $e^{\beta} = 0.0005$ and $e^{\beta} = 0.19$ for the pre-crisis and crisis/post-crisis regimes, respectively, after controlling for No Deposit Insurance Scheme (Panel A of [Table 5a](#)). The correspondingly log-odds for Quality of Government are $e^{\beta} = 0.36$ and $e^{\beta} = 0.83$ for the pre-crisis and crisis/post-crisis regimes, respectively (Panel A of [Table 5a](#)). These results, however, contrast with those of the 2009–2019 period. Thus, for the 2009–2019 period, both Investor Protection and Quality of Governments increased the likelihood of the pre-crisis and crisis/post-crisis regimes, in support of [H4B](#). Following [Kaminsky & Reinhart \(1999\)](#), economic crises have unique origins, such that crisis predictors may not have similar effects across different crises.

The tables also show that both foreign and government ownership increased the likelihood of the 2005–2009 crisis regimes (p -value ≤ 0.10). Their effects are more pronounced during the pre-crisis regimes. However, Government Ownership has stronger effects than

Table 5b

Multinomial logistic regression using crisis regimes as dependent variables and Z-score, legal and bank regulation at country level.

The post-crisis bias test for 686 banks in 40 countries, where the crisis year is by determined country using the [Laeven & Valencia \(2018\)](#) database and extended to the more recent period. In Panel A, the sample period is 2005–2009 which contains the 2007–2008 GFC period. In Panel B, the sample period is 2009–2019 which contains the 2010–2018 Eurozone Crisis period. (Y = 1) is the pre-crisis regime/year(s). (Y = 2) is the crisis/post-crisis regime/year(s). (Y = 0) is the tranquil regime/year(s). The regressions include Quality of Government, Investor Protection, ownership and bank regulation and supervision (BRS) rules. The BRS variables, i.e., Capital Regulatory Index, Overall Restrictions on Banking, Independence of Supervisory Authority (political) and No Explicit Deposit Insurance Scheme are from World Bank Surveys on Bank Regulation database. ADRI is the [Spamann \(2010\)](#) investor protection. The [Djankov et al. \(2008\)](#) revised ADRI is used for China, Kazakhstan, Ukraine, Russia, Poland and Tunisia due to unavailable [Spamann \(2010\)](#) ADRI data. Z-score, Foreign and Government Ownership are aggregated at country level (see Panel B, [Table 1](#)). The control variables are according to [Table 2a](#) or [2b](#). Some of the control variables are not shown to save space. Variable definitions are in the [WEB Appendix A](#). Robust standard errors are in parentheses. ^a, ^b, and ^c denote significance at the 1%, 5%, and 10% levels, respectively.

Panel A. Estimates for the 2005–2009 period								
Variable	Capital regulatory index		Overall Restrictions on Banking		Independence of Supervisory Authority (political)		No Explicit Deposit Insurance	
	Y = 1	Y = 2	Y = 1	Y = 2	Y = 1	Y = 2	Y = 1	Y = 2
Z-Score	–8.955 ^a (1.260)	–1.571 ^a (0.538)	–4.451 ^a (1.708)	–1.731 ^a (0.530)	–5.316 ^b (2.071)	–1.656 ^a (0.547)	–9.191 ^a (1.068)	–1.526 ^a (0.491)
ADRI (Investor Protection)	–2.913 ^a (0.576)	–1.840 ^b (0.881)	–5.439 ^a (0.731)	–1.417 (0.888)	–3.241 ^a (0.733)	–0.834 (0.559)	–2.450 ^a (0.607)	–0.691 (0.464)
Quality of Government	–0.926 ^a (0.057)	–0.202 ^b (0.102)	–0.943 ^a (0.062)	–0.236 ^a (0.060)	–0.926 ^a (0.047)	–0.156 ^a (0.055)	–0.908 ^a (0.050)	–0.141 ^b (0.063)
Foreign Ownership	0.479 (0.386)	–0.032 (0.242)	0.887 (0.541)	0.173 (0.280)	0.710 (0.453)	0.100 (0.231)	0.994 ^a (0.184)	0.164 (0.198)
Government Ownership	0.433 ^a (0.065)	0.097 (0.063)	0.824 ^a (0.094)	0.099 ^c (0.053)	0.839 ^a (0.095)	0.053 (0.040)	0.707 ^a (0.055)	0.060 (0.044)
Bank Regulation and Supervision	3.417 ^a (0.510)	0.352 (0.430)	–3.933 ^a (0.725)	–0.979 ^b (0.425)	5.619 ^a (1.501)	–0.285 (0.852)	–6.635 ^a (0.930)	–1.488 (1.062)
Constant	70.415 ^a (9.071)	14.489 ^b (7.103)	44.951 ^a (8.486)	20.698 ^a (6.544)	38.939 ^a (7.609)	11.218 ^b (5.472)	21.368 ^b (8.896)	9.769 ^c (5.228)
Observations	143	143	143	143	145	145	144	144
Pseudo R ²	0.725 ^a		0.684 ^a		0.720 ^a		0.687 ^a	
Panel B. Estimates for the 2009–2019 period								
Z-Score	–0.142 ^b (0.059)	0.0003 (0.0003)	–0.150 ^c (0.082)	0.0003 (0.0003)	–0.169 ^c (0.091)	0.0006 (0.0004)	–0.137 ^c (0.072)	0.0003 (0.0003)
ADRI (Investor Protection)	2.973 ^a (1.087)	3.075 ^b (1.556)	2.461 ^a (0.760)	1.606 (1.092)	2.446 ^b (0.996)	3.449 ^a (0.985)	2.619 ^a (0.818)	1.441 ^b (0.713)
Quality of Government	2.743 ^a (0.826)	1.746 ^a (0.545)	2.443 ^a (0.910)	1.108 ^a (0.276)	2.564 ^a (0.871)	1.440 ^a (0.294)	2.275 ^a (0.859)	1.002 ^a (0.247)
Foreign Ownership	0.132 ^a (0.032)	0.118 ^a (0.033)	0.112 ^a (0.028)	0.099 ^a (0.028)	0.132 ^a (0.026)	0.113 ^a (0.031)	0.119 ^a (0.026)	0.092 ^a (0.029)
Government Ownership	–0.377 ^a (0.092)	–0.334 ^a (0.084)	–0.239 ^a (0.066)	–0.204 ^a (0.052)	–0.244 ^a (0.051)	–0.318 ^a (0.066)	–0.220 ^a (0.052)	–0.222 ^a (0.059)
Bank Regulation and Supervision	1.388 ^b (0.637)	1.234 ^a (0.432)	–0.530 (0.481)	–0.474 (0.684)	0.721 (2.328)	–4.455 ^a (1.320)	–9.831 ^b (3.997)	–19.413 ^a (1.388)
Constant	–17.923 (16.839)	–25.931 ^b (12.431)	4.892 (16.660)	–9.833 (12.522)	–1.837 (11.699)	–19.049 ^a (6.732)	–1.973 (11.389)	–15.840 ^b (6.327)
Observations	186	186	186	186	186	186	186	186
Pseudo R ²	0.768 ^a		0.736 ^a		0.772 ^a		0.739 ^a	

Foreign Ownership (see [Tables 5a–5b](#), Panel A). Overall, these results support **H4B**, indicating that ownership increased the likelihood of the crisis regimes. In contrast to the 2005–2009 period, Foreign Ownership had more pronounced effects on the likelihood of the 2009–2019 crisis regimes (p -value ≤ 0.01). Foreign Ownership increased the likelihood of the crisis regimes with more pronounced effects during the pre-crisis regime. In contrast, Government Ownership decreased the likelihood of the 2009–2019 crisis regimes (p -value ≤ 0.01), indicating that, unlike the 2005–2009 period, Government Ownership had a stabilizing effect during the 2009–2019 period. However, across the sub-periods, the AMEs of both ownership measures are relatively small – around 0.50% – when the associated regression coefficients are significant. Thus, the influence of ownership on crisis regime predictability is comparatively small.

BRS rules have mixed coefficient signs. The tables show that No Explicit Deposit Insurance had more pronounced effects in reducing the likelihood of the 2009–2019 crisis regimes compared to the 2005–2009 crisis regimes. Furthermore, No Explicit Deposit Insurance had more pronounced effects in reducing the likelihood of the 2009–2019 crisis/post-crisis regime compared to the 2005–2009 crisis/post-crisis regime. Thus, our results imply that deposit insurance reduced systemic fragility more strongly for the 2009–2019 crisis/post-crisis regime. Advocates of deposit insurance claim that its adverse effects are constrained by effective supervisory power and prudential regulation. Indeed, [Anginer et al. \(2014\)](#) report that deposit insurance increased bank risk and systemic fragility during the 2004–2006 pre-crisis regime but it had stronger destabilizing effects during normal times compared to the 2007–2009 crisis period.

4.7. A generalized bivariate copula approach for predicting crisis and no-crisis regimes

In this section, we directly examine the relationship between crisis regimes and risk-taking, using the generalized bivariate copula function (BICOP) of [Hernández-Alava & Pudney \(2016\)](#). The BICOP procedure is a generalization of the more familiar bivariate probit model but does not require the bivariate dependent variables are continuous, as in standard copulas. BICOP can be specified as follows:

$$Y_{i,1}^* = \beta_1 X_{i,1} + U_{i,1} \quad (6a)$$

$$Y_{i,2}^* = \beta_2 X_{i,2} + U_{i,2}, \quad (6b)$$

where $Y_{i,1}^*$ and $Y_{i,2}^*$ are the latent variables with row vectors of covariates $X_{i,1}$ and $X_{i,2}$ and with coefficients β_1 and β_2 , respectively. $U_{i,1}$ and $U_{i,2}$ are unobservable residuals, which may be stochastically dependent and non-normal. $U_{i,1}$ and $U_{i,2}$ are assumed to have a bivariate joint distribution with correlation, $\rho \neq 0$. Under the BICOP formulation, the likelihood function of the estimates can be maximized, knowing the properties of the joint distribution of $F(U_{i,1}, U_{i,2})$. Denote $Y_{i,1}^*$ as a crisis dummy, where 1 represents the crisis year(s) by country; 0, otherwise. Denote $Y_{i,2}^*$ as the threshold for risk-taking, where 1 captures high risk-taking and 0 captures low risk-

Table 6

Gaussian copula regressions using crisis and RISK dummies as dependent variables.

The Gaussian copula regressions are for 686 banks in 40 countries where the crisis year is determined by country using the [Laeven & Valencia \(2018\)](#) database and extended to the more recent period. In Panel A, the sample period is 2005–2009 which contains the 2007–2008 GFC period. In Panel B, the sample period is 2009–2019 which contains the 2010–2018 Eurozone Crisis period. EQ 1 is a dependent variable which has a value of 1 for the crisis year(s); 0, otherwise. EQ 2 is a zero/one dependent variable which has a value of 1 for RISK observations above the median; 0, otherwise. RISK is at country level. ADRI is the [Spamann \(2010\)](#) investor protection measure. The [Djankov et al. \(2008\)](#) revised ADRI is used for China, Kazakhstan, Ukraine, Russia, Poland and Tunisia due to unavailable [Spamann \(2010\)](#) ADRI data. The control variables are according to [Table 2a](#) or [2b](#). The Bank Regulation and Supervision (BRS) variables, i.e., Capital Regulatory Index, Overall Restrictions on Banking, Independence of Supervisory Authority (political) and No Explicit Deposit Insurance Scheme are from World Bank Surveys on Bank Regulation database. Foreign and Government Ownership are aggregated at country level. The control variables are not shown to save space. Variable definitions are in [WEB Appendix A](#). The Wald χ^2 Equality is a test of the equality of the coefficients in the bivariate regressions. The Wald χ^2 is a test of independence. Theta is the dependency parameter. Robust standard errors are in parentheses. ^a, ^b, and ^c denote statistical significance at the 1%, 5%, and 10% level, respectively.

Panel A: Gaussian copula estimates for the 2005–2009 period								
Variable	Capital regulatory index		Overall Restrictions on Banking		Independence of Supervisory Authority (political)		No Explicit Deposit Insurance	
	EQ 1	EQ 2	EQ 1	EQ 2	EQ 1	EQ 2	EQ 1	EQ 2
ADRI (Investor Protection)	−0.602 ^b (0.298)	−0.863 ^a (0.211)	−0.220 (0.180)	−0.666 ^a (0.161)	−0.488 ^c (0.258)	−0.724 ^a (0.184)	−0.333 (0.266)	−0.710 ^a (0.154)
Quality of Government	0.197 ^a (0.074)	0.012 (0.045)	0.007 (0.045)	−0.048 (0.040)	0.246 ^a (0.074)	−0.005 (0.041)	0.206 ^a (0.054)	−0.035 (0.039)
Foreign Ownership	0.009 (0.015)	−0.010 (0.009)	0.011 (0.009)	−0.012 (0.007)	0.013 (0.015)	−0.007 (0.008)	0.015 (0.016)	−0.011 (0.007)
Government Ownership	−0.073 ^a (0.023)	−0.032 ^a (0.009)	−0.046 ^a (0.016)	−0.023 ^a (0.008)	−0.083 ^a (0.022)	−0.027 ^a (0.009)	−0.074 ^a (0.024)	−0.022 ^a (0.008)
Bank Regulation and Supervision	0.029 (0.136)	0.137 (0.085)	−0.201 ^b (0.088)	−0.012 (0.074)	−0.453 (0.441)	−0.078 (0.247)	−1.306 ^b (0.575)	0.634 ^b (0.297)
Observations	144	144	144	144	146	146	145	145
Wald χ^2 Equality	2507.686 ^a		38.449 ^a		2301.116 ^a		44.233 ^a	
AIC	232.619		317.053		232.477		220.714	
Theta	0.064		−0.073		0.463		0.433	
Wald χ^2 Independence	4.179 ^b		8.159 ^a		4.174 ^b		7.695 ^a	
Panel B: Gaussian copula estimates for the 2009–2019 period								
ADRI (Investor Protection)	0.848 ^a (0.269)	0.265 ^c (0.136)	0.506 ^c (0.273)	0.086 (0.150)	1.231 ^a (0.328)	0.331 ^b (0.139)	0.548 ^b (0.215)	0.339 ^b (0.138)
Quality of Government	0.447 ^a (0.092)	−0.123 ^a (0.030)	0.349 ^a (0.068)	−0.167 ^a (0.034)	0.471 ^a (0.087)	−0.108 ^a (0.029)	0.341 ^a (0.068)	−0.122 ^a (0.033)
Foreign Ownership	0.027 ^a (0.010)	−0.003 (0.006)	0.027 ^a (0.010)	−0.0001 (0.006)	0.030 ^a (0.011)	−0.003 (0.006)	0.023 ^b (0.010)	−0.004 (0.007)
Government Ownership	−0.089 ^a (0.023)	−0.004 (0.006)	−0.068 ^a (0.019)	−0.007 (0.006)	−0.101 ^a (0.025)	−0.003 (0.006)	−0.077 ^a (0.020)	−0.003 (0.006)
Bank Regulation and Supervision	0.280 ^b (0.142)	−0.118 ^c (0.067)	−0.153 (0.157)	−0.135 ^b (0.066)	−1.493 ^a (0.536)	−0.052 (0.235)	−5.969 ^a (0.768)	−0.453 (0.316)
Observations	186	186	181	181	186	186	186	186
Wald χ^2 Equality	96.788 ^a		93.004 ^a		76.528 ^a		133.545 ^a	
AIC	299.541		312.374		299.245		301.792	
Theta	0.576		0.331		0.500		0.436	
Wald χ^2 Independence	8.298 ^a		1.724		4.801 ^b		3.725 ^b	

taking, based on the median values of RISK and Z-score for each of the 2005–2009 and 2009–2019 sub-periods. We estimate BICOP under the Gaussian, Frank, Gumbel, Joe, and Clayton copula functions. Since the Gaussian copula provides the best overall fit, using the Akaike Information Criterion (AIC), we focus on these results.

Table 6 shows our results using the RISK dummy in each regression. The unreported results using Z-score are available on request. The panels of the table show that the Wald χ^2 statistic of independence is significant for all but one regression estimate (p -value ≤ 0.05). As such, we reject the null hypothesis that the covariates are conditionally independent. This result therefore suggests dependence between risk-taking and crisis events, meaning that higher risk-taking is associated with a higher likelihood of a crisis event. Both Investor Protection and Government Ownership decreased the likelihood of the crisis and higher risk-taking during the 2005–2009 period (see Panel A of Table 6). The result for Investor Protection (Government Ownership) is consistent (inconsistent) with those of our post-crisis bias test for the same sub-period. Investor Protection had a stronger decreasing effect on risk-taking compared to its decreasing effects on the probability of the crisis regime (see Panel A). The table shows that Foreign Ownership had no effect on the crisis event and risk-taking for the 2005–2009 period. However, Quality of Government increased the probability of the crisis although it had no effect on risk-taking. While No Explicit Deposit Insurance reduced the probability of the crisis event, it increased the

Table 7a

DID regressions of RISK on institutional measures and country-crisis years.

The IV-GMM coefficients are for 686 banks in 40 countries. Country Crisis is a dummy variable which is 1 in crisis year(s) and 0 otherwise. Crisis year is determined by country using the [Laeven & Valencia \(2018\)](#) database and extended to the more recent period. In Panel A, the sample period is 2005–2009. In Panel B, the sample period is 2009–2019. RISK is the dependent variable at bank level. ADRI is the [Spamann \(2010\)](#) investor protection measure. The [Djankov et al. \(2008\)](#) revised ADRI is used for China, Kazakhstan, Ukraine, Russia, Poland and Tunisia due to unavailable [Spamann \(2010\)](#) ADRI data. IM denotes Institutional Mechanism in terms of Rule of Law, Control of Corruption, Regulatory Quality, Quality of Government and Government Effectiveness. The control variables are: Bank Deposit; Bank Size; Tangible Equity; Funding Fragility; Real GDP Growth; Government Expenditure Growth; Broad Money Growth; Terms of Trade; Market Capitalization to GDP; Reserve Growth; and Stock Market Turnover Ratio. Most control variables are not shown to save space. $DLoans_{i,t}$ are the deviation of bank i loans to total assets of bank i , from the average country-level bank loans to total assets. $DLoans_{i,t}$ are instrumented with Gross National Product per Capita and Domestic Credit to Private Sector over GDP. Variable definitions are available in WEB Appendix A. ^a, ^b, and ^c denote statistical significance at 1%, 5%, and 10% levels, respectively.

Panel A: Estimates are for the 2005–2009 period with country-crisis dummies										
Variable	Rule of Law		Control of Corruption		Regulatory Quality		Govt. Effectiveness		Quality of Government	
ADRI (Investor Protection)	−0.412 ^a (0.071)	−0.153 ^c (0.084)	−0.262 ^a (0.081)	−0.134 ^c (0.072)	−0.320 ^a (0.060)	−0.030 (0.064)	−0.262 ^a (0.045)	−0.382 ^b (0.165)	−0.395 ^a (0.094)	−0.194 ^b (0.078)
Institutional Mechanism (IM)	−1.998 ^a (0.409)	−1.281 ^a (0.393)	−0.857 ^b (0.355)	−0.679 ^b (0.316)	−1.029 ^a (0.326)	−0.350 (0.309)	−1.057 ^a (0.218)	−1.290 ^a (0.333)	−0.371 ^a (0.083)	−0.262 ^a (0.065)
High_ADRI × IM		−0.057 (0.069)		−0.146 ^b (0.060)		−0.220 ^b (0.110)		0.271 (0.194)		−0.004 (0.013)
Low_ADRI × IM		0.336 ^b (0.157)		0.108 (0.085)		0.275 ^b (0.112)		0.321 (0.246)		0.035 (0.023)
Country Crisis	0.483 ^b (0.227)	0.602 ^c (0.341)	0.970 ^a (0.256)	1.005 ^a (0.223)	0.517 (0.353)	1.264 ^a (0.266)	1.380 ^a (0.465)	2.639 ^a (0.800)	1.133 ^a (0.334)	0.821 ^a (0.313)
ADRI × Country Crisis	−0.130 ^b (0.063)	−0.120 ^c (0.070)	−0.322 ^a (0.088)	−0.308 ^a (0.071)	−0.043 (0.050)	−0.304 ^a (0.071)	−0.180 ^a (0.059)	−0.434 ^a (0.152)	−0.244 ^a (0.084)	−0.157 ^a (0.059)
IM × Country Crisis	0.148 (0.109)	−0.001 (0.165)	−0.159 ^b (0.070)	−0.165 ^b (0.067)	−0.077 (0.209)	−0.338 ^a (0.128)	−0.344 (0.229)	−0.925 ^b (0.376)	−0.036 (0.028)	−0.013 (0.032)
Constant	0.544 (0.611)	−0.061 (0.623)	1.167 ^c (0.698)	0.741 (0.616)	1.777 ^a (0.536)	0.638 (0.590)	0.925 (0.577)	1.312 (1.264)	0.154 (0.772)	−0.087 (0.594)
Observations	1043	1054	1005	1005	1037	1001	1052	1052	1054	1052
R-squared	0.132	0.085	0.158	0.159	0.102	0.129	0.132	0.138	0.142	0.143
Panel B: Estimates are for the 2009–2019 period with country-crisis dummies										
ADRI (Investor Protection)	−0.275 ^b (0.139)	−0.316 ^c (0.163)	−0.666 ^c (0.388)	−0.406 ^c (0.218)	−0.592 ^c (0.303)	−0.231 ^c (0.128)	−0.333 ^c (0.190)	−0.498 ^c (0.256)	−0.461 ^c (0.241)	−0.124 (0.138)
Institutional Mechanism (IM)	−1.542 ^a (0.487)	−0.500 ^a (0.145)	−1.390 ^b (0.547)	−0.380 ^a (0.147)	−1.464 ^b (0.653)	−0.333 ^b (0.151)	−0.770 ^b (0.355)	−0.324 (0.348)	−0.250 ^a (0.081)	−0.255 ^a (0.082)
High_ADRI × IM		0.139 (0.333)		0.224 (0.307)		−0.111 (0.257)		0.430 (0.515)		−0.056 (0.044)
Low_ADRI × IM		0.164 (0.661)		0.175 (0.514)		0.391 (0.270)		0.857 (0.572)		0.091 ^c (0.050)
Country Crisis	−4.074 (2.628)	−1.822 (2.707)	−2.554 (2.417)	−0.769 (1.836)	−4.179 (4.150)	−3.834 (2.450)	−2.312 (2.250)	−0.587 (2.452)	−4.358 (3.371)	−3.890 (3.252)
ADRI × Country Crisis	−0.156 (0.274)	−0.229 (0.289)	−0.260 (0.498)	−0.248 (0.277)	−0.004 (0.252)	−0.011 (0.211)	−0.400 (0.443)	−0.443 (0.507)	−0.005 (0.252)	−0.125 (0.241)
IM × Country Crisis	4.143 (2.630)	2.643 (2.654)	1.738 (2.136)	1.855 (2.100)	3.220 (3.435)	3.661 ^c (2.163)	3.356 (2.980)	1.705 (2.584)	0.593 (0.552)	0.635 (0.545)
Constant	0.446 (2.444)	2.163 (6.060)	11.566 (8.394)	4.354 (6.249)	7.947 ^c (4.299)	3.882 (3.083)	3.628 (2.467)	9.734 ^c (5.562)	5.341 (4.114)	3.968 (3.026)
Observations	2244	2266	2266	2266	2266	2283	2261	2283	2283	2283
R-squared	0.061	0.053	0.061	0.053	0.057	0.054	0.056	0.052	0.058	0.059

probability of higher risk-taking (p -value ≤ 0.05).

In contrast to the 2005–2009 period, higher Investor Protection increased the probability of the crisis and higher risk-taking for the 2009–2019 period (Panel B; p -value ≤ 0.10). Foreign Ownership (Government Ownership) increased (decreased) the probability of the crisis for the same period. While ownership had no effect on risk-taking, Quality of Government increased the probability of the crisis and decreased the probability of higher risk-taking (p -value ≤ 0.01). These results are partly in line with those of the post-crisis bias test. A distinguishing feature of these results is that we find evidence for dependence between risk-taking and the crisis events.

5. Additional tests

To validate our main results, we perform several additional tests. First, we run DID regressions to assess the differential effect that crisis events have on countries. As before, we use the [Laeven & Valencia \(2018\)](#) database extended to the end of our sample period to identify the crisis years by country for each sample period. [Tables 7a–7b](#) show the results of the DID regressions. These results do not alter our previous findings. Indeed, the tables show that institutional mechanisms and Investor Protection reduced risk-taking (p -value ≤ 0.10). However, the Country Crisis coefficients for the 2005–2009 period are positive and significant when RISK is the dependent variable (p -value ≤ 0.10), indicating that risk-taking increased during the period. We find corresponding results using Z-score as the dependent variable (see [Table 7b](#)). Using Panel A of [Table 7a](#), the interaction terms, i.e., ADRI $\times$ Country Crisis and IM $\times$ Country Crisis, are negative when significant. This result suggests that Investor Protection (ADRI) and institutional mechanisms (IM) reduced risk-taking during the 2005–2009 period (p -value ≤ 0.10). Since the main effects of Investor Protection and Quality of Government are both negative and significant, their combined effects with ADRI $\times$ Country Crisis and IM $\times$ Country Crisis indicate that, overall, these measures decreased risk-taking during the 2005–2009 period. To illustrate, for the case of Investor Protection, the coefficient of the Country Crisis is 0.48 (p -value ≤ 0.05), when we control for Rule of Law. The associated ADRI $\times$ Country Crisis coefficient is -0.13 (p -value ≤ 0.05). The positive impact of the crisis dummy is therefore reduced to 0.35 ($= 0.48 + (-0.13)$) by the ADRI $\times$ Country Crisis effect. The main effect for Investor Protection is -0.41 (p -value ≤ 0.01). Thus, overall, Investor Protection reduced risk-taking when we account for DID in our regressions. The results for Z-score are, however, weak (for the 2005–2009 period). Thus, using Z-score, only one Country Crisis coefficient is significant. The crisis year interaction terms are also insignificant, except in one case (see [Table 7b](#), Panel A).

Investor Protection and institutional mechanisms are negatively related to RISK for the 2009–2019 period (see Panel B of [Tables 7a–7b](#)). These results are in line with those of the 2005–2009 period. However, only one IM $\times$ Country Crisis coefficient is significant when RISK is the dependent variable (Panel B of [Table 7a](#); p -value ≤ 0.10). No Country Crisis coefficient is significant. It is worth noting that, contrary to our results in [Table 2a](#), only one Low_ADRI $\times$ IM interaction term has a positive and significant coefficient and High_ADRI $\times$ IM interaction terms have insignificant coefficients in all cases, when RISK is used as the dependent variable. Two Country Crisis coefficients are negative and significant (p -value ≤ 0.10 ; Panel B, [Table 7b](#)), when Z-score is used as the dependent variable whereas, the IM $\times$ Country Crisis coefficients are insignificant in all cases. However, the ADRI $\times$ Country Crisis coefficients are positive and significant (p -value ≤ 0.10), indicating that risk-taking decreased during the crisis years. [Baker et al. \(2022\)](#) note, however, that there are econometric issues associated with applying DID tests to avoid Type I and Type II errors.

Following a Reviewer's suggestion, we use the ratio of NPLs to total gross loans as an alternative risk-taking measure. Using NPLs, [Table 8](#) shows that Investor Protection and institutional mechanisms reduced risk-taking (p -value ≤ 0.10) in line with our earlier results. The associated coefficient values are larger (in absolute value) compared to those in [Table 2a](#). This may reflect the more direct impact of Investor Protection and institutional mechanisms on NPLs, unlike the RISK and Z-score measures which represent aggregate levels of risk-taking. It is useful to note that the definition of NPLs varies across countries, leading to large variation in its dispersion across countries ([Laeven & Valencia, 2018](#)). While banks may follow national and/or international regulations for NPL recognition, collateral enforcement of debt obligations may be impeded by legal, judicial, and consumer protection impediments and recovery costs ([European Central Bank: Banking Supervision, 2017](#)). These conditions are likely to impose substantial managerial discretion in the determination of NPL levels across countries, as well as its quality for accounting disclosure. As such, we argue that Z-score and RISK are more reliable risk-taking measures since they allow less managerial and accounting discretion in their determination. [Agoraki et al. \(2011\)](#) report that market power is negatively related to NPLs, and supervisor power and capital requirements reduce the level of NPLs. In line with the implication of their results, we show that institutional mechanisms also reduce the level of NPLs.

We next investigate whether the larger average size of U.S. banks unduly influenced our results. We therefore re-run the regressions in [Table 2a](#) by excluding all U.S. banks from the sample. The results in [WEB Appendix C](#) are consistent with our earlier findings. Furthermore, since the Eurozone Crisis mostly affected Eurozone banks, we also re-run the regressions in [Table 2a](#) by including only Eurozone banks in the sample. Here, we identify 127 Eurozone banks in 16 countries for this analysis. We find that institutional mechanisms and Investor Protection decreased risk-taking in line with earlier results (see [WEB Appendix D](#)). However, unlike the insignificant effects of Low_ADRI in [Table 2a](#) (Panel B), low Investor Protection countries experienced decreases in risk-taking. In addition, we use the World Economic Situation and Prospects (WESP) and the Worlddata.info classification schemes, to group all banks into developed and developing economies. While the two classification schemes are not entirely consistent, the untabulated results do not alter our findings in [Table 2a](#). As stated before, using the ratio of Market Capitalization to GDP controls for variation in economic development across countries.¹⁷ Our use of country income fixed effects also controls for unobservable development effects. Thus, our

¹⁷ [Wurgler \(2000\)](#) shows that the strength of financial market development positively influences capital allocation. Capital allocation efficiency is negatively correlated with state ownership but positively correlated with protection of minority investors (see also [La Porta et al., 1997](#)).

Table 7b

DID regressions of Z-score on institutional measures and country-crisis years.

The IV-GMM coefficients are for 686 banks in 40 countries. Country Crisis is a dummy variable which is 1 in crisis year(s) and 0 otherwise. Crisis year is determined by country using the [Laeven & Valencia \(2018\)](#) database and extended to the more recent period. Z-score is the dependent variable at bank level. In Panel A, the sample period is 2005–2009. In Panel B, the sample period is 2009–2019. ADRI is the [Spamann \(2010\)](#) investor protection measure. The [Djankov et al. \(2008\)](#) revised ADRI is used for China, Kazakhstan, Ukraine, Russia, Poland and Tunisia due to unavailable [Spamann \(2010\)](#) ADRI data. IM denotes Institutional Mechanism in terms of Rule of Law, Control of Corruption, Regulatory Quality, Quality of Government and Government Effectiveness. The control variables are: Bank Deposit; Bank Size; Tangible Equity; Funding Fragility; Real GDP Growth; Government Expenditure Growth; Broad Money Growth; Terms of Trade; Market Capitalization to GDP; Reserve Growth; and Stock Market Turnover Ratio. Most control variables are not shown to save space. $DLoans_{i,t}$ are the deviation of bank loans to total assets of bank i , from the average country-level bank loans to total assets. $DLoans_{i,t}$ are instrumented with Domestic Credit to Private Sector over GDP and GDP per capita. Variable definitions are in [WEB Appendix A](#). Robust standard errors are in parentheses. ^a, ^b, and ^c denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Estimates are for the 2005–2009 period with country-crisis dummies										
Variable	Rule of Law		Control of Corruption		Regulatory Quality		Govt. Effectiveness		Quality of Government	
ADRI (Investor Protection)	0.475 ^a (0.096)	0.299 ^a (0.096)	0.369 ^a (0.105)	0.195 ^b (0.077)	0.414 ^a (0.077)	0.196 ^b (0.089)	0.341 ^a (0.125)	0.336 ^b (0.157)	0.376 ^a (0.075)	0.307 ^a (0.106)
Institutional Mechanism (IM)	1.368 ^a (0.256)	1.532 ^a (0.252)	1.162 ^a (0.182)	1.250 ^a (0.166)	0.993 ^b (0.386)	0.872 ^c (0.456)	1.281 ^a (0.339)	1.241 ^a (0.258)	0.284 ^a (0.050)	0.293 ^a (0.056)
High_ADRI × IM		0.358 ^b (0.154)		0.373 ^a (0.127)		0.599 ^c (0.337)		0.008 (0.240)		0.060 ^b (0.028)
Low_ADRI × IM		−0.089 (0.156)		−0.083 (0.132)		−0.104 (0.157)		−0.023 (0.147)		0.005 (0.027)
Country Crisis	−0.070 (0.291)	−0.013 (0.329)	−0.366 (0.284)	−0.370 (0.333)	0.318 (0.310)	0.472 (0.512)	−0.561 (0.935)	−0.687 (0.822)	−0.537 ^c (0.307)	−0.482 (0.320)
ADRI × Country Crisis	−0.045 (0.077)	−0.056 (0.067)	0.031 (0.067)	0.060 (0.077)	−0.178 ^b (0.088)	−0.176 (0.137)	−0.003 (0.235)	0.028 (0.190)	0.047 (0.071)	0.034 (0.069)
IM × Country Crisis	−0.069 (0.126)	−0.134 (0.139)	0.088 (0.129)	0.060 (0.161)	−0.202 (0.159)	−0.176 (0.190)	0.099 (0.502)	0.169 (0.426)	0.015 (0.026)	0.005 (0.028)
Constant	3.931 ^a (0.686)	4.577 ^a (0.802)	4.140 ^a (0.671)	4.596 ^a (0.715)	3.297 ^a (0.877)	3.341 ^a (0.792)	4.114 ^b (1.967)	3.954 ^a (1.478)	4.638 ^a (0.675)	4.919 ^a (0.760)
Observations	1046	1029	1029	1029	1046	996	1044	1044	1029	1029
R-squared	0.110	0.115	0.104	0.122	0.105	0.107	0.108	0.109	0.113	0.106
Panel B: Estimates are for the 2009–2019 period with country-crisis dummies										
ADRI (Investor Protection)	0.265 ^c (0.137)	0.178 ^c (0.107)	0.163 ^a (0.033)	0.150 ^a (0.047)	0.220 ^c (0.127)	0.245 ^c (0.127)	0.169 ^c (0.092)	0.214 ^c (0.116)	0.332 ^c (0.169)	0.339 ^c (0.186)
Institutional Mechanism (IM)	1.071 ^a (0.235)	1.069 ^a (0.196)	0.131 ^a (0.039)	0.243 ^a (0.061)	1.160 ^a (0.311)	0.734 ^a (0.182)	0.974 ^a (0.184)	0.620 ^a (0.150)	0.314 ^a (0.052)	0.123 ^a (0.042)
High_ADRI × IM		0.063 (0.121)		−0.181 (0.139)		−0.012 (0.157)		−0.053 (0.136)		−0.060 ^c (0.036)
Low_ADRI × IM		0.098 (0.152)		−0.080 (0.155)		0.065 (0.192)		0.060 (0.157)		−0.012 (0.039)
Country Crisis	−0.436 (1.062)	−0.187 (0.830)	−0.974 ^b (0.420)	−0.609 (0.470)	−1.075 (1.388)	−1.524 (1.302)	−0.984 (0.838)	−1.450 ^c (0.878)	1.500 (1.342)	−1.561 (1.464)
ADRI × Country Crisis	0.256 (0.173)	0.238 ^c (0.130)	0.084 (0.093)	0.054 (0.106)	0.337 ^b (0.147)	0.334 ^b (0.140)	0.206 (0.153)	0.284 ^c (0.162)	0.240 ^c (0.142)	0.405 ^b (0.160)
IM × Country Crisis	−0.413 (0.924)	−0.952 (0.594)	0.095 (0.289)	−0.119 (0.313)	−0.502 (1.068)	−0.253 (0.978)	−0.118 (0.808)	−0.223 (0.781)	−0.197 (0.265)	−0.041 (0.213)
Constant	1.834 (1.413)	3.779 ^a (0.841)	3.385 ^a (0.486)	2.723 ^a (0.703)	2.847 (1.798)	2.926 ^a (1.068)	2.563 ^b (1.037)	2.986 ^a (0.981)	−1.616 (1.925)	1.649 (1.652)
Observations	2250	2272	2326	2327	2272	2272	2272	2272	2317	2250
R-squared	0.146	0.159	0.098	0.099	0.145	0.141	0.158	0.146	0.141	0.144

results for developing and developed countries are unsurprising.

Finally, we replicate the [Beltratti & Stulz \(2012\)](#) and [Hoque et al. \(2015\)](#) method using buy-and-hold returns. The buy-and-hold returns are from June 2007 to December 2008 for the GFC period (see [Beltratti & Stulz, 2012](#); [Hoque et al., 2015](#)) and May 2011 to December 2011 for the Eurozone Crisis period (see [Hoque et al., 2015](#)). Our analysis is based on banks with total asset values of US \$10 billion or more in 2006 (2010) for 2005–2009 (2010–2019), since we want to include banks with comparable sizes to those of [Beltratti & Stulz \(2012\)](#). Our untabulated results are consistent with those of [Beltratti & Stulz \(2012\)](#) and [Hoque et al. \(2015\)](#). Specifically, prior period Investor Protection and Quality of Government are poor predictors of buy-and-hold returns during crisis periods. Ownership is unrelated to buy-and-hold returns. While prior studies test an alternative hypothesis to ours, we note that crisis period buy-and-hold returns are likely to be uncorrelated with governance mechanisms since stock prices and investment opportunities are unusually depressed during crisis periods ([Stein & Stone, 2013](#)). Thus, the difference between our results and those of prior studies reflects our research design and, correspondingly, the hypotheses being tested.

Table 8

IV-GMM coefficients for institutional measures using Non-performing Loans as the dependent variable.

The table shows IV-GMM regression results when the ratio of non-performing Loans to Gross Loans (NPL) is the risk-taking measure at the bank level. The GFC crisis period spans 2005–2009 which contains the 2007–2008 GFC period. The Eurozone Crisis period spans 2009–2019 which contains the 2010–2018 Eurozone Crisis period. ADRI is the Spamann (2010) ADRI for investor protection measure. The Djankov et al. (2008) revised ADRI is used for China, Kazakhstan, Ukraine, Russia, Poland and Tunisia due to unavailable Spamann (2010) ADRI data. IM denotes Institutional Mechanism in terms of Rule of Law, Control of Corruption, Regulatory Quality, Quality of Government and Govt. Effectiveness. Control variables are: Bank Deposit; Bank Size; Tangible Equity; Funding Fragility; Real GDP Growth; Government Expenditure Growth; Broad Money Growth; Terms of Trade; Market Capitalization to GDP; Reserve Growth; and Stock Market Turnover Ratio. Most control variables are not shown to save space. $DLoans_{i,t}$ are the deviation of bank loans to total assets of bank i , from the average country-level bank loans to total assets. $DLoans_{i,t}$ are instrumented with Private Credit to GDP and GDP per capita. Robust standard errors are in parentheses. ^a, ^b, and ^c denote statistical significance at the 1%, 5%, and 10% levels, respectively. Variable definitions are in WEB Appendix A.

Panel A: Estimates for the 2005–2009 period					
	Rule of Law	Control of Corruption	Regulatory Quality	Govt. Effectiveness	Quality of Government
ADRI (Investor Protection)	–2.896 ^c (1.551)	–1.611 ^c (0.829)	–1.537 ^a (0.305)	–0.789 ^a (0.235)	–0.527 ^b (0.215)
Institutional Mechanism (IM)	–1.851 ^c (1.018)	–0.995 (0.713)	–8.984 ^a (1.635)	–4.335 ^a (1.397)	–0.669 ^a (0.211)
Constant	–11.516 (11.931)	8.820 ^b (4.026)	13.718 ^a (2.439)	6.603 ^a (2.060)	4.607 ^a (1.497)
Number of observations	695	695	698	698	698
R-squared	0.0975	0.321	0.235	0.127	0.114
Panel B: Estimates for the 2009–2019 period					
ADRI (Investor Protection)	–0.749 ^b (0.373)	–1.855 ^b (0.911)	–1.335 ^a (0.455)	–1.032 ^b (0.415)	–2.816 ^c (1.486)
Institutional Mechanism (IM)	–4.930 ^a (0.985)	–5.793 ^a (0.992)	–5.811 ^a (1.274)	–5.636 ^a (1.026)	–1.236 ^a (0.291)
Constant	–6.902 ^b (3.305)	–19.935 ^a (6.719)	–11.932 ^a (3.667)	–11.469 ^a (4.101)	–30.728 ^b (13.002)
Number of observations	3381	3363	3381	3363	3121
R-squared	0.245	0.310	0.291	0.295	0.308

6. Conclusion

Prior studies blame financial crises on excessive risk-taking, poor institutional laws and ownership structures, and weak BRS rules. Weaknesses in these mechanisms are said to incentivize expropriation by controlling shareholders, especially during crisis periods (Boyd & Hakenes, 2014; Johnson et al., 2000; Kirkpatrick, 2009). We focus on the effects of institutional mechanisms, Investor Protection, BRS rules, and ownership, on bank risk-taking. We also assess their predictive effects during crisis regimes. First, we find robust results that institutional mechanisms, Investor Protection, ownership, and BRS rules reduce risk-taking. Our overall results are robust across the sample periods, although we find some variation that depends on the risk-taking measure. Second, institutional mechanisms have the most pronounced effects on risk-taking, followed by Investor Protection, BRS rules, and ownership effects (in that order). While the effects of institutional mechanisms and Investor Protection are economically large, the crises still happened. This suggests that other factors such as panic and contagion effects may provide better explanations for crisis events. Prior studies view foreign ownership as a key transmitter of contagion effects around crisis events (see IMF, 2009), whereas government ownership is seen as a market stabilization mechanism in many countries, especially during crisis periods (see Iannotta et al., 2013). Our results suggest that using Government Ownership to stabilize financial markets may be seen as costly, given its small economic impact on risk-taking.¹⁸ A preferred policy would be for governments and regulators to set policies that improve the economic, legal, and financial conditions in countries for institutional mechanisms and BRS rules to work more effectively. In line with this view, we find that Foreign and Government Ownership increase risk-taking in both high and low Investor Protection countries, and institution mechanisms reduce (increase) risk-taking in high (low) Investor Protection countries for the 2005–2009.

We also find that the pre-crisis regimes are more predictable than crisis-post/crisis regimes. Higher risk-taking increases the likelihood of pre-crisis and crisis/post-crisis regimes, with stronger effects during pre-crisis regimes. Investor Protection and Quality of Government reduced the likelihood of crisis regimes for 2005–2009 period but increased the likelihood of crisis regimes for the 2009–2019 period. BRS rules tend to have mixed effects. Government Ownership increased the likelihood of the 2005–2009 crisis regimes but decreased the likelihood of the 2009–2019 crisis regimes. Our results pose a challenge to governments and regulators regarding the specific policy to apply in the presence of institutional, ownership, and BRS rules, when seeking to mitigate crisis events. A policy stance might be to quickly react to excessive risk-taking during pre-crisis regimes since this is likely to be more effective in curbing impending crises. Since we find dependency between risk-taking and crisis regimes, a further policy stance would be for

¹⁸ Lucas (2019) shows that, for the U.S., the total fair value direct cost of the GFC was US\$498 billion, representing 3.5% of the U.S. gross domestic product at 2009.

regulators to ensure that banks maintain adequate distance from default, given that balance sheet instability is a strong transmitter of economic shocks (Ahrend & Goujard, 2015; Kapan & Minoiu, 2018). Our results are supported by a battery of tests, thereby giving us confidence in our findings. However, we do not suggest that we have examined a comprehensive list of economic factors that influence risk-taking and crisis regime outcomes.¹⁹

Data availability

Data will be made available on request.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.bar.2024.101451>.

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¹⁹ In additional results, we find that stronger Limitations on Foreign Bank Entry increased the likelihood of crisis regimes and Financial Statement Transparency decreased the likelihood of crisis regimes.

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