

Contents lists available at [ScienceDirect](https://www.sciencedirect.com)

Global Finance Journal

journal homepage: www.elsevier.com/locate/gfj

Measuring the risk appetite of bank-controlling shareholders: The Risk-Weighted Ownership index

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ARTICLE INFO

JEL classification:

G21

G32

Keywords:

Bank

Ownership

Risk appetite

Corporate governance

ABSTRACT

This study proposes a measure of the risk appetite of a bank's ownership structure and investigates whether ownership risk propensity is related to performance and default risk. Our indicator, the Risk-Weighted Ownership (RWO), assumes that credit risk is a proxy for shareholders' risk appetite and assigns risk weights based on the Basel standard approach to the stakes held by the top 5, 10, and 20 controlling shareholders. We calculate the RWO index using a sample of 76 listed banks from the Eurozone and the United Kingdom from 2008 to 2017. The RWO correlates with bank fundamentals when we regress it with accounting- and market-based performance and risk measures. We present two major findings. First, the RWO index incorporates the risk appetite of controlling shareholders, and its variance is affected by the ownership structure. Second, a higher risk appetite among shareholders is associated with higher profitability but lower bank capitalization, implying a trade-off between performance and default risk. Overall, we find that the risk appetite of the ownership structure is an important driver of bank performance and risk.

1. Introduction

Over the last 40 years, the world has witnessed numerous banking crises at both domestic and cross-country levels. These difficult times in our recent financial history demonstrate banks' risky nature and vulnerability to exogenous shocks (Barry et al., 2011). Scholars looking into the causes of these crises have discovered that poor corporate governance and ownership structures are at the root of excessive bank risk-taking (Berger et al., 2016; Gorton & Rosen, 1995; Kirkpatrick, 2009). Despite regulatory efforts to compel banks to adopt better corporate governance practices, these mechanisms have frequently proven ineffective as long as safety nets and too-big-to-fail incentives continue to be a means of offloading risks onto creditors and taxpayers (Anginer et al., 2018; Bhattacharya & Thakor, 1993; Macey & O'Hara, 2003; Mehran et al., 2011). Furthermore, banks differ from nonfinancial firms in that financial distress causes systemic spillovers (Stulz, 2015). As a result, limiting the importance of shareholders' interests over those of other stakeholders is critical, not least in protecting the overall stability of the financial system (Adams & Mehran, 2003; Berger et al., 2014; Bolton et al., 2015). In contrast to shareholder power, the literature shows that creditors' and management's interests are aligned through internal control mechanisms (i.e., the board of directors, CEO power, executive pay, and risk management) and external control mechanisms (i.e., interest rates on capital raising and deposit rates). Srivastav and Hagendorff (2016) examine corporate governance mechanisms that

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<https://doi.org/10.1016/j.gfj.2024.100935>

Received 27 June 2023; Received in revised form 1 February 2024; Accepted 1 February 2024

Available online 2 February 2024

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limit shareholder power and bank risk-taking. However, the risk of ownership structure is treated as homogeneous in this literature. Conversely, are the risk levels of banks' major shareholders equivalent? Is the risk appetite of all controlling shareholders equal, or do some owners encourage more risk-taking than others? Should control mechanisms be more robust when shareholders' risk appetite is higher? Might supervision demand additional control measures when shareholders have a greater appetite for risk?

For banks, risk appetite is a strategic framework that defines the level of risk a bank is willing to embrace or tolerate to achieve its business objectives. It embodies the delicate balance of risk and reward and the parameters within which a bank feels comfortable operating (BIS and Bank for International Settlements, 2015). Risk appetite establishes limits on the types and levels of risks a bank can undertake. A more assertive risk appetite may enable the bank to pursue higher-yielding opportunities, potentially resulting in increased profitability, but at the expense of increased risk exposure. On the contrary, a more conservative risk appetite may result in lower profits but greater stability. Finding the right balance is critical to ensuring that the bank meets its strategic objectives while remaining financially stable. Scholars find that the type of ownership (state vs. private, foreign vs. domestic, listed vs. unlisted, and so on) is related to bank performance and risk. Privately owned banks, for example, outperform publicly traded banks (Iannotta et al., 2007, 2013; Pennathur et al., 2012; Yin et al., 2013; Zhu & Yang, 2016), and institutional investors expose banks to excessive risk-taking (Barry et al., 2011; Erkens et al., 2012; Garel & Petit-Romec, 2017; Switzer et al., 2018). Thus, although there is evidence that different ownership structures expose banks to varying performance and risk levels, little is known about controlling shareholders' individual and collective risk appetites. This could be important in determining whether a bank is exposed to greater risks. Consequently, governance mechanisms should be strengthened to prevent shareholders from prevailing over other stakeholders, putting not only individual banks, but the financial system as a whole, at risk.

In this paper, we attempt to quantify bank-controlling shareholders' risk appetite and investigate its relationship with performance and risk measures. We address this research goal by developing the Risk-Weighted Ownership (RWO) index, which aims to measure the individual and collective risks of the ownership structure, with credit risk serving as the primary driver of risk appetite.

Our RWO index is based on the three assumptions listed below. First, Bolton et al. (2015) show that shareholders have no incentive to control risk exposure and benefit more than other stakeholders. Our main hypothesis is that corporate decisions reflect a greater alignment of management with the interests of shareholders (Srivastav & Hagendorff, 2016). Second, based on the literature showing that default risk is correlated with market returns (Dichev & Piotroski, 2001; Hand et al., 1992; Vassalou & Xing, 2004), and stock prices reflect credit risk, we assume shareholder credit risk is related to individual risk appetite (Bai et al., 2017; Bekaert & Hoerova, 2016; Han et al., 2017). Third, we contend that controlling shareholders do contribute to bank risk, proportionally on their stake. Based on these assumptions, the RWO index is calculated as the sum of stakes held by controlling shareholders, each one multiplied by its corresponding risk weight.

The following procedure is used to assign risk weights. First, we define a bank's ownership structure at various levels based on the number of shareholders: the top 5, 10, and 20 shareholders (Demsetz & Lehn, 1985; Kang et al., 2007; Zhang et al., 2013). Second, we attribute risk weights to controlling shareholders using a scoring methodology that assigns credit risk coefficients in accordance with the Basel framework's standard model (see Section 3 for details). Third, we determine the types of shareholders (government, bank, corporate, etc.) based on the Basel framework classes. Fourth, we assign long-term ratings to each shareholder (from S&P, Moody's, or Fitch). Fifth, we assign ratings to unrated financial shareholders based on data from our sample's rated shareholders by estimating their bank Z-score (Laeven & Levine, 2009). If the available data do not allow a Z-score estimate, we use the rating attached to the shareholder's country of domicile.

We calculated the RWO index on 76 listed banks in the Eurozone and the United Kingdom using data from Bloomberg for each bank and controlling shareholder from 2008 to 2017. In addition, we present descriptive statistics on the RWO index estimates and examine their relationship with bank performance and risk. The generalized method of moments (GMM) estimator accounts for the endogeneity of governance studies (Arellano & Bond, 1991). Furthermore, we analyze the corporate governance variables that mitigate the impact of shareholder power.

Our main results show that the RWO is a sensitive indicator of the composition of the shareholding structure based on two major variables. The first is the shareholding of controlling shareholders, both individually and collectively. The second is the credit risk associated with controlling shareholders in the top 5, 10, and 20. The RWO index, consequently, ignores the risk diversification (or concentration) effect for the combination of individual risk profiles. It also shows significant variation between individual entities as well as between countries. Furthermore, the empirical analysis reveals a trade-off between performance and capitalization, as the RWO index is positively correlated with performance while negatively correlated with the main Basel capital adequacy measures. Thus, a higher risk appetite of the ownership structure appears to lead to better accounting and market performance (return on assets (RoA), price-to-book ratio) but lower capitalization (common equity Tier 1 [CET1] ratio, Tier 1 ratio), potentially offloading default costs onto the community. Finally, we explore how RWO influences strategic decisions regarding loan portfolio composition and investment choices to better understand the mechanisms underlying the link between the risk appetite of the ownership structure and bank profitability. The results suggest that banks with a higher risk appetite are less likely to set aside reserves than others, whereas there are no statistically significant differences in terms of nonperforming loans or risk-weighted assets.

Our study makes two significant contributions to the literature. First, this paper proposes a new synthetic indicator that assigns a risk measure to the bank's ownership structure. Our approach is novel in that it computes an index that derives bank risk appetite from the identity of controlling shareholders, thereby providing an *ex-ante* signal of bank risk propensity. The existing literature highlights the importance of dominant shareholders in exposing banks to individual and systemic risk (De Haan & Vlahu, 2016; Srivastav & Hagendorff, 2016), but it has limited the investigation of the role of shareholder type, avoiding delving deeper into the individual and collective risk associated with the ownership structure. Our paper attempts to fill this gap. The second contribution is the application of the RWO index to a preliminary empirical analysis, which appears to highlight a trade-off between performance and default risk in

institutions with higher risk appetites. This evidence adds to the academic, practitioner, and regulatory debate about the importance of increasing interest in and research on bank ownership, which has been underinvestigated in the last decade due to a lack of structured data (Shaban & James, 2018). A better understanding of the major shareholders' ownership incentives and private benefits is critical in determining which governance mechanisms are most effective in avoiding excessive risk exposure.

The rest of this paper is structured as follows. Section 2 discusses the theoretical foundations of our research and related literature. Section 3 describes the methodology underlying the construction of the RWO index. Section 4 presents the econometric modeling. Section 5 describes the sample's construction, detailing the summary statistics of the variables included in our models, and then presents and discusses the results of our empirical analysis. Finally, Section 6 draws our conclusions and discusses the policy implications.

2. Related literature

Our paper contributes to the literature on the relationship between bank ownership on the one hand and performance and risk-taking on the other.

A pertinent line of research examines the type of shareholder, comparing publicly held versus privately owned, domestic versus foreign. Although evidence shows state ownership is associated with poor bank performance, particularly in financially troubled countries (Berger et al., 2005; Boubakri et al., 2020), the opposite may be true if the controlling government is foreign (Micco et al., 2007). In any case, even when the response to a severe shock is considered, the type of major shareholder is found to have a nonzero association with performance (Cornett et al., 2010). Despite this, government intervention is found to make banks less profitable, more volatile in terms of earnings, and more likely to default because public ownership changes the governance structure of a bank by transferring power from directors to CEO (Borisova et al., 2012; Saghi-Zedek & Tarazi, 2015).

Iannotta et al. (2007) find that privately owned banks are more profitable when they examine alternative ownership structures. In contrast, government-owned banks are generally less capitalized, have lower retail deposits, and extend less credit. Furthermore, Iannotta et al. (2013) find that state-owned banks have an artificially lower default risk than privately owned institutions due to governmental backing, which allows for lower funding costs and higher operating risk. In various domestic contexts, such inefficiencies of state ownership in banking have been confirmed (Pennathur et al., 2012; Zhu & Yang, 2016). Further empirical evidence suggests that different types of ownership can affect bank risk-taking (Balla & Rose, 2019; Martín-Oliver et al., 2017); however, no structural or persistent differences between publicly and privately owned banks are found (Akhigbe et al., 2017; Barry et al., 2011).

Ownership concentration is another factor influencing bank performance and risk-taking. The reasoning is that, since large shareholders are more involved in corporate strategy, the interests of agents are more aligned with those of principals. Nonetheless, lower agency costs shift the conflict of interest from managers versus controlling shareholders to managers versus minority shareholders, raising the possibility of entrenchment due to the exploitation of private benefits (Jensen & Meckling, 1976; Shleifer & Vishny, 1986). The benefits of highly concentrated ownership structures have been highlighted in the literature, though these are much more relevant in terms of loan quality, asset risk, and insolvency risk than profitability (Iannotta et al., 2007; Tan & Floros, 2018) or market value (Busta et al., 2014). Even outside of the financial industry, the benefits of ownership concentration include a lower risk of stock crash (Yeung & Lento, 2018). Shehzad et al. (2010) find that the effect of ownership concentration on bank risk-taking is positive in terms of both credit quality and capital adequacy by analyzing a sample of 500 commercial banks located in >50 countries between 2005 and 2007. On the contrary, Haw et al. (2010) show that concentration reduces performance and cost efficiency while increasing the risk of insolvency. In addition, by investigating whether ownership concentration explains earnings management, Bouvatier et al. (2014) find that banks with larger shareholders exhibit higher levels of discretionary provisioning. However, the majority of these results are highly dependent on the institutional setting. Low-quality accounting practices, for example, are less common in the presence of a strong regulatory framework that seeks to prevent insider expropriation and enforce private monitoring, thereby protecting minority shareholders.

Insiders are another source of market risk within a bank's ownership structure (Anderson & Fraser, 2000; Demsetz et al., 1997; Knopf & Teall, 1996; Saunders et al., 1990), even if the effect can be mitigated by CEO duality (Pi & Timme, 1993), board size (Pathan, 2009), or too-big-to-fail conditions (Lee, 2002). Insider ownership, on the other hand, is associated with a lower default risk (Pathan, 2009; Spong & Sullivan, 2007). According to the most recent literature on the global financial crisis (GFC) period, large executive shareholdings positively impact stock market returns (Beltratti & Stulz, 2012) while reducing the risk of default (Berger et al., 2016). Meanwhile, outside directors and executives are found to have no significant effect on excessive bank risk-taking. The relationship between insider ownership and profitability is more contentious, with varying results for different types of insiders (Aebi et al., 2012; Berger et al., 2016; Cheng et al., 2012; Grove et al., 2011; Westman, 2011).

Few but recent contributions have been made to the study of the effect of ownership-related incentives on bank risk-taking. Conversely, studies investigating the nature of shareholders as a potential determinant of risk-taking focus on the role of institutional investors. Barry et al. (2011) made one of the first attempts, using a European sample of 249 publicly traded and privately held banks between 1999 and 2005 to investigate the relationship between ownership structure and risk. Five categories of owners are discerned (managers/directors, institutional investors, nonfinancial firms, individuals/families, and banks), highlighting that a shift in equity from institutional investors to individuals/families or banks is associated with lower asset and default risk. When looking at nonfinancial firms, however, no significant difference is found. The authors also show that, for publicly traded banks, ownership changes do not affect risk-taking; thus, market discipline is supposed to align risk-taking strategies, so that ownership structure is not a determinant of risk differences.

Conversely, Erkens et al. (2012) found that financial firms with higher levels of institutional ownership and more independent

boards had lower stock returns during the GFC. More specifically, the increased presence of institutional investors in the ownership structure exposed financial firms to greater risks prior to the crisis, resulting in greater losses in the aftermath. Garel and Petit-Romec (2017) confirm these results by examining the investment horizon of owners in 419 publicly traded US banks. In particular, they claim that not all investors are the same, and thus the issue is not only how much capital is provided, but also *who* provides it. According to the authors, short-term institutional investors had a positive impact on bank performance during the GFC but failed to improve long-term resilience to shocks.

Switzer et al. (2018) provide additional post-crisis evidence on the role of institutional investors. They show that institutional ownership reduces the probability of default by analyzing the corporate governance characteristics of 117 financial firms outside North America in the post-GFC period; conversely, insider ownership is positively related to credit risk but does not affect credit default swap (CDS) spreads. More specifically, Switzer et al. (2018), Erkens et al. (2012), and Aebi et al. (2012) suggest that, prior to the GFC, institutional investors encouraged managers to take on excessive risk exposures in order to drive performance; however, in the aftermath of the shock, surviving banks shifted their strategy toward more prudent risk-taking in order to gain stock performance from the recovery of losses.

The literature has also investigated into the effect of specific types of owners (for example, states and families) on diversification. Evidence shows that when large owners are banks, institutional investors, or industrial companies with above-average skills and expertise, banks benefit from product diversification (Saghi-Zedek, 2016).

Insider ownership can also have an important impact on risk-taking. According to agency theory, corporate insiders may find it advantageous to take excessive risks by seeking short-term returns (Jensen & Meckling, 1976). Since Saunders et al. (1990), research has confirmed that the greater the proportion of capital managers hold, the greater the bank risk-taking, because compensation policies align the interests of agents and principals.

Shareholders can collude with managers against depositors to make high-risk investments (Boyd et al., 1998; Shehzad et al., 2010). Fahlenbrach and Stulz (2011) find that CEOs of banks experiencing stock price drops had incentives more aligned with shareholders' interests. Shareholders, in particular, may consider asking managers to take excessive risks as the best option because they will not suffer from internalizing bankruptcy social costs; however, public insurance on deposits reduces debtor control (Erkens et al., 2012).

The presence of endogenous and exogenous governance mechanisms (i.e., the supervision exerted by the board of directors and regulators, respectively) and executives with a lower risk appetite vis-à-vis shareholders reduces the pressure to take excessive risks. This is because executives jeopardize the value of their human capital in the labor market, and thus their private benefits (De Andres & Vallelado, 2008; Laeven & Levine, 2009). Shareholders typically mitigate this misalignment through compensation policies, which are frequently linked to stock market performance (DeYoung et al., 2013), or dividend policies (Onali et al., 2016).

3. The RWO index

3.1. RWO data

To create the RWO index, we use data from Moody's BankFocus on 76 listed banks from 17 countries (i.e., 16 eurozone countries plus the United Kingdom). We look for banks that have the following characteristics:

- They are active; that is, operating and legally autonomous, as they have not been closed down for any reason (e.g., merger, bankruptcy, dissolution into a new company, etc.).
- They are located in the Eurozone (as of end-2017) or the United Kingdom, which means they are subject to the jurisdiction of one of those countries.
- They have a banking license, indicating they are properly engaged in banking activities. In more detail, we choose commercial banks, savings banks, cooperative banks, investment banks, and bank holding companies.
- Banks are listed, meaning their shares are traded on a regulated market. Because of more stringent disclosure requirements, ownership data on public companies are much more easily accessible.

Given these criteria, we excluded any banks with no or only one yearly observation from our sample.

We collect Bloomberg data on the name, type, and number of shares held by each bank and shareholder at the end of each year's fourth quarter between 2008 and 2017.¹ We compute the corresponding stakes as the percentage of shares held to the bank's total number of shares outstanding.² Pursuant to the literature, we define the ownership structure as the 20 largest shareholders (Demsetz & Lehn, 1985; Kang et al., 2007; Zhang et al., 2013).

Table 1 shows our sample's composition. The United Kingdom, France, Spain, Italy, and Germany are the most relevant countries, accounting for 88% of our sample's total assets. In terms of number of entities, the five most populous countries, namely the United

¹ We capture almost the entirety of a bank's shareholding base, leaving only floating capital aside. Bloomberg does not report investors possessing almost zero stakes.

² In the case of a bank having shares of various types (e.g., preferred ones), we consider the ticker that refers to ordinary shares. The issuance and sale of preferred stocks are highly sensitive to either contingent systemic or unusual but structural market-wide conditions. The beta against the market index is significantly lower vis-à-vis common stocks (Brabenc et al., 2020). If the same stock is listed on different markets, we consider the ticker referring to the market located in the country where the bank is domiciled.

Table 1
Sample composition.

Country	Number of banks	Total assets (2017, EUR millions)	Total assets (2017)	Share of cumulated total assets (2017)	Share of the domestic banking sector, in total assets, out of the whole	Share of cumulated total assets of domestic banking sectors (2017)
United Kingdom	11	5,963,612.84	28.01%	28.01%	24.15%	24.15%
France	4	5,283,818.90	24.82%	52.83%	22.69%	46.84%
Spain	7	3,053,718.87	14.34%	67.17%	7.31%	54.15%
Italy	18	2,438,892.90	11.46%	78.63%	9.98%	64.12%
Germany	5	1,996,160.44	9.38%	88.01%	20.70%	84.82%
The Netherlands	3	1,243,751.35	5.84%	93.85%	6.38%	91.20%
Belgium	2	475,287.40	2.23%	96.08%	2.74%	93.94%
Austria	5	393,095.74	1.85%	97.93%	2.18%	96.11%
Greece	5	256,895.47	1.21%	99.14%	0.81%	96.92%
Portugal	2	101,414.98	0.48%	99.62%	1.06%	97.98%
Slovakia	2	27,369.70	0.13%	99.75%	0.21%	98.19%
Malta	3	19,497.34	0.09%	99.84%	0.13%	98.32%
Finland	3	15,849.62	0.07%	99.91%	1.21%	99.53%
Cyprus	2	10,702.38	0.05%	99.96%	0.22%	99.75%
Slovenia	2	5019.84	0.02%	99.98%	0.11%	99.86%
Lithuania	1	2038.56	0.01%	99.99%	0.08%	99.93%
Estonia	1	1772.24	0.01%	100.00%	0.07%	100.00%
Total	76	21,288,898.56	100.00%	-	100.00%	-

Note: This table shows our sample composition. Countries are ordered by their total assets.

Kingdom, Italy, Spain, Germany, and Austria, account for roughly 60% of the total sample. Regarding total assets, the financial institutions in our sample account for >57% of the banking sectors studied in this study (that is, all banks incorporated in a given country, not just listed ones). When we look at individual countries, we can see that the most significant differences from the reference population are Germany's underrepresentation and Spain's overrepresentation, which are easily explained by the nature of the two systems: the German one is distinguished by a large number of private independent institutions that are not insignificant in absolute size; a few listed entities currently dominate the Spanish one as a result of repeated bankruptcies in smaller banks during the GFC (Martín-Oliver et al., 2017). Interestingly, our sample represents approximately 94% if we consider EU banks that were listed on April 3, 2019 (from Moody's BankFocus) and had available data on total assets.³

3.2. RWO methodology

This section explains the methodology of the RWO index and presents a computation in a real case from our sample.

For a bank i at time t , the RWO index is defined as follows:

$$RWO_{it} = 100 \bullet \sum_{s=1}^S (q_{st} \bullet w_{st}), s \in i, S = \{5; 10; 20\}$$

where $s \in i$ indexes subjects s holding an equity stake in bank i , and t indexes years. q is the percentage stake held by the subject s at time t ; w is the weight we assign to capture the risk appetite of the shareholders composing the ownership structure.

Following a ranking of shareholders based on the size of their stakes, a subject is included in the computation only if it is one of the S largest owners, with each alternative value of S (5, 10, or 20) denoting a different version of the RWO index (top 5, top 10, and top 20 shareholders, respectively).

To assign risk weights to the bank ownership structure, we first match the shareholders' identities with their Basel regulatory classes, identifying the type of shareholder (government or public sector, bank, financial institution, etc.).⁴ After attaching the reference classes to the individual shareholders, we associate a rating to each shareholder through the following five-step procedure.

1. We use the long-term issuer rating from S&P, Moody's, or Fitch. Due to decreasing data availability, we assign ratings from more than one agency, beginning with S&P's, then Moody's, and finally Fitch's.

³ This is the closest date to December 31, 2017 for which we could retrieve all the listed banks, knowing that very little changes had occurred therefrom. Total assets refer to the last available year as of that point in time: that is, mostly to 2018; some to 2017, some others to 2016 or 2015. Given the very high figure obtained, using end-2017 information would not bring any substantial changes to our sample's representativeness.

⁴ For details on how shareholders' stakes are risk weighted under the Basel portfolios, see Appendix A.

Table 2

Example of an RWO computation (Banco Santander, December 31, 2017).

#	Shareholder name	Shareholder category	Risk weight	Number of shares held	Common equity stake
1	State Street Corporation	Investment manager	30%	1,903,708,929	11.80%
2	BlackRock, Inc.	Investment manager	20%	1,086,487,267	6.73%
3	The Vanguard Group, Inc.	Investment manager	20%	539,141,586	3.34%
4	ClearStream Banking	Investment manager	20%	487,885,849	3.02%
5	The Capital Group Companies, Inc.	Investment manager	20%	402,920,326	2.50%
6	Norges Bank	Bank	20%	340,453,829	2.11%
7	Dimensional Fund Advisors LP	Investment manager	20%	240,578,858	1.49%
8	Deutsche Bank AG	Bank	30%	198,084,473	1.23%
9	Lyxor International Asset Management SAS	Investment manager	20%	196,692,016	1.22%
10	Dodge & Cox	Open-end fund	20%	144,553,656	0.90%
11	Government Pension Investment Fund Japan	Pension fund	30%	125,155,338	0.78%
12	BNP Paribas SA	Bank	30%	109,776,950	0.68%
13	FMR LLC	Investment manager	30%	108,759,278	0.67%
14	Credit Agricole Group	Bank	30%	91,742,992	0.57%
15	Ana Botín-Sanz de Sautuola y O'Shea	Natural person	75%	79,072,050	0.49%
16	Francisco Javier Botín-Sanz de Sautuola y O'Shea	Natural person	75%	73,879,802	0.46%
17	UBS AG	Investment bank	30%	69,672,831	0.43%
18	JPMorgan Chase & Co.	Investment manager	30%	66,770,275	0.41%
19	WisdomTree Investments, Inc.	Investment manager	30%	57,767,698	0.36%
20	The Wellcome Trust Ltd.	Nonprofit organization	20%	55,005,061	0.34%

Note: This table shows an example of the risk weighting for the top 20 shareholders. Those from #1 to #5 are included in all RWO versions; those from #6 to #10, in both the top 10 and the top 20 versions; those from #11 to #20, in the top 20 version only.

- We use the corresponding Basel creditworthiness classes for shareholder ratings,⁵ with a scale of 1 to 5 denoting the most creditworthy to the least creditworthy classes. For further details on Basel class attributions, see [Appendix B](#). For unrated shareholders of financial nature, we compute the bank Z-score ([Laeven & Levine, 2009](#)) by running a pooled ordinary least squares regression with available ratings as the dependent variable and country dummies. We calculated the ratings based on the fitted values (see [Appendix C](#)). We use the bank Z-score because many of the top 20 shareholders in our sample are financial sector investors (bank, investment managers, etc.).
- If Z-score data are not available, we use the rating of the shareholder's home country. Sovereign ratings are a de facto cap on the ratings of domestic company downgrades ([Bellia et al., 2019](#); [BIS and Bank for International Settlements, 2011](#)).
- If the shareholder is a natural person, we use a 75% weight according to the Basel framework.
- We attribute the "unrated" label to describe entities that do not have a rating evaluation associated with them.

We use credit risk to proxy the risk appetite of the shareholders. This decision is supported by the literature, which regards it as one of the primary return drivers for compensating both equity and debt investors for risk ([Chamizo & Novales, 2020](#); [Pertaia et al., 2022](#)). The rationale is that higher levels of credit risk are associated with more aggressive investment strategies.

3.3. The RWO index: example and sample distribution

[Table 2](#) shows an example of RWO measurement and the computational procedure for Banco Santander as of December 31, 2017. State Street Corporation, a US-incorporated investment manager, was the largest shareholder, with an 11.80% stake and a risk weight of 30%. This weight is derived from the bank's A rating (assessment of idiosyncratic risk of default) and its status as a regulated financial intermediary (Basel-compliant categorization).

We obtain the synthetic RWO index by repeating the same procedure for the top 5, 10, and 20 shareholders, which measures the risk appetite of the various levels of the ownership structure. The RWO index is determined as follows:

$$\begin{aligned}
 \mathbf{RWO}_{\text{Top5}} &= \underbrace{30\% \times 11.80}_{\#1} + \underbrace{20\% \times 6.73}_{\#2} + \underbrace{20\% \times 3.34}_{\#3} + \underbrace{20\% \times 3.02}_{\#4} + \underbrace{20\% \times 2.50}_{\#5} \cong \mathbf{6.66} \\
 \mathbf{RWO}_{\text{Top10}} &= \mathbf{RWO}_{\text{Top5}} + \underbrace{20\% \times 2.11}_{\#6} + \underbrace{20\% \times 1.49}_{\#7} + \underbrace{30\% \times 1.23}_{\#8} + \underbrace{30\% \times 1.22}_{\#9} + \underbrace{20\% \times 0.90}_{\#10} \cong \mathbf{8.17} \\
 \mathbf{RWO}_{\text{Top20}} &= \mathbf{RWO}_{\text{Top10}} + \underbrace{30\% \times 0.78}_{\#11} + \underbrace{30\% \times 0.68}_{\#12} + \underbrace{30\% \times 0.67}_{\#13} + \underbrace{30\% \times 0.57}_{\#14} + \underbrace{75\% \times 0.49}_{\#15} + \underbrace{75\% \times 0.46}_{\#16} + \underbrace{30\% \times 0.43}_{\#17} \\
 &\quad + \underbrace{30\% \times 0.41}_{\#18} + \underbrace{30\% \times 0.36}_{\#19} + \underbrace{20\% \times 0.34}_{\#20} \cong \mathbf{10.12}.
 \end{aligned}$$

[Tables 3 and 4](#) show the distributions of the RWO index across countries and years, respectively, in our sample.

⁵ The Basel rating classes include the unrated category. See [Appendix B](#) for details.

Table 3
RWO index by country, averaged across years.

Country	RWO top 5	RWO top 10	RWO top 20
Austria	21.018	21.606	21.951
Germany	10.043	10.875	11.370
Spain	11.861	12.641	13.236
France	9.562	10.406	11.273
United Kingdom	11.878	14.638	17.239
Greece	35.046	36.002	36.697
Italy	17.686	19.403	20.416
The Netherlands	7.379	9.6133	11.054
Other	17.668	18.848	19.387
Total	16.228	17.640	18.614

Note: This table reports the RWO index by country. We report the RWO average for countries that count at least five banks or 5% of our sample in terms of total assets terms at the end of 2017; we label the other countries as other.

Table 4
RWO index by year, averaged across countries.

Year	RWO top 5	RWO top 10	RWO top 20
2008	17.001	18.759	19.739
2009	18.954	20.523	21.395
2010	19.656	21.304	22.192
2011	19.440	20.473	21.240
2012	13.455	14.589	15.298
2013	17.265	18.423	19.250
2014	18.102	19.472	20.505
2015	13.639	15.046	16.169
2016	12.758	14.391	15.631
2017	13.792	15.264	16.443
Total	16.228	17.640	18.614

Note: This table reports the RWO index average distribution across the years in the time horizon under investigation.

Table 3 explicitly reports the RWO average figures for countries with at least five banks, or 5% of our sample in terms of total assets as of end-2017 (Table 1); the remaining countries are labeled as *Other*. By construction, the RWO figures increase or remain constant from the top 5 to the top 10 to the top 20 shareholders: for all data in the sample, the RWO increases 8.70% from the top 5 to the top 10, and by 5.52% from the top 10 to the top 20 (+14.70% overall). The Netherlands has the greatest expansion (+30.28% from the top 5 to the top 10 and +14.99% from the top 10 to the top 20, implying +49.80% overall), followed by the United Kingdom, which has the greatest increase from the top 10 to the top 20 (+17.77%, which when combined with +23.24% from the top 5 to the top 10, yields +45.13% overall). Austria has the smallest expansion (+2.80% from the top 5 to the top 10 and +1.60% from the top 10 to the top 20, implying +4.44% overall), followed by Greece, which has the smallest increase from top 5 to top 10 (+2.73%, which, when combined with +1.93% from top 10 to top 20, yields +4.71% overall). The top 20 shareholders in Greece have the highest RWO index, 36.697. Austria and Italy are next, with 21.951 and 20.416, respectively. The differences in the three ownership layers between the countries in our sample are minor, implying that the relevant stakes for determining ownership risk appetite are those held by the top 5 shareholders.

Concerning the time-varying dynamics reported in Table 4, we find that the RWO index varies over time, reflecting the investor risk appetite. The greatest growth occurred in 2016 (+12.80% from the top 5 to the top 10 and +8.62% from the top 10 to the top 20, for a total of +22.52%). The smallest expansion occurred in 2011 (+5.31% from the top 5 to the top 10 and +3.75% from the top 10 to the top 20, implying +9.26% overall).

4. Empirical model

We assess the relation between bank profitability, capitalization, and risk and our RWO indexes using the following regression setup:

$$Y_{it} = \alpha + \beta RWO_{it} + \mathbf{X}_{it}\gamma + \varepsilon_{it}$$

where the dependent variables are the measures of profitability (e.g., *RoA*, *Price-to-book ratio*, and *RoE*), capitalization (i.e., *CET1 ratio* and *Tier 1 ratio*), and risk (*Bank Z-score*, *CDS spread*, and *Beta*) of bank *i* in year *t*. The RWO index is the variable of interest, as previously stated. We report the results using all of the measures used in the regression tables (top 5, top 10, and top 20). We also include the top shareholder's weight to investigate how this measure affects bank risk and performance in comparison to the influence of higher levels of ownership structure. Finally, \mathbf{X} is a vector of bank characteristics that may affect a bank's profitability, capitalization, and risk, whereas, ε is the idiosyncratic error term. We include several control variables that account for board characteristics, such as board size

Table 5
Description of variables.

Variable	Description	Source
<i>Top owner's risk weight</i>	The risk weight attributed to the largest shareholder, if it were a borrower, pursuant to the Basel II framework (and further amendments).	Authors' calculation from information available on Bloomberg
<i>Return on assets (%)</i>	The ratio between (a) the trailing 12-month net income and (b) the average total assets, where (a) is the end-of-year net income as reported in the income statement, and (b) is the average of the total assets beginning and end of year.	Bloomberg
<i>Return on equity (%)</i>	The ratio between net income (a) and total equity (b), where (a) is computed at the end of the year, and (b) is the average of the beginning and end of the year.	Bloomberg
<i>Tier 1 ratio (%)</i>	The ratio between Tier 1 capital and risk-weighted assets at the end of the year.	Bloomberg
<i>CET1 ratio (%)</i>	The ratio between CET1 capital and risk-weighted assets at the end of the year.	Bloomberg
<i>Bank Z-score</i>	Following Laeven and Levine (2009) , the sum of (a) the return on assets and (b) the capital-to-assets ratio, divided by the 5-period backward standard deviation of (a), where (b) is the ratio between total common equity and total assets, both at the end of the year as recorded in the balance sheet.	Authors' computation from Bloomberg variable(s)
<i>CDS spread (bps)</i>	The simple average over a 1-year window of daily observations of the 5-year CDS spread, where the latter is the risk premium in bps, which expresses the cost of underwriting a 5-year maturity CDS that provides insurance against a bank's default on its debt. This measure is calculated according to the probability of default risk of the Bloomberg issuer model.	Authors' computation from Bloomberg variable(s)
<i>Price-to-book ratio</i>	The ratio between (a) market capitalization and (b) total common equity, where (a) is the marked-to-market value of the end of year of all outstanding shares and (b) is the end-of-year figure as recorded in the balance sheet.	Authors' computation from Bloomberg variable(s)
<i>Beta (raw)</i>	Simple average of the market beta against each stock's benchmark market index, calculated over a 2-year window of weekly observations.	Authors' computation from Bloomberg variable(s)
<i>HHI (0–100 scale)</i>	The sum of squared stakes pertaining to all shareholders of a bank, expressed in percentage terms, and then divided by 100 (alternatively, expressed with no manipulations and then multiplied by 100 after summation).	Authors' calculation from information available from Bloomberg
<i>Independent directors (% of board members)</i>	The proportion of independent directors at the end of the year on the board of directors.	Bloomberg
<i>Insider ownership (% of total equity)</i>	The end-of-year proportion of outstanding shares held by insiders of total equity.	Bloomberg
<i>Institutional investors (% of total equity)</i>	The end-of-year proportion of outstanding shares held by institutional investors out of total equity.	Bloomberg
<i>Board size (number of members, log)</i>	The natural logarithm of the number of members on the board of directors in the end year.	Bloomberg
<i>CEO duality (dummy)</i>	A dichotomic variable that takes a value of 1 if the chairperson of the main management body and the CEO are the same person, and 0 otherwise.	Bloomberg
<i>Average executive compensation (EUR million)</i>	The overall compensation received, on average, by an executive director. Includes stock options and other nonsalary items.	Bloomberg
<i>Size of the risk committee (number of members)</i>	The number of directors sitting on the board committee entrusted with risk management.	Bloomberg
<i>Loan-to-asset ratio</i>	The ratio between a company's total gross loans and total assets at the end of the year.	Bloomberg
<i>Total assets (EUR million, log)</i>	The natural logarithm of total assets at the end of the year.	Bloomberg
<i>NPL ratio (%)</i>	The ratio between nonperforming loans and total gross loans at the end of year.	Bloomberg
<i>Coverage ratio (%)</i>	The ratio between loan-loss reserves and total gross loans at the end of the year.	Bloomberg
<i>RWA/total equity</i>	The ratio between risk-weighted assets and total equity at the end of the year.	Bloomberg
<i>Maximum stake that a single owner is allowed to hold (%)</i>	The highest stake a single owner can hold in a bank, according to the legislation of the bank's home jurisdiction.	World Bank's Bank Regulation and Supervision Survey
<i>Maximum stake that a related party is allowed to hold (%)</i>	The highest stake that a "related party" (e.g., insiders, relevant suppliers, large customers, etc.) is allowed to hold in a bank, according to the law of the bank's home jurisdiction.	World Bank's Bank Regulation and Supervision Survey
<i>Commercial bank (dummy)</i>	A dichotomic variable that takes value of 1 if the credit institution is a commercial bank and 0 otherwise.	Moody's BankFocus
<i>Bank holding company (dummy)</i>	A dichotomic variable that takes the value of 1 if the credit institution is a bank holding company, and 0 otherwise.	Moody's BankFocus
<i>Investment bank (dummy)</i>	A dichotomic variable that takes the value of 1 if the credit institution is an investment bank and 0 otherwise.	Moody's BankFocus
<i>Savings or cooperative bank (dummy)</i>	A dichotomic variable that takes the value of 1 if the credit institution is a savings or cooperative bank, and 0 otherwise.	Moody's BankFocus

Note: This table describes the variables used to investigate the relationship between RWO, performance, and risk.

Table 6
Sample summary statistics.

Variable	Obs.	Mean	Std. dev.	Min.	Max.
RWO index					
Top owner's risk weight (%) ^a	617	38.136	27.832	0.000	150.000
RWO index, top 5 shareholders	616	16.228	16.093	0.010	103.870
RWO index, top 10 shareholders	616	17.640	16.043	0.010	104.790
RWO index, top 20 shareholders	616	18.614	15.953	0.010	105.460
Bank ownership and governance characteristics					
Insider ownership (% of total equity)	557	1.721	7.271	0.000	55.550
Institutional investors (% of total equity)	559	51.519	30.698	0.140	100.000
HHI (0–100 scale)	617	15.173	19.092	0.010	93.620
Board size (number of members, log)	467	14.890	4.424	6.000	25.000
Independent directors (% of board members)	430	57.676	25.182	0.000	100.000
CEO duality (dummy)	463	0.037	0.188	0.000	1.000
Average executive compensation (EUR million)	352	1.126	1.445	0.000	10.324
Size of the risk committee	535	3.553	2.729	0.000	15.000
Accounting and market risk measures					
Bank Z-score	658	2.941	4.044	−2.790	35.950
CDS spread (bps)	674	217.69	296.29	0.020	2570.77
Beta (raw)	700	1.047	0.569	−0.095	2.295
Price-to-book ratio	697	1.000	0.786	0.090	4.970
Bank characteristics					
CET1 ratio (%)	233	13.555	3.881	5.400	31.940
Tier 1 ratio (%)	600	12.558	3.732	5.960	26.750
Return on equity (%)	722	3.781	16.878	−86.390	41.975
Return on assets (%)	722	0.339	1.369	−6.050	6.952
Total assets (EUR million)	731	307,096.4	543,807.5	138.380	2,703,344
Loan-to-asset ratio (%)	694	56.943	21.424	3.940	90.880
NPL ratio (%)	523	8.842	9.382	0.190	48.800
Coverage ratio (%)	517	79.913	82.502	28.390	655.270
RWA/total equity (%)	593	7.498	4.480	0.000	55.750

Note: ^a In the empirical analysis, this variable is featured with the value it takes in computing the RWO (i.e., between 0 and 1.5). It is hereby reported in percentage points (i.e., between 0 and 150), just for the sake of explanation.

and the proportion of independent directors, as well as a binary variable set to one if the chairman of the main management body and the CEO are the same person. We also consider ownership characteristics such as the percentage of insider and institutional owners. Furthermore, we control for the bank's size (represented as the logarithm of total assets) and the loan-to-asset ratio. We include a comprehensive set of fixed effects for different bank types in our regression analysis to fully account for potential variations.⁶ In robustness checks, we also include a proxy of CEO compensation (*Average executive compensation*) and a proxy of risk management practices (*Number of directors in the risk committee*).

To account for the dynamic dimension of the panel, we estimate the empirical model in (1) using the GMM estimator described by Arellano & Bond (1991). This fits our dataset's "small T , large N " framework. Furthermore, the GMM estimation considers the endogeneity of the RWO variables in our specifications. Endogeneity, in particular, is concerned with the bidirectional causal relationship between bank profitability and risk and their ownership structure.⁷

The variables used in the empirical analysis are listed in Table 5.

5. Results

5.1. Data description

Table 6 reports descriptive statistics.

The three RWO versions have the same minimum (i.e., 0.01) and slightly increasing maxima, rising from 103.870 (top 5) to

⁶ Commercial banks typically engage in a wide array of banking activities, maintaining a diversified portfolio of loans, investments, and financial products. Their risk appetite is shaped by factors like credit, market, and operational risks. In contrast, investment banks primarily concentrate on capital markets activities, M&As, and trading, resulting in a potentially distinct risk appetite profile with a greater emphasis on market risk. Similarly, savings banks and cooperative banks, often community-oriented with a local focus (see, e.g., Minetti et al., 2021), may exhibit different risk appetites compared to larger commercial or investment banks. Their risk appetite may be influenced by factors such as the nature of their customer base, funding sources, and their dedication to supporting local communities.

⁷ In all the specifications, we employ two sets of instruments. As GMM-style instruments, we use one and further lags of RWO indexes. As instrumental variable-style instruments, we use the one-year lag of all the control variables. We use the collapse option to minimize the number of instruments. Furthermore, in Table 11a, we complement this approach by including two external instrumental variables (IVs), both obtained from the World Bank's Bank Regulation and Supervision Survey. These variables represent the maximum ownership stake permitted for a single owner and the maximum ownership stake allowed for related parties in a bank, in compliance with the regulations of their respective home countries.

Table 7
Correlation matrix.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Top owner's risk weight	1																			
RWO index, top 5 shareholders	0.63	1																		
RWO index, top 10 shareholders	0.60	0.99	1																	
RWO index, top 20 shareholders	0.58	0.99	1.00	1																
Return on assets (%)	0.03	0.02	0.04	0.045	1															
Return on equity (%)	0.06	0.02	0.03	0.04	0.78	1														
CET1 ratio (%)	0.12	0.14	0.17	0.17	0.15	0.16	1													
Tier 1 ratio (%)	0.12	0.09	0.10	0.12	0.22	0.16	0.69	1												
Bank Z-score	0.04	-0.05	-0.06	-0.06	0.23	0.27	0.08	-0.07	1											
CDS spread (bps)	0.01	0.14	0.13	0.12	-0.42	-0.34	0.09	-0.06	-0.20	1										
Beta (raw)	-0.16	-0.13	-0.13	-0.12	-0.20	-0.19	-0.19	0.03	-0.33	0.31	1									
Price-to-book ratio	0.08	0.08	0.09	0.09	0.38	0.40	0.28	0.23	0.26	-0.19	-0.27	1								
Independent directors (% of board members)	-0.15	-0.23	-0.21	-0.18	0.13	0.09	-0.01	0.06	0.10	-0.24	0.00	0.02	1							
Insider ownership (% of total equity)	0.07	0.21	0.23	0.24	0.13	0.13	-0.06	-0.01	-0.06	-0.07	-0.23	0.14	-0.27	1						
Institutional investors (% of total equity)	0.29	0.12	0.13	0.14	0.22	0.15	-0.07	0.10	0.08	-0.17	0.05	0.08	0.04	0.01	1					
Board size (number of members, log)	-0.17	-0.03	-0.03	-0.04	-0.21	-0.19	-0.35	-0.31	-0.28	-0.03	0.24	-0.33	-0.08	-0.11	-0.33	1				
CEO duality (dummy)	-0.12	-0.02	-0.03	-0.03	0.04	0.06	-0.10	-0.12	0.03	-0.02	0.07	-0.02	0.06	-0.05	-0.13	-0.01	1			
HHI (0–100 scale)	0.96	0.61	0.58	0.56	0.04	0.05	0.11	0.10	0.06	0.01	-0.13	0.05	-0.14	0.0484	0.29	-0.15	-0.11	1		
Loan-to-asset ratio (%)	-0.17	0.03	0.02	0.01	-0.07	-0.13	-0.31	-0.37	0.05	0.29	-0.06	-0.26	-0.04	0.03	0.04	-0.12	-0.04	-0.14	1	
Total assets (EUR million)	-0.22	-0.32	-0.32	-0.31	-0.05	-0.04	-0.21	-0.04	-0.08	-0.14	0.34	-0.18	0.20	-0.11	0.07	0.23	0.06	-0.21	-0.37	1

Note: This table reports the correlation matrix relative to the variables used in the empirical analysis. Faded figures are those that do not achieve statistical significance at the 95% level.

Table 8
RWO, profitability, and capitalization.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Return on assets (%)				CET1 ratio (%)			
Top owner's risk weight	1.903*** (0.598)				-3.258** (1.224)			
RWO index, top 5 shareholders		0.050*** (0.015)				-0.065*** (0.016)		
RWO index, top 10 shareholders			0.051*** (0.015)				-0.066*** (0.016)	
RWO index, top 20 shareholders				0.051*** (0.015)				-0.067*** (0.017)
HHI (0–100 scale)	-0.001 (0.005)	-0.022* (0.011)	-0.020* (0.010)	-0.019* (0.010)	0.020 (0.016)	0.041** (0.019)	0.038** (0.019)	0.036* (0.018)
Independent directors (% of board members)	0.010** (0.004)	0.008* (0.005)	0.007 (0.005)	0.006 (0.005)	-0.013 (0.015)	-0.010 (0.015)	-0.010 (0.015)	-0.009 (0.015)
Insider ownership (% of total equity)	0.057 (0.038)	0.041 (0.036)	0.041 (0.037)	0.041 (0.038)	-0.196* (0.112)	-0.188 (0.122)	-0.192 (0.124)	-0.198 (0.125)
Institutional ownership (% of total equity)	0.013*** (0.003)	0.008** (0.004)	0.008* (0.004)	0.007* (0.004)	-0.021 (0.014)	-0.010 (0.016)	-0.009 (0.017)	-0.008 (0.017)
Board size (number of members, log)	-0.511 (0.322)	-0.628* (0.365)	-0.646* (0.367)	-0.641* (0.367)	-2.233** (0.974)	-2.236** (0.911)	-2.265** (0.913)	-2.285** (0.918)
CEO duality (dummy)	0.446* (0.257)	0.459** (0.229)	0.468** (0.229)	0.480** (0.229)	-1.286* (0.733)	-1.311* (0.716)	-1.341* (0.717)	-1.376* (0.719)
Total assets (log)	-0.128 (0.084)	-0.094 (0.086)	-0.079 (0.087)	-0.068 (0.086)	-1.154*** (0.244)	-1.147*** (0.244)	-1.156*** (0.244)	-1.163*** (0.244)
Loan-to-assets ratio (%)	-0.014*** (0.005)	-0.009 (0.006)	-0.008 (0.006)	-0.008 (0.006)	-0.039 (0.024)	-0.043 (0.026)	-0.044 (0.026)	-0.044 (0.026)
Commercial bank (dummy)	0.360 (0.572)	0.624 (0.725)	0.611 (0.737)	1.815 (1.308)	38.026*** (4.349)	36.994*** (4.579)	37.280*** (4.598)	-1.111 (0.743)
Bank holding company (dummy)	0.472 (0.643)	0.839 (0.789)	0.791 (0.798)	1.950 (1.358)	39.432*** (4.479)	38.085*** (4.734)	38.377*** (4.753)	0.000 (0.000)
Savings or cooperative bank (dummy)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	1.213 (1.320)	36.850*** (4.731)	36.066*** (4.900)	36.354*** (4.932)	-2.041 (2.254)
Constant	1.554 (1.239)	1.523 (1.267)	1.355 (1.306)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	38.557*** (4.755)
Observations	310	310	310	310	173	173	173	173

Note: This table shows the results for the RWO index as the main explanatory variable of accounting-based profitability and capitalization. *, **, and *** denote statistical significance at 10%, 5%, and 1%, respectively. Robust standard errors are reported in parentheses.

104.790 (top 10) and 105.460 (top 20). The most significant differences can be seen in their means, which rise from 16.228 (top 5) to 17.640 (top ten), an 8.70% increase, and then up to 18.614 (top 20), recording a + 5.52% increase (+14.73% from the top 5 average). When combined with the descriptive statistics presented in Tables 3 and 4, this result suggests that the overall risk appetite expands

Table 9
RWO and risk.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Variables	Bank Z-score				CDS spread (bps)			
Top owner's risk weight	1.641** (0.789)				-588.347*** (200.012)			
RWO index, top 5 shareholders		0.037* (0.020)				-10.827** (4.593)		
RWO index, top 10 shareholders			0.035* (0.020)				-10.902** (4.619)	
RWO index, top 20 shareholders				0.035* (0.020)				-11.017** (4.642)
HHI (0–100 scale)	-0.025 (0.016)	-0.039* (0.021)	-0.037* (0.021)	-0.036* (0.021)	3.821* (2.005)	7.493* (3.843)	7.248* (3.759)	7.032* (3.687)
Independent directors (% of board members)	0.017 (0.013)	0.015 (0.013)	0.015 (0.013)	0.014 (0.013)	-3.805** (1.771)	-3.286* (1.658)	-3.128* (1.665)	-2.967* (1.674)
Insider ownership (% of total equity)	0.072 (0.110)	0.063 (0.104)	0.064 (0.105)	0.064 (0.105)	-21.960* (11.620)	-17.729* (10.518)	-17.786* (10.574)	-17.870 (10.668)
Institutional ownership (% of total equity)	0.018** (0.009)	0.014 (0.009)	0.014 (0.010)	0.013 (0.010)	-3.912*** (1.332)	-2.910** (1.384)	-2.801* (1.406)	-2.662* (1.432)
Board size (number of members, log)	-2.015* (1.087)	-2.040* (1.079)	-2.034* (1.078)	-2.024* (1.077)	8.953 (109.957)	-10.033 (102.795)	-5.103 (103.535)	-5.469 (104.368)
CEO duality (dummy)	0.415 (0.817)	0.414 (0.853)	0.439 (0.862)	0.459 (0.865)	53.329 (76.218)	19.946 (54.895)	19.138 (53.399)	17.509 (52.527)
Total assets (mil EUR, log)	-0.223 (0.225)	-0.206 (0.214)	-0.200 (0.215)	-0.195 (0.215)	-18.969 (19.162)	-20.175 (16.775)	-23.520 (16.544)	-26.023 (16.492)
Loan-to-assets ratio (%)	-0.015 (0.015)	-0.012 (0.014)	-0.011 (0.014)	-0.011 (0.014)	5.735*** (2.113)	4.302* (2.183)	4.184* (2.205)	4.136* (2.227)
Commercial bank (dummy)	9.017** (3.759)	9.272** (3.634)	1.911*** (0.677)	1.898*** (0.678)	719.889** (337.220)	678.704** (322.038)	716.381** (331.440)	748.986** (339.771)
Bank holding company (dummy)	8.841** (3.619)	9.179** (3.498)	1.786* (1.032)	1.742* (1.029)	743.361** (352.483)	684.839** (338.482)	729.790** (346.000)	771.817** (353.208)
Savings or cooperative bank (dummy)	7.288* (3.801)	7.332* (3.691)	0.000 (0.000)	0.000 (0.000)	794.831 (475.803)	800.863* (461.025)	835.814* (476.207)	866.872* (488.600)
Constant	0.000 (0.000)	0.000 (0.000)	7.238* (3.720)	7.157* (3.749)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
Observations	291	291	291	291	306	306	306	306

Note: This table shows the results for the RWO index as the main explanatory variable of accounting-based and market risk measures. *, **, and *** denote statistical significance at 10%, 5%, and 1%, respectively. Robust standard errors are reported in parentheses.

less than proportionally as one moves from the top 5 to the top 10 and top 20 shareholders. Since the standard deviation, despite being very high, remains essentially constant at around 16, the RWO expansion, along with the extent of shareholders encompassed, is most likely the result of an algebraic effect, because the cumulative stakes of the top 5 owners are typically much larger than those held by the 6th to 20th largest owners by size. In other words, the five largest shareholders are those that actually control a bank's behavior, with smaller shareholders playing an increasingly marginal role. In terms of the risk weight assigned to the largest shareholder, the average figure in our sample is >38%; this indicates a relatively risky subject, though this variable also has a large standard deviation (almost 28%). Furthermore, when we look at the minimum and maximum risk weights, we see that the most extreme risk weights are also represented in our sample, with figures ranging from 0% to 150%.

Since the sample mean of the Herfindahl–Hirschman index (HHI) is around 1571, ownership is quite dispersed, and institutional investors, on average, hold the majority of capital (51.5%). Conversely, insiders own only a small portion (1.72%). The top owner has an average risk weight of 38.1%, making the investment manager the most frequent investor in the banks in our sample. Concerning the board of directors, we observe that >14 people are in charge on average, with independents holding 57.7% of the seats; the CEO also serves as the board chair in only 3.7% of the sample. Banks have total assets of EUR 43.8 billion on average, with business models that are more commercial than investment-oriented (on average, 56.9% of total assets consist of loans). Furthermore, the banks in our sample are well capitalized (the average Tier 1 ratio is 12.56%) and far from insolvent (the average bank Z-score is 2.94). The average RoA is 0.34%, and the average return on equity (RoE) is 3.78% for these banks. In terms of the market price of default risk, we report a premium of 217.7 basis-points (bps) on average. Bank stock returns are nearly perfectly correlated with the market portfolio (the average raw beta is 1.05) and priced based on book value (the average price-to-book ratio is one).

The correlation matrix is shown in Table 7. The bank Z-score, RoA, and price-to-book ratio all correlate negatively with the RWO indices, while the CDS spread, beta, and RoE all have a negative correlation with the RWO.

5.2. Empirical findings on RWO

The results of regressing accounting and market-based performance measures on the RWO index at various specification levels (top 5, 10, and 20 shareholders) are reported in Tables 8, 9, and 10. Control variables include ownership concentration, corporate

Table 10
RWO and stock market performance.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Variables	Beta (raw)				Price-to-book ratio			
Top owner's risk weight	−0.235** (0.103)				0.262 (0.167)			
RWO index, top 5 shareholders		−0.005 (0.004)				0.010** (0.004)		
RWO index, top 10 shareholders			−0.005 (0.003)				0.010** (0.004)	
RWO index, top 20 shareholders				−0.005 (0.003)				0.010** (0.004)
HHI (0–100 scale)	0.001 (0.002)	0.003 (0.003)	0.002 (0.003)	0.002 (0.003)	−0.005 (0.003)	−0.009** (0.004)	−0.009** (0.004)	−0.008** (0.003)
Independent directors (% of board members)	−0.003 (0.002)	−0.003 (0.002)	−0.003 (0.002)	−0.003 (0.002)	0.002 (0.002)	0.002 (0.002)	0.002 (0.002)	0.001 (0.002)
Insider ownership (% of total equity)	−0.035** (0.015)	−0.033** (0.015)	−0.033** (0.015)	−0.033** (0.015)	−0.019 (0.023)	−0.020 (0.022)	−0.020 (0.021)	−0.020 (0.021)
Institutional ownership (% of total equity)	0.001 (0.002)	0.001 (0.002)	0.001 (0.002)	0.001 (0.002)	0.001 (0.002)	0.001 (0.002)	0.001 (0.002)	0.001 (0.002)
Board size (number of members, log)	0.224 (0.148)	0.223 (0.147)	0.225 (0.146)	0.224 (0.145)	−0.384* (0.210)	−0.438** (0.207)	−0.442** (0.209)	−0.442** (0.209)
CEO duality (dummy)	0.153 (0.115)	0.159 (0.116)	0.158 (0.117)	0.157 (0.117)	−0.149 (0.237)	−0.171 (0.240)	−0.169 (0.242)	−0.166 (0.243)
Total assets (mil EUR, log)	0.092*** (0.026)	0.090*** (0.026)	0.088*** (0.025)	0.087*** (0.025)	−0.242*** (0.075)	−0.232*** (0.076)	−0.229*** (0.076)	−0.227*** (0.076)
Loan-to-asset ratio (%)	0.004** (0.002)	0.004* (0.002)	0.004* (0.002)	0.004* (0.002)	−0.026*** (0.007)	−0.025*** (0.007)	−0.025*** (0.007)	−0.025*** (0.007)
Commercial bank (dummy)	−0.060 (0.175)	−0.079 (0.184)	−0.078 (0.184)	−0.398 (0.453)	0.179 (0.143)	0.233 (0.162)	0.230 (0.164)	6.106*** (1.417)
Bank holding company (dummy)	−0.081 (0.218)	−0.102 (0.230)	−0.098 (0.229)	−0.414 (0.462)	0.017 (0.232)	0.095 (0.253)	0.085 (0.253)	5.953*** (1.325)
Savings or cooperative bank (dummy)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	−0.321 (0.490)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	5.878*** (1.434)
Constant	−0.338 (0.480)	−0.345 (0.493)	−0.331 (0.492)	0.000 (0.000)	5.929*** (1.405)	5.934*** (1.434)	5.906*** (1.435)	0.000 (0.000)
Observations	310	310	310	310	310	310	310	310

Note: This table shows the results for the RWO index as the main explanatory variable of the performance variables of the stock market. *, **, and *** denote statistical significance at 10%, 5%, and 1%, respectively. Robust standard errors are reported in parentheses.

governance, size, and business model.

As shown in Table 8, banks with a more risk-oriented ownership structure (higher RWO) tend to be more profitable (higher RoA) and less capitalized (lower CET1 ratio). Our findings hold true regardless of the RWO version we use. Furthermore, we find a positive correlation with the risk weight of the top owner. On average, a 0.1 increase in the risk weight attached to the largest owner (e.g., from 20% to 30%) increases the RoA by ~0.19 pp. and the CET1 ratio decreases by ~0.33 pp.; also, a one-point increase in the RWO increases the RoA by ~0.05 percentage points (pp); that is, approximately one sixth of the sample mean (0.3%); the CET1 ratio decreases by 0.065–0.067 pp., which is a relatively small amount compared to the sample mean (~13%).

We also investigate the RWO's relationship with synthetic accounting and market risk measures, specifically the bank Z-score and the CDS spread, which are the two most widely used measures of default risk in the literature (Table 9). Our results suggest that banks with a more risk-oriented shareholding base (i.e., higher RWO) are less likely to default, whether we look at it from an accounting or a market-based perspective.

A 10-point increase in the risk weight assigned to the largest owner raises the bank's Z-score by slightly >0.16 points on average. Once adjusted for the different scales of these variables, the estimated coefficient of the top owner's *risk weight* is 4–5 times larger than the coefficients of the RWO measures, because a 0.1 increase in the latter results in a ~0.35-point increase in the ratio that expresses the distance from the bank to default. Furthermore, we find no discernible differences based on the size of the shareholding base under consideration (i.e., the largest 5, 10, or 20 owners).

The CDS spread decreases by nearly 59 result points after a 10-point increase in the *Top owner's risk weight*, and by 108–110 bps following a 10-point increase in the RWO index. The alignment of the coefficients relative to the bank Z-score and the CDS spread, combined with the CET1 ratio results, suggests that shareholders with a higher risk appetite only have a negative influence on capitalization (hence, among the bank Z-score components, on the capital-to-assets ratio). On the contrary, they appear to be able to improve profitability (i.e., the RoA levels and standard deviation). As a result, financial markets will perceive the institution's likelihood of defaulting on its debt differently, lowering the risk premium on contracts that provide insurance against the event.

Table 10 shows the results of regressing two market fundamentals, the beta and the price-to-book ratio, on the RWO index. If the principal owner's risk weight increases by 0.1, beta decreases by >0.02 points, while the RWO index produces no statistically significant results. In contrast, the latter significantly affects the price-to-book ratio—consistently across our models—such that a one-

Table 11a
Robustness checks: Alternative Empirical Methodology.

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	Return on assets (%)		CET1 ratio (%)		Bank Z-score	
Top owner's risk weight	1.714*** (0.575)		-3.211*** (1.195)		0.704 (0.913)	
RWO index, top 5 shareholders		0.047*** (0.014)		-0.064*** (0.015)		0.018 (0.023)
HHI (0–100 scale)	-0.001 (0.005)	-0.020* (0.010)	0.020 (0.016)	0.040** (0.018)	-0.019 (0.015)	-0.026 (0.022)
Independent directors (% of board members)	0.009** (0.004)	0.008* (0.004)	-0.012 (0.015)	-0.009 (0.015)	0.016 (0.013)	0.015 (0.013)
Insider ownership (% of total equity)	0.053 (0.036)	0.038 (0.035)	-0.193* (0.109)	-0.185 (0.118)	0.067 (0.107)	0.065 (0.103)
Institutional ownership (% of total equity)	0.013*** (0.003)	0.008** (0.004)	-0.021 (0.014)	-0.011 (0.016)	0.015* (0.008)	0.014 (0.009)
Board size (number of members, log)	-0.496 (0.312)	-0.626* (0.355)	-2.223** (0.975)	-2.231** (0.910)	-1.944* (1.050)	-1.974* (1.044)
CEO duality (dummy)	0.458* (0.253)	0.464** (0.228)	-1.307* (0.727)	-1.331* (0.708)	0.489 (0.831)	0.446 (0.850)
Total assets (mil EUR, log)	-0.133 (0.082)	-0.098 (0.085)	-1.155*** (0.241)	-1.147*** (0.243)	-0.244 (0.221)	-0.232 (0.217)
Loan-to-asset ratio (%)	-0.013*** (0.005)	-0.009 (0.006)	-0.039 (0.024)	-0.043* (0.026)	-0.013 (0.015)	-0.012 (0.014)
Commercial bank (dummy)	2.018* (1.156)	0.607 (0.706)	37.998*** (4.310)	-1.105 (0.733)	1.674*** (0.524)	1.780*** (0.572)
Bank holding company (dummy)	2.131* (1.211)	0.821 (0.770)	39.410*** (4.444)	0.000 (0.000)	1.520* (0.889)	1.662 (0.994)
Savings or cooperative bank (dummy)	1.665 (1.208)	0.000 (0.000)	36.821*** (4.691)	-2.041 (2.227)	0.000 (0.000)	0.000 (0.000)
Constant	0.000 (0.000)	1.636 (1.226)	0.000 (0.000)	38.079*** (4.701)	7.742** (3.746)	7.760** (3.706)
Observations	310	310	173	173	291	291

	(7)	(8)	(9)	(10)	(11)	(12)
Variables	CDS spread (bps)		Beta (raw)		Price-to-book ratio	
Top owner's risk weight	-495.924** (185.838)		-0.109 (0.117)		0.291* (0.173)	
RWO index, top 5 shareholders		-9.253** (4.490)		-0.002 (0.004)		0.011** (0.004)
HHI (0–100 scale)	3.326* (1.801)	6.503* (3.576)	0.000 (0.002)	0.001 (0.003)	-0.005* (0.003)	-0.010** (0.004)
Independent directors (% of board members)	-3.636** (1.690)	-3.224** (1.596)	-0.003 (0.002)	-0.003 (0.002)	0.002 (0.002)	0.002 (0.002)
Insider ownership (% of total equity)	-21.114* (10.834)	-17.622* (9.990)	-0.034** (0.015)	-0.033** (0.015)	-0.020 (0.023)	-0.022 (0.022)
Institutional ownership (% of total equity)	-3.646*** (1.276)	-2.808** (1.329)	0.001 (0.002)	0.001 (0.002)	0.003 (0.002)	0.001 (0.002)
Board size (number of members, log)	5.367 (103.764)	-10.773 (97.928)	0.215 (0.147)	0.218 (0.146)	-0.385* (0.210)	-0.445** (0.206)
CEO duality (dummy)	49.508 (71.851)	18.939 (54.608)	0.146 (0.116)	0.157 (0.116)	-0.149 (0.236)	-0.171 (0.241)
Total assets (log)	-17.188 (18.099)	-18.242 (16.063)	0.095*** (0.026)	0.093*** (0.025)	-0.242*** (0.075)	-0.230*** (0.076)
Loan-to-asset ratio (%)	5.528*** (1.994)	4.316** (2.055)	0.004** (0.002)	0.004** (0.002)	-0.026*** (0.007)	-0.025*** (0.007)
Commercial bank (dummy)	670.890** (319.530)	-111.779 (316.426)	-0.457 (0.441)	-0.064 (0.170)	6.110*** (1.385)	0.242 (1.162)
Bank holding company (dummy)	692.752** (333.379)	-104.886 (343.206)	-0.480 (0.448)	-0.086 (0.215)	5.945*** (1.295)	0.104 (0.251)
Savings or cooperative bank (dummy)	742.125 (454.286)	0.000 (0.000)	-0.403 (0.472)	0.000 (0.000)	5.927*** (1.397)	0.000 (0.000)
Constant	0.000 (0.000)	751.730* (440.221)	0.000 (0.000)	-0.405 (0.480)	0.000 (0.000)	5.938*** (1.430)
Observations	306	306	310	310	310	310

Note: This table presents a robustness check on the baseline results, incorporating IV estimators based on regulatory policies (*Maximum stake that a single owner is allowed to hold* and *Maximum stake that a related party is allowed to hold*). *, **, and *** denote statistical significance at 10%, 5%, and 1%, respectively. Robust standard errors are reported in parentheses. The results for other RWO versions (top 10 and top 20), available upon request, are qualitatively similar.

point increase in the RWO index causes the ratio to rise by 0.01 point, regardless of the shareholding base we consider.

Overall, our findings on the positive correlation between the RWO index and performance are consistent with those of Caselli et al. (2023) on Italian listed companies, which are found to be more profitable if there is “at least a pervasive presence of shareholders with substantial voting power”, such as families and founders, to whom higher risk weights are attached in the Basel framework, resulting in a higher RWO index. Furthermore, the fact that privately owned shareholders are typically assigned higher risk weights (thus, on average, higher RWO figures), combined with the positive relationship between our indicator and performance, is consistent with recent literature that has found privately owned institutions to be more profitable than state-owned ones (Mutarindwa et al., 2021). The same is true for the capital base, which we find to be negatively affected by the RWO index, which is consistent with evidence that government-owned banks aim for higher capital ratios and can adjust more quickly in the event of equity shortages (Jiang et al., 2019).

5.3. Other explanatory variables

In this section, we will review the results from additional regression model specifications.

We find that a high degree of ownership concentration negatively correlates with profitability. Our results contradict recent evidence from specific countries (Ozili & Uadiale, 2017; Huang, 2023; Hanafi et al., 2018), but no general conclusion can be drawn on the concentration-profitability relationship, at least in advanced economies, because the relationship varies greatly across institutional frameworks (Gedajlovic & Shapiro, 1998). Furthermore, our evidence shows that a higher HHI is associated with a lower bank Z-score. In models with the RWO of the 5 or top 10 as the explanatory variable, a one-point increase in the HHI on a scale of 0–100 (i.e., a 100-point change over the 0–10,000 range) causes the bank Z-score to decrease by ~ 0.04 . Furthermore, an increase in HHI increases CDS spread by 3.8–7.5 bps. These findings imply that banks with more concentrated ownership structures are more likely to fail (Ashraf et al., 2016; Chalermchatvichien et al., 2014; Laeven & Levine, 2009). However, we find no evidence that ownership concentration positively affects the capital base (Klein et al., 2021).

We find a negative correlation between board size and profitability (De Andres & Vallelado, 2008; Grove et al., 2011) and capitalization (Faleye & Krishnan, 2017). Our results are also consistent with the findings of Anginer et al. (2018), who contend that the more shareholders' interests are protected within a bank's governance structure (inter alia, by the presence of a relatively large board), the lower the incentives to maintain a strong capital base. Consistent with Anginer et al. (2018), our findings show that a larger board size is associated with a lower bank Z-score but has no statistically significant effect on the CDS spread.

In terms of CEO duality, we find that it improves performance but degrades capitalization. Our results are consistent with the literature, which shows that CEO empowerment increases risk-taking to the detriment of the board, which becomes less effective (Elsayed, 2011; Faleye & Krishnan, 2017; Grove et al., 2011; Larcker et al., 2007; Pi & Timme, 1993; Wang et al., 2012). However, determining the CEO duality effect a priori is difficult without knowing the bank's other governance features, such as the presence of an audit committee on the board (Hardwick et al., 2011; Pathan, 2009).

Looking more closely at the board of directors, we find that a larger proportion of independent members positively contributes to performance (Bhatia & Gulati, 2021; Cornett et al., 2010) and reduces risk-taking (Erkens et al., 2012; Mongiardino & Plath, 2010). A 10-pp increase in the proportion of independents on the board is associated with a ~ 0.1 -pp higher RoA and a 30-to-38-bps lower CDS spread.

In terms of insider ownership, when we examine the models with the CET1 ratio as the dependent variable, we find that our results are consistent with the vast majority of the literature, which contends that banks with a higher proportion of equity held by insiders increase risk-taking (Saunders et al., 1990). In fact, a one-point increase in insider ownership is associated with a 0.2-point decrease in CET1 ratio. In contrast, we find that insider ownership is negatively associated with the CDS spread, because a one-point higher stake held by insiders implies an 18–22 bps lower risk premium on insurance against bank default. Our findings are consistent with previous research on the relationship between insider ownership and overall bank stability (Zheng et al., 2017). We also find that insider ownership lowers market risk, as a one-point increase in insider equity stakes is associated with a 0.03 lower beta.

According to Pathan et al. (2021), institutional ownership is advantageous to the fundamentals of a bank. On the one hand, it helps accounting-based profitability: a one-point increase in institutional investors' cumulative equity stakes increases the RoA by $\sim 0.01\%$. Higher institutional ownership, on the other hand, is consistently associated with a lower CDS spread across models: A one-point increase in equity stakes implies a lower CDS premium by 3–4 bps.

Moreover, the loan-to-asset ratio is negatively related to profitability, capitalization, and the price-to-book ratio; however, it has a positive correlation with the beta and the CDS spread: a one-point increase in the ratio reduces the RoA by ~ 0.01 pp. and the CDS spread by 4.4 to 5.9 bps, respectively. We also find a positive relationship between market valuation and risk, as measured by the market-to-book ratio and the beta. Our results are consistent with those of Guerry and Wallmeier (2017), who found that investment-oriented banks have higher valuations.

Finally, we find that larger banks have lower performance and higher risk, which is consistent with the majority of the existing literature.

5.4. Robustness checks

As a robustness check, we also run alternative specifications. First, we add a GMM estimator that includes external instrumental variables to the baseline regressions. More specifically, we introduce two new variables as instruments for the RWO measures, both of which assess regulatory policies sourced from the World Bank's Bank Regulation and Supervision Survey: namely, the maximum stake allowed for a single owner and the maximum stake allowed for a related party. Table 11a displays the results. For the sake of

Table 11b
Robustness checks: Additional control variables.

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	Return on assets (%)		CET1 ratio (%)		Bank Z-score	
Top owner's risk weight	1.408* (0.703)		-2.463* (1.303)		0.866 (1.144)	
RWO index, top 5 shareholders		0.052* (0.028)		-0.071** (0.031)		0.008 (0.052)
HHI (0–100 scale)	-0.005 (0.006)	-0.028 (0.017)	-0.012 (0.021)	0.010 (0.028)	-0.036* (0.020)	-0.039 (0.027)
Independent directors (% of board members)	0.018 (0.011)	0.022 (0.014)	-0.018 (0.020)	-0.023 (0.021)	0.023 (0.021)	0.019 (0.024)
Insider ownership (% of total equity)	0.099 (0.098)	-0.054 (0.102)	0.212 (0.567)	0.413 (0.651)	0.123 (0.303)	0.084 (0.336)
Institutional ownership (% of total equity)	0.014** (0.006)	0.002 (0.009)	0.001 (0.017)	0.018 (0.022)	0.014 (0.017)	0.014 (0.025)
Board size (number of members, log)	-0.252 (0.509)	-0.354 (0.578)	-3.285** (1.324)	-3.245** (1.370)	-2.361** (0.872)	-2.458** (0.963)
CEO duality (dummy)	0.087 (0.244)	-0.101 (0.312)	0.267 (0.619)	0.386 (0.506)	0.742 (0.678)	0.836 (0.678)
Total assets (mil EUR, log)	0.041 (0.132)	0.057 (0.139)	-1.278*** (0.267)	-1.264*** (0.276)	0.106 (0.284)	0.098 (0.282)
Loan-to-assets ratio (%)	-0.014 (0.009)	-0.018 (0.011)	-0.029 (0.030)	-0.024 (0.033)	-0.030** (0.015)	-0.028* (0.016)
Commercial bank (dummy)	-0.483 (2.538)	0.729 (0.864)	39.030*** (4.537)	38.000*** (4.851)	1.883** (0.851)	9.035** (3.968)
Bank holding company (dummy)	-0.418 (2.457)	1.135 (0.862)	41.114*** (4.389)	39.582*** (4.713)	0.000 (0.000)	7.187* (3.821)
Savings or cooperative bank (dummy)	-1.013 (2.452)	0.000 (0.000)	38.524*** (5.019)	37.689*** (5.288)	0.623 (0.967)	7.878* (4.183)
Average executive compensation (mil EUR)	0.074 (0.059)	0.064 (0.062)	-0.129 (0.148)	-0.107 (0.162)	0.056 (0.308)	0.060 (0.280)
Size of the risk committee (number of members, log)	-0.391 (0.350)	-0.259 (0.394)	1.460 (0.910)	1.294 (1.053)	-1.091 (0.724)	-1.062 (0.781)
Constant	0.000 (0.000)	-0.732 (2.403)	0.000 (0.000)	0.000 (0.000)	6.514* (3.749)	0.000 (0.000)
Observations	125	125	99	99	120	120

	(7)	(8)	(9)	(10)	(11)	(12)
Variables	CDS spread (bps)		Beta (raw)		Price-to-book ratio	
Top owner's risk weight	-627.980*** (211.604)		-0.237** (0.109)		0.171 (0.246)	
RWO index, top 5 shareholders		-17.185** (8.464)		-0.005 (0.004)		0.013 (0.009)
HHI (0–100 scale)	6.482* (3.789)	13.437* (6.983)	0.000 (0.003)	0.003 (0.004)	-0.004 (0.006)	-0.009 (0.008)
Independent directors (% of board members)	-10.688*** (3.842)	-11.485** (4.274)	-0.006* (0.003)	-0.005* (0.003)	0.001 (0.006)	0.003 (0.007)
Insider ownership (% of total equity)	-71.942* (42.187)	-20.271 (52.804)	0.010 (0.024)	0.027 (0.029)	0.033 (0.062)	-0.008 (0.071)
Institutional ownership (% of total equity)	-3.563 (3.136)	-0.173 (3.953)	0.002 (0.002)	0.003 (0.003)	0.008** (0.004)	0.004 (0.005)
Board size (number of members, log)	-237.610 (240.639)	-238.533 (229.726)	0.254 (0.177)	0.272 (0.177)	-0.620* (0.349)	-0.627* (0.349)
CEO duality (dummy)	337.009*** (88.747)	336.200*** (114.192)	0.164* (0.086)	0.167* (0.092)	0.409** (0.189)	0.283 (0.186)
Total assets (mil EUR, log)	-76.999** (34.766)	-72.698* (39.181)	0.038 (0.036)	0.038 (0.037)	-0.239* (0.121)	-0.231* (0.124)
Loan-to-assets ratio (%)	8.014** (3.535)	8.690** (4.258)	0.009*** (0.003)	0.009*** (0.003)	-0.025*** (0.008)	-0.026*** (0.009)
Commercial bank (dummy)	-66.457 (312.963)	1796.944** (688.444)	-0.153 (0.496)	-0.049 (0.201)	6.441*** (2.037)	0.387* (0.221)
Bank holding company (dummy)	0.000 (0.000)	1737.342** (675.556)	-0.147 (0.521)	-0.075 (0.293)	6.302*** (2.039)	0.336 (0.319)
Savings or cooperative bank (dummy)	24.633 (453.807)	1929.404** (789.472)	-0.111 (0.492)	0.000 (0.000)	6.126*** (2.026)	0.000 (0.000)
Average executive compensation (mil EUR)	-35.157 (30.673)	-28.606 (31.340)	-0.033** (0.016)	-0.031* (0.017)	-0.018 (0.039)	-0.020 (0.039)

(continued on next page)

Table 11b (continued)

Variables	(7)	(8)	(9)	(10)	(11)	(12)
	CDS spread (bps)		Beta (raw)		Price-to-book ratio	
Size of the risk committee (number of members, log)	227.051 (149.551)	188.861 (139.526)	0.117 (0.096)	0.107 (0.106)	0.034 (0.178)	0.052 (0.200)
Constant	2077.796*** (752.705)	0.000 (0.000)	0.000 (0.000)	-0.221 (0.504)	0.000 (0.000)	6.061*** (2.104)
Observations	122	122	125	125	125	125

Note: This table presents a robustness check on the baseline results, including additional control variables (i.e., *average executive compensation* and the *size of the risk committee*). *, **, and *** denote statistical significance at 10%, 5%, and 1%, respectively. Robust standard errors are reported in parentheses. The results for other RWO indexes (top 10 and top 20), available upon request, are qualitatively similar.

conciseness, we only show the top owner risk weight and the top 5 versions of the RWO index.

In line with baseline results, a 0.1-point increase in *Top owner's risk weight* (e.g., from 20% to 30%) makes the *RoA* grow by 0.17 pp., *CET1 ratio* decrease by 0.32 pp., *CDS spread* decrease by nearly 50 basis-points, and *Price-to-book ratio* grow by almost 0.03. However, no statistically significant effects are found for either the *Bank Z-score* or the raw *Beta*. Similarly, a one-point increase in the *RWO index, top 5 shareholders* is associated with a 0.05 pp. higher *RoA*, a 0.06 pp. lower *CET1 ratio*, a 9.3 bp lower *CDS spread*, and a 0.01 higher *price-to-book ratio*. These coefficients show that when we use our indicator as an instrument based on the maximum stake permitted by law, the RWO retains its explanatory capacity and the direction of its relationship with a bank's fundamentals. More risk-averse controlling shareholders are associated with banks with higher profitability and lower capitalization, charge a lower premium for default insurance, and command higher valuations in equity markets.

We introduce controls related to governance mechanisms in the second robustness check: one (*Average executive compensation*) serves as a proxy of aligning the interests of managers and shareholders, while the other (*Size of the risk committee*) serves as a proxy of a bank's focus on risk management. These factors are recognized in the literature as potential influencers of a bank's (or a firm's) risk-

Table 11c

Robustness checks: Alternative measures of banks' capital base and profitability.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Tier 1 ratio (%)				Return on equity (%)			
Top owner's risk weight	-1.246 (0.941)				15.812* (9.193)			
RWO index, top 5 shareholders		-0.068*** (0.019)				0.408* (0.211)		
RWO index, top 10 shareholders			-0.065*** (0.018)				0.418* (0.209)	
RWO index, top 20 shareholders				-0.062*** (0.018)				0.426** (0.209)
HHI (0–100 scale)	0.003 (0.016)	0.034 (0.023)	0.030 (0.023)	0.028 (0.022)	0.004 (0.080)	-0.153 (0.146)	-0.148 (0.140)	-0.140 (0.135)
Independent directors (% of board members)	-0.003 (0.011)	-0.002 (0.012)	-0.001 (0.012)	0.000 (0.012)	0.102* (0.053)	0.091* (0.053)	0.085 (0.053)	0.079 (0.053)
Insider ownership (% of total equity)	-0.088 (0.079)	-0.093 (0.092)	-0.093 (0.092)	-0.093 (0.092)	0.838 (0.552)	0.674 (0.474)	0.674 (0.475)	0.676 (0.478)
Institutional ownership (% of total equity)	0.006 (0.012)	0.012 (0.015)	0.013 (0.015)	0.013 (0.015)	0.116 (0.073)	0.076 (0.074)	0.073 (0.074)	0.067 (0.075)
Board size (number of members, log)	-2.919*** (0.735)	-2.499*** (0.680)	-2.514*** (0.679)	-2.549*** (0.679)	-3.942 (4.873)	-4.650 (4.755)	-4.858 (4.785)	-4.852 (4.777)
CEO duality (dummy)	-1.748*** (0.543)	-1.441*** (0.482)	-1.483*** (0.477)	-1.520*** (0.473)	4.556 (3.461)	5.477 (3.425)	5.506 (3.435)	5.592 (3.439)
Total assets (log)	-0.220 (0.190)	-0.294 (0.196)	-0.302 (0.195)	-0.307 (0.194)	-2.103* (1.095)	-1.879* (1.054)	-1.745 (1.060)	-1.643 (1.059)
Loan-to-Assets ratio (%)	-0.041* (0.022)	-0.041 (0.025)	-0.042* (0.025)	-0.043* (0.025)	-0.292*** (0.070)	-0.250*** (0.070)	-0.245*** (0.070)	-0.243*** (0.071)
Commercial bank (dummy)	25.691*** (3.476)	25.167*** (4.058)	25.366*** (4.046)	25.528*** (4.025)	1.489 (5.148)	3.681 (5.794)	3.619 (5.945)	35.733** (15.331)
Bank holding company (dummy)	26.932*** (3.513)	26.237*** (4.164)	26.472*** (4.145)	26.685*** (4.119)	0.796 (6.245)	4.010 (7.016)	3.667 (7.119)	35.420** (15.663)
Savings or cooperative bank (dummy)	26.274*** (3.556)	26.217*** (4.185)	26.370*** (4.165)	26.497*** (4.141)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	32.152** (13.456)
Constant	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	35.535** (13.993)	34.913** (13.162)	33.441** (13.351)	0.000 (0.000)
Observations	298	298	298	298	310	310	310	310

Note: This table shows the results for the robustness checks for the analyzes. *, **, and *** denote statistical significance at 10%, 5%, and 1%, respectively. Robust standard errors are reported in parentheses.

Table 12
RWO and credit risk policies.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Variables	NPLs/total loans (%)				Loan-loss reserves/total loans (%)				RWA/total equity (%)			
Top owner's risk weight	-0.078 (2.160)				-4.170** (2.041)				-1.536 (1.363)			
RWO index, top 5 shareholders		-0.161 (0.101)				-0.156** (0.061)				0.042 (0.063)		
RWO index, top 10 shareholders			-0.161 (0.101)				-0.153** (0.060)				0.036 (0.065)	
RWO index, top 20 shareholders				-0.159 (0.101)				-0.150** (0.060)				0.036 (0.065)
HHI (0–100 scale)	0.065 (0.040)	0.152* (0.084)	0.149* (0.083)	0.144* (0.081)	0.017 (0.020)	0.081* (0.048)	0.076 (0.046)	0.071 (0.044)	-0.011 (0.020)	-0.042 (0.058)	-0.038 (0.057)	-0.037 (0.055)
Independent directors (% of board members)	-0.059* (0.032)	-0.058 (0.037)	-0.056 (0.037)	-0.054 (0.038)	-0.044** (0.020)	-0.041* (0.021)	-0.038* (0.021)	-0.036* (0.021)	-0.021 (0.013)	-0.020 (0.013)	-0.020 (0.014)	-0.021 (0.014)
Insider ownership (% of total equity)	-0.259 (0.436)	-0.343 (0.440)	-0.340 (0.437)	-0.338 (0.437)	-0.254 (0.216)	-0.254 (0.198)	-0.252 (0.195)	-0.251 (0.195)	-0.004 (0.087)	0.007 (0.086)	0.009 (0.085)	0.009 (0.085)
Institutional ownership (% of total equity)	-0.012 (0.032)	0.013 (0.050)	0.014 (0.051)	0.015 (0.051)	-0.009 (0.014)	0.010 (0.022)	0.011 (0.022)	0.011 (0.023)	-0.022 (0.027)	-0.025 (0.034)	-0.025 (0.035)	-0.025 (0.036)
Board size (number of members, log)	1.869 (3.424)	3.180 (3.776)	3.244 (3.789)	3.191 (3.790)	0.950 (1.572)	1.671 (1.671)	1.706 (1.677)	1.652 (1.681)	2.405 (1.515)	1.733 (1.729)	1.766 (1.769)	1.784 (1.761)
CEO duality (dummy)	-0.638 (1.591)	0.485 (1.739)	0.392 (1.743)	0.292 (1.737)	-0.358 (0.824)	-0.041 (0.836)	-0.114 (0.845)	-0.184 (0.846)	0.612 (0.472)	0.058 (0.792)	0.096 (0.776)	0.118 (0.757)
Total assets (log)	0.189 (0.648)	0.060 (0.682)	0.040 (0.680)	0.031 (0.678)	0.028 (0.323)	-0.067 (0.320)	-0.102 (0.316)	-0.124 (0.314)	-0.160 (0.300)	-0.069 (0.284)	-0.068 (0.288)	-0.065 (0.289)
Loan-to-Assets ratio (%)	0.191*** (0.062)	0.214*** (0.076)	0.211*** (0.075)	0.209*** (0.075)	0.095*** (0.032)	0.092** (0.037)	0.089** (0.036)	0.088** (0.036)	0.055*** (0.012)	0.049** (0.019)	0.049*** (0.018)	0.049*** (0.017)
Commercial bank (dummy)	-4.975 (9.523)	-8.599 (11.288)	-8.279 (11.243)	2.577 (2.864)	1.577 (4.989)	-0.387 (5.124)	0.159 (5.117)	1.877 (1.722)	-0.161 (0.818)	-0.229 (1.017)	2.906 (6.107)	2.820 (5.959)
Bank holding company (dummy)	-7.332 (10.533)	-11.287 (12.637)	-10.938 (12.587)	0.000 (0.000)	-0.013 (5.537)	-2.448 (5.910)	-1.830 (5.865)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	3.112 (6.735)	3.000 (6.540)
Savings or cooperative bank (dummy)	1.655 (10.714)	-0.515 (11.936)	-0.216 (11.959)	10.603 (7.776)	2.203 (5.379)	1.218 (5.479)	1.701 (5.502)	3.363 (3.767)	-1.838 (1.525)	-2.310 (2.010)	0.869 (5.145)	0.793 (5.009)
Constant	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	-10.489 (12.479)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	-1.245 (5.805)	2.702 (5.555)	3.252 (6.954)	0.000 (0.000)	0.000 (0.000)
Observations	276	276	276	276	295	295	295	295	292	292	292	292

Note: This table presents a robustness check on the baseline results, including additional control variables (executive compensation and the size of the risk committee). *, **, and *** denote statistical significance at 10%, 5%, and 1%, respectively. Robust standard errors are reported in parentheses. The results for other RWO indexes (top 10 and top 20), available upon request, are qualitatively similar.

taking. The former has been discussed by John et al. (2010, 2000) and Bolton et al. (2015), while the latter has been explored by Akbar et al. (2017) and Bhuiyan et al. (2020). Table 11b contains the findings of this analysis.

The only statistically significant effects observed for the two newly introduced control variables are for beta, which decreases by approximately 0.03 when executives receive an additional €1 million in compensation. A 0.1-point increase in the risk weight of the top owner is associated with a 0.14-pp increase in RoA, a 0.25-pp decrease in CET1 ratio, and a 0.63 basis point increase in CDS spread. In contrast to previous results, there is no statistically significant relationship with the price-to-book ratio, but the unadjusted beta decreases by >0.02 in response to a 0.1 increase in the explanatory variable.

Furthermore, a one-point increase in the RWO index (calculated using the five largest shareholders) demonstrates a nonzero relationship with only RoA (+0.05%), CET1 ratio (−0.07%), and CDS spread (−17.2 basis-points). Neither of the two primary variables has a statistically significant relationship with either the bank Z-score or the price-to-book ratio, implying that governance mechanisms, rather than ownership structure composition, may play a more significant role in explaining these variables.

The final check we performed involves alternative capitalization (i.e., Tier 1 ratio) and profitability measures (i.e., RoE). Table 11c displays the results.

The only variable that fails to explain the Tier 1 ratio is the risk weight of the top owner, implying that a broader measure of a bank's capital base is unaffected by the owner of the largest stake alone. In all other cases, however, the risk tolerance of the controlling shareholders has a significant relationship with both dependent variables. A 0.1 increase in the former corresponds to a 0.16-pp increase in RoE. A one-point increase in RWO is associated with a 0.06-to-0.07-pp decrease in capital ratio and a slightly >0.4 percentage point increase in profitability. It should be noted that these differences are minor when compared to the baseline results.

5.5. Mechanisms

We show a positive correlation between the risk appetite of the ownership structure and bank profitability in the preceding paragraphs. In recent years, the empirical literature has delved deeper into this issue in a variety of ways: about the impact of privatization policies on banks' asset quality (Boubakri et al., 2020), or to understand whether different ownerships were associated with different responses to the COVID-19 pandemic in terms of lending (Susanto et al., 2023), or to investigate the impact between related lending and NPLs, which could well be driven by the type of largest owner (Vyshnevskiy & Sohn, 2023). All of the studies mentioned above find a direct relationship between a bank's ownership structure, albeit in broad terms (i.e., publicly owned vs. privately held, or based on the identity of the largest shareholder), on the one hand, and its lending strategies, on the other; this, in turn, affects asset quality (e.g., NPL stock).

In this section, we delve into the underlying mechanisms underlying this relationship, looking at how controlling shareholders' risk appetite can affect strategic decisions about loan portfolio composition, reserve policies, and investment choices. Table 12 summarizes the results.

Notably, the top owner's risk weight and RWO measures show a nonzero correlation, primarily with the coverage ratio, which represents the relationship between loan-loss reserves and total gross loans. A 0.1 increase in the top owner's risk weight results in a 0.42-point reduction in the coverage ratio, whereas a 1-point increase in RWO measures results in a 0.15-point decrease in the dependent variable. These findings suggest that shareholders with a higher risk appetite do not favor riskier lending practices or investments in higher-yielding but riskier assets. However, banks with a higher appetite for risk appear to be less likely to set aside reserves than others. This is consistent with the results for capital ratios, implying that banks with a more risk-tolerant ownership base are more likely to hold less capital and implement less conservative provisioning policies in response to borrower defaults.

The evidence presented is part of a large body of literature on agency problems and moral hazard arising from controlling shareholders' risk proclivity within banking institutions, which can affect the alignment of interests between management and various stakeholders. Banks can pass on the costs of excessive risk-taking to creditors and taxpayers, owing to mandatory public deposit protection (Macey & O'Hara, 2003; Mehran et al., 2011). Given interbank deposit insurance, a bank may be tempted to pursue riskier credit and investment policies due to moral hazard, which effectively absolves the institution of deposit repayment obligations (Allen et al., 2015). As a result, corporate control mechanisms in financial intermediaries are especially important in preventing the potential systemic propagation of obligations to depositors and creditors (Berger et al., 2016). However, the literature has shown that even good governance practices can be ineffective due to safety nets and incentives that encourage a too-big-to-fail attitude, exposing the financial system to excessive risk accumulation (Anginer et al., 2018). As a result, studying and analyzing the role of controlling shareholders in a bank's decision-making process is especially important in understanding how their risk preferences can impact bank corporate strategies. If controlling shareholders have a proclivity for higher risk-taking, they may push management to pursue more aggressive and risky strategies to maximize shareholder returns. This could jeopardize the bank's safety and financial stability, raising concerns among depositors and creditors who may see their claims compromised if the bank experiences financial distress. As a result, future research must focus on how controlling shareholders influence management and how these influences can be mitigated or controlled to ensure a fair alignment of interests among all stakeholders. Such an analysis can provide valuable insights into improving corporate governance and protecting depositors and creditors' interests.

6. Discussion and conclusions

This paper is the first to propose and empirically test a methodology for assessing the risk appetite of a bank's ownership structure. We develop a synthetic RWO index to build and test an *ex-ante* measure of a bank's risk appetite based on the risk profile of the major shareholders. The underlying rationale for this work is that, in general, the owners' appetite for risk exposes a bank to greater risk in

turn, because strategic decisions frequently reflect the preferences of controlling shareholders.

This study focuses on developing and empirically validating the RWO index, with a practical application to 76 publicly traded banks. Furthermore, we correlate the various RWO metrics with accounting and market-based performance and risk measures based on different levels of control (top 5, 10, and 20 shareholders, as well as the risk weight of the largest shareholder).

Our findings show that the RWO can be a reliable proxy of a bank's risk tolerance. Specifically, the RWO coefficient is statistically significant across multiple model specifications. Our empirical analysis highlights the important result that, all else being equal, a higher RWO is associated with improved accounting-based profitability and market value performance. Furthermore, a bank with a higher RWO is likelier to have a lower market perception of risk. However, RWO is inversely related to capital adequacy. As a result, the combined interpretation of these results reveals a trade-off between profitability and bank stability, as determined by the owners' risk tolerance.

Our findings have numerous implications. First, regulators are critical in ensuring the financial sector's stability and integrity. Our findings emphasize the importance of regulatory authorities taking controlling shareholders' risk appetite into account when assessing a bank's overall risk profile, which is consistent with a relevant strand of both scholarly (Berger et al., 2016; Gorton & Rosen, 1995; Kirkpatrick, 2009) and policymaking consensus (Verón, 2017). Regulators can develop more targeted and effective supervisory measures if they understand the impact of ownership structure on a bank's risk-taking behavior. Regulatory authorities should look for signs of excessive risk-taking by controlling shareholders, as this could lead to capital shortages and financial instability.

Second, institutional and retail investors are keenly interested in evaluating banks' risk and return profiles. Our findings suggest that a higher RWO is associated with higher accounting-based profitability and market value performance. This information can help investors make more informed decisions when investing in banks. They must, however, be wary of the potential trade-off between profitability and bank stability (Thakor, 2014). Understanding the ownership structure's risk appetite can help investors align their investment strategies with their risk tolerance.

Third, our findings emphasize the importance of understanding the impact of ownership structure on risk-taking behavior (Zheng et al., 2017). Bank executives and board directors should be aware that controlling shareholders' risk appetite can significantly impact strategic decisions and risk management practices. A higher RWO index may result in increased profitability, but it may also result in decreased capitalization. Bank executives must strike a balance between maximizing returns and ensuring financial stability. This entails implementing robust risk management practices to mitigate excessive risk-taking by controlling shareholders.

A better understanding of controlling shareholders' risk appetite can improve the shape of governance mechanisms and risk management practices. Our analysis suggests that regulatory authorities and market participants closely examine controlling shareholders' risk-taking tendencies to mitigate potential capital shortages. These results highlight the importance of strengthening governance mechanisms to prevent controlling shareholders from unduly influencing minority shareholders, which could jeopardize bank and financial system stability (Saghi et al., 2023).

However, as Shaban and James (2018) point out, our study is limited by the lack of data on controlling shareholders, which remains a substantial challenge in ownership-related research. Furthermore, our study assumes that only credit risk determines the risk appetite of the ownership structure, ignoring the potential contributions of other risk types. Future research could explore into the implications of noncredit risk and the potential system-wide effects of shareholder interactions.

Finally, the findings of our study have significant implications for various stakeholders and highlight the importance of transparency and governance in managing bank risk appetite. More research should be conducted to better understand these dynamics and their broader implications in the financial sector.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

CRedit authorship contribution statement

Luca Bellardini: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. **Pierluigi Murro:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. **Daniele Previtali:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing.

Declaration of competing interest

We report that there are no competing interests to declare.

Data availability

The authors do not have permission to share data.

Acknowledgments

We wish to give a special thanks to Ali Fatemi and to anonymous referees for many insightful comments and recommendations.

This study has also benefited from comments offered by Murillo Campello, Mario Comana, Domenico Curcio, the discussants at the University of Rome “Tor Vergata” Ph.D. seminars, and the discussants at ADEIMF 2019, CGFRI 2019 and IBEC 2020 conferences. We alone are responsible for any remaining errors.

Appendix A. Long-term ratings released by different credit rating agencies and risk weights pursuant to the Basel II framework (and further amendments)

We use the S&P long-term ratings, since S&P displays by far the largest number of ratings. In their absence, based on the number of ratings collected, we first use Moody’s and then Fitch (in this order, since the former outnumbers the latter in the number of ratings). The conversion to S&P’s scale is implemented as follows.

S&P	Moody’s	Fitch
AAA	Aaa	AAA
AA+	Aa1	AA+
AA	Aa2	AA
AA–	Aa3	AA–
A+	A1	A+
A	A2	A
A–	A3	A–
BBB+	Baa1	BBB+
BBB	Baa2	BBB
BBB–	Baa3	BBB–
BB+	Ba1	BB+
BB	Ba2	BB
BB	Ba3	BB
B+	B1	B+
B	B2	B
B	B3	B
CCC+	Caa1	CCC+
CCC	Caa2	CCC
CCC	Caa3	CCC
CC	Ca	CC
C		C
RD	C	RD
SD	–	D
D	–	–

In the following table, we show the attribution of Basel II risk weights in accordance with S&P’s rating scale.

1. Exposure to sovereigns and their central banks

External rating	AAA to AA–	A+ to A–	BBB+ to BBB–	BB+ to B–	Below B–	Unrated
Risk weight	0%	20%	50%	100%	150%	100%

2. Exposure to noncentral government public sector entities

External rating	AAA to AA–	A+ to A–	BBB+ to BBB–	BB+ to B–	Below B–	Unrated
Risk weight	20%	50%	50%	100%	150%	50%

3. Exposure to multilateral development banks

<i>External rating</i>	AAA to AA–	A+ to A–	BBB+ to BBB–	BB+ to B–	Below B–	Unrated
<i>Risk weight</i>	20%	30%	50%	100%	150%	50%

4. Bank exposures (“base” risk weights)

<i>External rating</i>	AAA to AA–	A+ to A–	BBB+ to BBB–	BB+ to B–	Below B–	Unrated
<i>Risk weight</i>	20%	30%	50%	100%	150%	100%

5. Corporate exposures

<i>External rating</i>	AAA to AA–	A+ to A–	BBB+ to BBB–	BB+ to B–	Below B–	Unrated
<i>Risk weight</i>	20%	30%	50%	100%	150%	100%

6. Residential real estate exposures

<i>External rating</i>	AAA to AA–	A+ to A–	BBB+ to BBB–	BB+ to B–	Below B–	Unrated
<i>Risk weight</i>	20%	30%	50%	100%	150%	100%

Note: The category of unrated covered bond exposures, which is featured in the Basel framework, is not used to match any of the shareholder identities, since it applies to securities rather than entities. Conversely, we acknowledge the possibility of having unrated banks, which has no match in reality (in fact, the Basel Committee had not envisaged this) but could theoretically occur in our database. Regarding residential real estate exposures, we convert loan-to-value figures into external ratings, keeping the standard Basel II subdivision (in decreasing order, from AAA to AAA–, from A+ to A–, from BBB+ to BBB–, from B+ to B–, below B–, and unrated). Nonresidential exposures are regarded as residential. Pursuant to the Basel II framework, natural persons do not receive any rating and are automatically weighted by 75%.

Appendix B. Reconciliation of shareholder identities with Basel-compliant categories

Shareholder identity	Basel category
Agricultural company	5
Bank	4
Banking foundation	2
Central bank	1
Closed-end fund	4
Construction company	5
Development bank	3
Financial advisor	5
Government agency	2
Hedge fund	5
Holding company	5
insurance company	4
Investment bank	4
Investment manager	4
Investment trust	5
Local government	2
Local government investment manager	2
Manufacturing company	5
Market infrastructure company	5
Natural person	8

(continued on next page)

(continued)

Shareholder identity	Basel category
Nonbank lender	4
Nonprofit organization	2
Open-end fund	4
Pension fund	4
Private equity firm	5
Real estate company	6
Religious institution	2
Service company	5
Sovereign investment manager	1
Sovereign state	1
Special-purpose vehicle	5
Trade company	5

Note: Construction companies are committed to developing buildings and material infrastructures, whereas the business of real estate companies is financial and consists of the sale and purchase of properties. Religious institutions (e.g., national churches or local branches thereof) are treated as sovereign bodies. All regulated (unregulated) financial intermediaries are treated as banks (corporations). Private equity firms and market infrastructure companies are treated as corporations due to the content of their business, since the former deal with mostly non-financial entities and the latter's role is just to support the financial markets themselves.

Appendix C. Attribution of bank Z-score to ratings classes

We attribute the bank Z-scores according to the following steps:

- **Step 1.** Express all judgments as S&P ratings, according to the conversion table provided by the EU Credit Rating Agency Regulation No. 462/2013 (see [Appendix A](#)).
- **Step 2.** Encode the ratings to construct a numeric variable.

First class ($R < 4.5$)				Second class ($4.5 \leq R < 7.5$)			Third class ($7.5 \leq R < 10.5$)						
AAA 1	AA+ 2	AA 3	AA- 4	A+ 5	A 6	A- 7	BBB+ 8	BBB 9	BBB- 10				
BB+ 11	BB 12	BB- 13	B+ 14	B 15	B- 16	CCC+ 17	CCC 18	CCC- 19	CC 20	C 21	R 22	SD 23	D 24
Fourth class ($10.5 \leq R < 16.5$)						Fifth class ($R \geq 16.5$)							

- **Step 3.** Regress the encoded ratings on bank Z-score.
- **Step 4.** Estimate the fitted values from Step 3 using

$$\widehat{R}_{fkt} = \widehat{\alpha} + \widehat{\beta} \text{BZS}_{fkt} + T_t \widehat{\tau} + C_k \widehat{\gamma}$$

where f indexes shareholders (belonging to the financial industry); k indexes the countries where shareholders are located; t denotes the years to which the bank Z-scores refer; R denotes *Rating*; α denotes a constant; BZS denotes *Bank Z-score*; β is the coefficient thereof; T denotes a row vector of dummy variables taking the value of 1 if the observation refers to a given year \tilde{t} , and 0 otherwise; τ is a column vector of related coefficients; C denotes a row vector of dummy variables taking the value of 1 if the observation refers to a given country \tilde{k} , and zero otherwise; and γ is a column vector of related coefficients. The caret (^) symbol indicates that the values were estimated in Step 3.

EXAMPLE. The rating estimate for an American investment manager with a *Bank Z-score* of 2.8 in 2017 yields the following computation:

$$\widehat{R} = 5.282 - 0.094 \times 2.8 + 2.363 - 0.823 \cong 6.559$$

where $\widehat{\alpha} = 5.282$ and $\widehat{\beta} = -0.094$. The fixed effect for 2017 is 2.363, whereas the fixed effect for the country concerning the United States amounts to -0.823 . Since the result equals 6.559, *Rating* falls into the second class, which ranges between 4.5 and 7.5.

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