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Monetary policy, ownership structure, and risk-taking at financial intermediaries

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Abstract

This paper examines how ownership structure interacts with monetary policy in shaping financial intermediaries' appetite for risk. By constructing a large panel of banks across Western Europe, we provide evidence that differences in bank ownership influence the transmission of monetary policy via the risk-taking channel. While shareholder banks actively adjust the riskiness of their portfolios to changes in interest rates, stakeholder banks appear to be less responsive to such changes. These findings call for greater attention to the nature of bank ownership when setting monetary policy.

KEYWORDS
bank ownership, financial crisis, macroprudential policy, monetary transmission mechanism, risk-taking channel, systemic risk

JEL CLASSIFICATION
E52, G01, G21

1 | INTRODUCTION

The blame for the 2008 global financial crisis and the ensuing economic contraction is often placed on monetary policy and on the role it played in increasing financial intermediaries' risk-taking. In the aftermath of the dot-com bust, a number of central banks responded to fears of an economic slowdown by gradually decreasing nominal interest rates. It is argued that this "too-low-for-too-long" interest rate environment spurred risk-taking by banks through changes in risk perception and aversion, adding to the build-up of risks in the economy via a "risk-taking channel" of monetary transmission (Borio & Zhu, 2012). Notwithstanding the close link between monetary conditions and bank risk-taking,

little attention has been paid to how ownership structure interacts with monetary policy in shaping banks' appetite for risk.

The aim of this paper is to cast new light on the role of banks in monetary policy by examining how bank ownership affects the transmission of monetary policy via the risk-taking channel. We test whether banks that pursue social as well as financial objectives (i.e., stakeholder banks) are less responsive to changes in interest rates than are profit-maximizing banks (i.e., shareholder banks). The results, based on a large panel of commercial, cooperative, and savings banks from 17 Western European countries, provide robust evidence that banks with alternative ownership types respond differently to changes in monetary policy. While shareholder banks tend to actively adjust the riskiness of their portfolios to changes in interest rates, stakeholder banks are found to be less responsive to such changes. Evidence that stakeholder banks' risk-taking varies less with interest rates than does that of shareholder banks is also available for the crisis years, when monetary policy continued to be effective at influencing the share of risky assets held in stakeholder banks' (but not shareholder banks') portfolios. In addition, we show that the loose monetary environment in the aftermath of the crisis delayed loan loss provisioning by stakeholder banks, possibly reflecting a positive impact of the accommodative monetary policy on borrowers' creditworthiness. Overall, these results suggest that stakeholder banks generally follow fewer procyclical risk-taking policies compared with their shareholder counterparts.

The property rights (Alchian & Demsetz, 1972) and agency theory (Jensen & Meckling, 1976) literature views ownership type as a key determinant of firm risk-taking. Shareholder-owned commercial banks (commercial banks hereafter) are characterized by a separation between ownership and debtholding (Valnek, 1999). Stockholders have all the cash flow rights and control the board by virtue of their voting rights (Bøhren & Josefsen, 2013), with votes apportioned according to the amount of capital provided to the bank (Hansmann, 2000). The one-share-one-vote rule to allocate cash flow rights and voting rights is, together with publicly traded common stock and the market for corporate control, one of the main mechanisms for motivating managers to maximize owners' utility (Valnek, 1999).

By contrast, the distinguishing feature of cooperative banks, which together with savings banks belong to the group of stakeholder banks, is that they are owned by their members, who are households and businesses whose aim is not exclusively the maximization of their ownership stake in the bank (Ayadi et al., 2010). It is optimal for depositors to own the bank, that is, for the bank to be a mutual when the cost of capital to depositors is not markedly larger than that to shareholders (Habib, 2018). Members of cooperative banks are entitled to only one vote (one-member-one-vote principle), stakes are generally not marketable, and the distribution of profits is limited. Like financial cooperatives, savings banks are not strictly profit-oriented institutions and are characterized by a dual financial and social mission (Ayadi et al., 2009). However, savings banks differ from financial cooperatives in that they are owned either by an organization that belongs to the government or by a foundation. The lower incentives for stakeholder banks to use leverage in an attempt to increase the expected return on equity, along with the significant obstacles (at least for cooperative banks) in raising external capital, may make stakeholder banks less prone to risk-taking (Llewellyn, 2017).

This paper contributes to the literature in several ways. In responding to recent calls for a better understanding of banks' incentives to increase their risk exposure (Bikker & Vervliet, 2018), it brings concepts from the property rights and agency theory perspectives into the analysis of the risk-taking channel. By estimating the differential effects of monetary intervention on bank risk-taking owing to ownership structure, our findings advance the literature concerned with the role of financial intermediaries as conduits for monetary policy transmission. These findings provide new evidence on the functioning of the risk-taking channel in Western European countries during periods of financial distress while contributing to a greater understanding of the implications that the ownership composition of the banking sector has for financial stability.

The remainder of the paper is organized as follows. Section 2 reviews the related literature and advances the key theoretical predictions. Section 3 describes the sample and key variables used in the analysis, alongside the econometric model to be estimated. Section 4 illustrates the main empirical results and summarizes a series of robustness checks. Section 5 discusses the implications of the findings, along with some suggestions for future research, and concludes.

2 | LITERATURE REVIEW

2.1 | Monetary policy and bank risk-taking

Fueled by the 2008 global financial crisis, an increasing number of studies have posited that changes in official rates affect banks' risk perception and tolerance through a risk-taking channel of monetary policy transmission. In a nutshell, this channel works via three primary mechanisms (Borio & Zhu, 2012): (1) the impact of interest rates on valuations, incomes, and cash flows; (2) the existence of "sticky" target rates of return; and (3) the reaction function and communication policies of the central bank. Among these mechanisms, particular attention has been devoted by researchers to the link between interest rates and the search-for-yield effect. A prolonged period of low interest rates may induce a degree of procyclical risk-taking into the financial system, eventually generating an equilibrium with deteriorated bank portfolios, lower and more volatile profits, and higher aggregate credit (Dell'Ariccia & Marquez, 2006).

Drawing on this, empirical research has started to explore the link between monetary policy and banks' appetite for risk. Evidence of a risk-taking channel is found for both the US and European financial systems. Paligorova and Santos (2017) collect data at the bank holding company (BHC) level and find that US banks charge riskier borrowers lower loan spreads in periods of monetary easing than in periods of monetary tightening. The relationship between policy rates and US banks' risk-taking appears to be more pronounced for domestic banks of smaller size (Buch et al., 2014) and for better capitalized banks (Dell'Ariccia et al., 2017). Evidence from commercial and savings banks in the United States also suggests that a relatively low interest rate environment might induce banks to alter their business models and expand their trading activities in order to reduce their reliance on the lending business (Bikker & Vervliet, 2018).

Within the European context, early support for a link between interest rates and bank risk is put forward by Delis and Kouretas (2011), who construct a sample of commercial, savings, and cooperative banks from 16 eurozone countries and show that the impact of loose monetary policy on risky assets is amplified for banks with less equity capital as well as more off-balance-sheet (OBS) items. Similarly, Jiménez et al. (2014) use a micro-level dataset for Spain and find support for a risk-taking channel operating through less-capitalized banks. More recent evidence corroborates the existence of a risk-taking channel in the euro area that works through the relaxation of lending standards for borrowers (Neuenkirch & Nöckel, 2018); the strength of this channel is reduced by means of more stringent prudential policy on either bank capital or the loan-to-value (LTV) ratio (Maddaloni & Peydró, 2013).

The negative relationship between interest rates and bank risk seems to hold even if one considers somewhat more heterogeneous samples (Altunbas et al., 2014). Based on a panel of commercial, savings, and cooperative banks from 10 Central and Eastern European (CEE) countries as well as Russia for the period 1997–2011, Drakos et al. (2016) find that foreign, well-capitalized banks from CEE countries behave more aggressively compared with other banks in the sample by increasing their risky investments in response to declining short-term rates.

2.2 | Ownership structure and bank stability

Extensive evidence in the literature suggests that banks' ownership type has a bearing on their behavior, performance, and ultimate survival (e.g., Fama & Jensen, 1983; Hansmann, 2000; O'Hara, 1981). Empirical research points to a number of differences in the behavior of shareholder banks vis-à-vis stakeholder banks.

By employing euro-area data covering the global financial crisis, Ferri et al. (2014) offer evidence suggesting that stakeholder banks attempt to smooth financial conditions for their customers by adopting fewer procyclical lending policies than do shareholder banks. These findings are complemented by Meriläinen (2016), who finds that the lending growth of cooperative and publicly owned savings banks across 18 Western European countries was less affected by the global financial crisis and the subsequent sovereign debt crisis compared with commercial banks.

Importantly, the literature lends support to the view that ownership structure has an impact on bank stability. Early evidence from the United States indicates that stakeholder banks are generally less risk-inclined than their shareholder peers (O'Hara, 1981). Moreover, there is evidence that stock firms exhibit higher concentration in lines of business and geographic areas with the greatest risk (Lamm-Tennant & Starks, 1993), together with the adoption of high-risk strategies through an investment in risky assets and a mismatch between assets and liabilities (Esty, 1997).

Similar evidence is found in Europe. Ayadi et al. (2009, 2010) compute Z-scores for cooperative, savings, and commercial banks operating in six Western European countries and show that cooperative and savings banks are generally more financially stable than commercial banks. Likewise, García-Marco and Robles-Fernández (2008) focus on the Spanish context and submit that savings banks have a lower insolvency risk relative to their commercial counterparts. Differences in default risk between shareholder- and stakeholder-oriented banks appear to be explained by the lower volatility of returns for stakeholder banks compared with their shareholder counterparts (Hesse & Cihák, 2007). In addition, empirical support is found for significant differences between the two ownership types in terms of loan quality, with stakeholder banks having lower nonperforming loans (Beck et al., 2009) and loan loss provisions (Iannotta et al., 2007) than shareholder banks do. A recent study by Meriläinen (2019) also shows that cooperative banks' loan loss provisions have a smaller cyclical component relative to other ownership types, as demonstrated by the limited effect of gross domestic product (GDP) growth on their provisioning.

Combined, the two major bodies of literature reviewed above suggest a key testable prediction: banks that seek to balance the interests of a multiplicity of stakeholders tend to be less responsive to changes in the monetary environment compared with banks that focus primarily on maximizing shareholder wealth. To disentangle the effects of ownership structure on bank risk-taking, our econometric specifications also include various other bank-level characteristics (e.g., size, capitalization, and profitability) along with industry-specific and macroeconomic factors.

3 | DATA AND METHODOLOGY

3.1 | Sample selection

The primary source of data is Bankscope, a global database of banks' financial statements and ownership structures maintained by Bureau van Dijk. We use annual report data for a panel of banks operating in 17 Western European countries, namely the 15 economies that joined the European Union before the 2004 accession (i.e., Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, and the United Kingdom) as well as Norway and Switzerland.[1] The sample period is from 1999 (the year in which the euro was officially launched) through 2011 (the last year for which consistent data on the regulatory indices is available).[2] This time window is interesting as it encompasses the global financial crisis as well as the eurozone sovereign debt crisis. The process that we adopted in selecting the sample is described in detail in the supplementary material available online.

Table 1 shows the composition of our sample of 5677 commercial, cooperative, and savings banks by country and ownership structure. Whereas the financial systems in Luxembourg and the United Kingdom are characterized by an overwhelming majority of shareholder banks relative to the total number of banks (97% and 70%, respectively), the financial systems in countries such as Germany (92%) and Austria (76%) have a dominant presence of stakeholder banks. Besides Italy (69%) and Germany (67%), other countries that exhibit a large number of cooperative banks are Austria (52%) and Switzerland (46%).[3] Savings banks are strongly present in the Scandinavian region, especially

[1] The validity of employing annual data when studying the risk-taking channel is supported by Delis & Kouretas (2011), who build a quarterly dataset with information collected from Bloomberg and find that their results are not sensitive to the frequency of the data.

[2] The survey results used to construct the regulatory indices are available at four points in time (i.e., 2001, 2003, 2007, and 2011) and cover the period from 1999 through 2011.

[3] Cooperative banks in Italy include the group of *Banche Popolari* that converted to joint-stock banks following the 2015 reform.

TABLE 1 Distribution of banks by country and ownership structure

	Shareholder banks		Cooperative banks		Savings banks		Stakeholder banks		Total	
	No.	TA	No.	TA	No.	TA	No.	TA	No.	TA
Austria	77	144	171	115	78	85	249	200	326	345
Belgium	52	967	12	10	11	6	23	16	75	983
Denmark	62	633	9	1	64	32	73	34	135	667
Finland	10	233	4	69	8	7	12	76	22	309
France	186	3108	165	1875	13	2	178	1877	364	4985
Germany	183	3468	1607	1046	598	3318	2205	4365	2388	7832
Greece	19	252	2	2	1	6	3	8	22	261
Ireland	23	536	3	21	0	0	3	21	26	557
Italy	220	1896	592	484	47	140	639	624	859	2520
Luxembourg	126	634	2	2	2	46	4	48	130	682
Netherlands	45	978	1	451	2	4	3	455	48	1432
Norway	19	226	2	2	124	99	126	100	145	326
Portugal	39	306	4	2	3	19	7	21	46	327
Spain	88	1243	87	84	61	1023	148	1108	236	2350
Sweden	19	556	0	0	91	21	91	21	110	577
Switzerland	159	1453	225	93	110	325	335	417	494	1870
UK	175	4482	68	402	8	3	76	405	251	4886
EA-12	1068	13,765	2650	4161	824	4657	3474	8818	4542	22,583
EU-15	1324	19,436	2727	4564	987	4713	3714	9277	5038	28,714
Total	1502	21,115	2954	4658	1221	5137	4175	9795	5677	30,910

Note: The table shows the composition of the sample by country and ownership structure. *Shareholder banks* are commercial banks while *stakeholder banks* include cooperative and savings banks. *TA* is the annual average of total assets in billions of US dollars. *EA-12* are the founding euro area countries, namely Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, and Spain. *EU-15* are the economies that joined the European Union before the 2004 accession, that is, the *EA-12* countries plus Denmark, Sweden, and the United Kingdom. The sample period goes from 1999 through 2011. *Sources*: Bankscope; authors' calculations.

in Norway (86%) and Sweden (83%).[4] Taken together, these figures confirm the considerable heterogeneity across Western European countries with respect to the ownership composition of the banking system, calling for a greater understanding of the implications that such heterogeneity might have for the transmission of monetary policy to bank risk.

3.2 | Variable construction

3.2.1 | Bank risk-taking

We measure the risk-taking behavior of banks with two proxies commonly used in the literature, namely the ratio of risky assets to total assets (*risky assets*) and the ratio of loan loss provisions to total loans (*LLPs*). Risky assets are calculated as the difference between total assets and the sum of loans and advances to banks, government securities, and cash. Therefore, this ratio includes all assets with non-negligible credit and market risk (Gropp et al., 2011) and captures the overall riskiness of bank portfolios at a given point in time (Delis & Kouretas, 2011). The *LLPs* variable is defined as the sum of provisions against possible losses on nonperforming loans over net loans (i.e., residential mortgage loans, other mortgage loans, other consumer loans, corporate and commercial loans, and other loans minus reserves for loan losses). This variable reflects the quality of loan portfolios (Bertay et al., 2015) and offers a more direct proxy for credit risk (Iannotta et al., 2007), with a higher ratio denoting a poorer credit quality.[5]

Data for the risk-taking proxies are collected from Bankscope, and descriptive statistics are summarized in Table 2, where both proxies are expressed in percentage terms.[6] Over the sample period, the *risky assets* ratio has an average value of 80% and a standard deviation of 16%. The mean value of *risky assets* was 77% in 1999 and 80% in 2004, suggesting a 4% increase in the average risk-taking behavior of banks until the mid-2000s. In turn, the *LLPs* ratio is characterized by a mean of 0.68% and a standard deviation of 1.02%. While the credit risk appetite of banks seemed at its highest in 2002 (0.89%), it reached its lowest level in 2011 (0.28%).

Table 3 presents summary statistics for the dependent variable by dividing the sample according to ownership type. At first glance, we notice several important differences among banks with alternative ownership structures. Whereas the average value of *risky assets* for stakeholder banks is higher than for their shareholder peers, largely reflecting their greater focus on the traditional lending business, the lower standard deviation for cooperative and savings banks implies less volatility in their risk-taking behavior relative to commercial banks. On average, stakeholder banks also show a lower and less volatile loan loss provision ratio compared with shareholder banks.

3.2.2 | Monetary policy

Since the onset of the global financial crisis, some researchers and market observers alike have blamed the relatively low interest rate environment in the first half of the 2000s for the softening of lending standards by banks and the subsequent materialization of risks in the economy. More recently, a related discussion has ensued on whether the current environment of exceptionally low interest rates is sowing the seeds for the next financial crisis (Dell'Ariccia

[4] In terms of total assets, the shareholder banking sector is particularly large in Belgium (98%) and Ireland (96%), while the stakeholder banking sector dominates in Austria (58%) and Germany (56%). The greatest aggregate size of cooperative banks is found in France (38%), with savings banks constituting a major player in countries such as Germany (42%) and Norway (30%).

[5] Ideally, we would have preferred to capture credit risk by the ratio of nonperforming loans to total loans (Delis & Kouretas, 2011). However, consistent data on nonperforming loans were available only for less than 10% of all the banks that make up the sample (mostly from Italy). In addition, more fine-grained measures of bank risk-taking such as the probability of default or loan spread of new originations were not available for many of the stakeholder banks included in the analysis.

[6] To mitigate the impact of outliers, we winsorize the accounting variables at the 1st and 99th percentiles of their sample distributions.

TABLE 2 Descriptive statistics

	Obs	Mean	SD	Min	Q1	Median	Q3	Max
Bank risk-taking								
Risky assets	44,271	80.26	16.10	7.96	75.93	84.84	90.61	99.46
LLPs	44,271	0.68	1.02	−5.48	0.20	0.53	0.95	10.00
Monetary policy								
Overnight rate	44,271	2.51	1.39	−0.00	0.91	2.74	3.86	7.35
Bank-level controls								
Size	44,271	6.51	1.69	2.48	5.36	6.29	7.45	12.46
Capitalization	44,271	8.38	6.32	1.07	5.00	6.68	9.82	79.11
Deposits	44,271	87.51	13.49	35.69	83.13	93.09	97.02	99.61
OBS items	44,271	10.12	14.57	0.01	3.33	5.76	10.81	175.66
Profitability	44,271	0.66	0.85	−5.20	0.30	0.54	0.92	7.89
Efficiency	44,271	68.59	16.35	15.11	60.47	68.32	75.45	198.09
Income diversity	44,271	0.49	0.19	0.00	0.38	0.48	0.61	0.98
Industry-specific controls								
Concentration	44,271	992.13	891.14	329.21	433.60	662.00	944.73	6116.74
Activity restrictions	44,271	6.70	2.80	2.00	5.00	7.00	9.00	12.00
Capital stringency	44,271	6.13	1.60	2.00	5.00	6.00	8.00	9.00
Supervisory power	44,271	9.58	2.21	4.00	8.00	10.00	11.00	14.00
Deposit insurance	44,271	1.81	0.85	0.00	1.00	2.00	2.00	4.00
Private monitoring	44,271	7.93	0.84	5.00	7.00	8.00	9.00	10.00
Macroeconomic controls								
Institutions	44,271	1.36	0.37	0.35	1.24	1.46	1.59	1.99
GDP growth	44,271	1.50	2.37	−8.86	0.71	1.71	3.27	8.44
Inflation	44,271	1.73	0.85	−4.48	1.10	1.67	2.30	4.88
Volatility	44,271	22.14	7.63	7.95	15.20	22.09	27.69	54.71
House prices	44,271	1.23	4.07	−15.49	−1.74	0.47	3.82	18.99

Note: The table summarizes descriptive statistics for the main regression variables. *Risky assets* is the ratio of risky assets to total assets; *LLPs* is the ratio of loan loss provisions to total loans; *Overnight rate* is the annual average of the daily overnight interbank rate; *Size* is the natural logarithm of real total assets; *Capitalization* is the ratio of equity to total assets; *Deposits* is the ratio of deposits to total liabilities; *OBS items* is the ratio of OBS items to total assets; *Profitability* is the ratio of profit before tax to total assets; *Efficiency* is the ratio of cost to total income; *Income diversity* is a measure of income diversification; *Concentration* is the Herfindahl–Hirschman Index of market concentration; *Activity restrictions* is an index of the extent to which banks can engage in a number of activities; *Capital stringency* is an index of the regulatory oversight of bank capital; *Supervisory power* is an index of the power of the supervisory authority to influence the behavior on the part of banks; *Deposit insurance* is an index of each country's explicit deposit insurance regime; *Private monitoring* is an index of the degree to which regulatory and supervisory policies affect the private monitoring of banks; *Institutions* is a composite measure of country-level governance; *GDP growth* is the annual growth rate of real GDP; *Inflation* is the annual change in the CPI; *Volatility* is the annual average of the daily historical volatility of the country's stock market index; *House prices* is the annual change in the residential property price index (divided by the GDP deflator).

TABLE 3 Summary statistics of bank-level variables by ownership structure

	Shareholder banks		Cooperative banks		Savings banks		Stakeholder banks	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Risky assets	66.80	24.49	82.15	11.30	86.58	9.32	83.59	10.90
LLPs	0.83	1.55	0.65	0.78	0.64	0.93	0.65	0.83
Size	7.38	1.98	5.95	1.41	7.02	1.54	6.30	1.54
Capitalization	11.34	10.75	7.75	4.11	7.43	4.65	7.65	4.30
Deposits	85.75	14.33	87.32	14.28	89.25	10.64	87.95	13.24
OBS items	19.48	25.19	7.67	8.29	8.09	10.23	7.81	8.97
Profitability	0.93	1.49	0.59	0.54	0.60	0.65	0.60	0.58
Efficiency	67.97	26.93	70.13	12.39	65.85	11.93	68.74	12.41
Income diversity	0.56	0.25	0.49	0.18	0.46	0.15	0.48	0.17

Note: The table presents summary statistics for the bank-specific variables by dividing the sample according to ownership type. *Shareholder banks* are commercial banks while *stakeholder banks* include cooperative and savings banks. *Risky assets* is the ratio of risky assets to total assets; *LLPs* is the ratio of loan loss provisions to total loans; *Size* is the natural logarithm of real total assets; *Capitalization* is the ratio of equity to total assets; *Deposits* is the ratio of deposits to total liabilities; *OBS items* is the ratio of OBS items to total assets; *Profitability* is the ratio of profit before tax to total assets; *Efficiency* is the ratio of cost to total income; *Income diversity* is a measure of income diversification.

et al., 2017). For this reason, the main measure of monetary policy used in this paper is the short-term interest rate (*overnight rate*), computed as the annual average of the daily overnight interbank rate.

After the collapse of Lehman Brothers in September 2008, many central banks sought to maintain financial and economic stability by implementing an unprecedented set of nonstandard monetary policy measures. As a result, central bank balance sheets expanded sharply in many advanced economies, largely reflecting the increase in the amount of liquidity supplied to the banking sector (Gambacorta et al., 2014).[7] To disentangle the effects of nonstandard monetary policy measures on bank riskiness from those due to variations in short-term rates, the estimations for the crisis period also include the ratio of central bank assets to nominal GDP (*central bank assets*) as a proxy for unconventional monetary policy.[8]

3.2.3 | Control variables

We control for a number of bank-level, industry-specific, and macroeconomic factors that might affect banks' appetite for risk. One of the main empirical challenges with studying the transmission of monetary policy to bank risk is to distinguish the risk-taking channel from the partially overlapping bank-lending channel. According to Bernanke and Blinder (1988), an expansionary monetary policy tends to increase credit supply by making it less costly for financial intermediaries to fund loans, leading to an equilibrium with higher aggregate credit and larger bank balance sheets. Therefore, one concern is that our *risky assets* measure could go up not because the riskiness of bank loan portfolios increases (risk-taking channel) but because bank balance sheets expand (bank-lending channel).[9]

[7] Between 2008 and 2011, the assets of the Bank of England tripled, while the size of the balance sheets of the Eurosystem and the Swiss National Bank doubled. The growth in the asset size of the Sveriges Riksbank and the Danmarks Nationalbank was also significant whereas the balance sheet of the Norges Bank expanded only in the period following the Lehman bankruptcy.

[8] As a robustness check, we capture unconventional monetary policy using the ratio of monetary base to nominal GDP. The results are available upon request. Because there is evidence that central bank assets are a better gauge of nonstandard monetary policy than is the monetary base (Gambacorta et al., 2014), we use the former in the benchmark specifications.

[9] We are grateful to an anonymous reviewer for making this point.

In our empirical estimations, we hold these additional supply-side effects constant by including four bank-level characteristics that are commonly used by the literature to capture the bank-lending channel. First, we account for a possible "too-big-to-fail" phenomenon by including bank size (*size*), defined as the natural logarithm of real total assets. We also test whether better capitalized banks have stronger or weaker incentives to take on risk by considering the ratio of equity to total assets (*capitalization*). Finally, because recent empirical evidence suggests that bank-specific characteristics such as deposits and securitization could influence banks' funding needs and explain bank risk (Altunbas et al., 2014; Azam et al., 2022; Guo & Zhang, 2020), we control for the deposits-to-total-liabilities ratio (*deposits*) and the ratio of OBS items to total assets (*OBS items*).

Alongside these four bank characteristics, at the micro level, we add the ratio of profit before tax to total assets as a measure of bank profitability (*profitability*) and the cost-to-income ratio as a proxy for bank efficiency (*efficiency*), with higher values indicating less efficient banking operations. As empirical findings show that diversification away from traditional lines of business influences bank risk-taking (e.g., Hesse & Cihák, 2007), we also include a variable to control for differences in banks' income (*income diversity*).[10] Building on Laeven and Levine (2007), this variable is calculated as follows:

$$\textit{Income diversity} = 1 - \left| \frac{\textit{Net interest income} - \textit{Other operating income}}{\textit{Total operating income}} \right| \quad (1)$$

The set of industry-related controls comprises the Herfindahl–Hirschman Index as a proxy for market concentration (*concentration*), computed as the sum of squared market shares of all banks in the country.[11] To capture the regulatory environment, we construct five indices using data from the *Bank Regulation and Supervision Survey* (BRSS) conducted by the World Bank and described in Barth et al. (2001, 2004, 2006, 2012).[12] *Activity restrictions* measures the extent to which banks can engage in a range of activities (e.g., securities underwriting, brokering, and dealing), with higher numbers indicating more regulatory impediments on nonlending activities. *Capital stringency* proxies for the regulatory oversight of bank capital, with higher values denoting more stringent guidelines on the nature and sources of regulatory capital. *Supervisory power* reflects the right of the supervisory agency to take actions such as forcing banks to change their organizational structures, suspending directors' decisions to distribute dividends, and declaring insolvency, with a higher index implying greater supervisory power. *Deposit insurance* captures each country's explicit deposit insurance regime, with greater values pointing to higher protection of depositors in case of bank default. *Private monitoring* shows the degree to which regulatory and supervisory policies affect the private monitoring of banks; in this case, higher numbers reflect greater incentives for market discipline.

At the country-level, we account for an array of institutional and macroeconomic variables that are likely to influence bank risk-taking. Because there is evidence that greater institutional development contributes to financial stability (Beck et al., 2006; Hesse & Cihák, 2007), the econometric estimations include a composite measure of country-level governance (*institutions*) constructed using the *Worldwide Governance Indicators* (WGI) by Kaufmann et al. (2010).[13]

Because the demand for loans is mostly dependent on macroeconomic factors, the empirical literature has tended to discriminate between loan supply and demand by controlling for the state of the macroeconomic environment (e.g., Altunbas et al., 2014; Ferri et al., 2014). We follow this literature and hold demand-side effects constant by

[10] These bank-specific characteristics also control for differences in business models across shareholder and stakeholder banks (Table 3), alleviating potential concerns that the ownership dummy might capture differences in business models rather than differences in ownership structures.

[11] In additional estimations, we use the Lerner Index as a direct measure of market power, obtained following the approach in Demirgüç-Kunt and Martínez Pería (2010). The results are available upon request.

[12] Details about the specific survey questions used to derive the regulatory variables are available from the authors upon request.

[13] Alternatively, we proxy institutional quality using the *Corruption Perceptions Index* by Transparency International, which scores countries based on how corrupt their public sector is perceived to be. The results are available upon request.

conditioning the model on four macroeconomic variables.[14] We control for the growth rate of real GDP (*GDP growth*) and the annual change in the CPI (*inflation*). Furthermore, we capture developments in stock markets by computing a measure of share price volatility (*volatility*), calculated as the annual average of the daily historical volatility of a country's stock market index.[15] Finally, the empirical setup aims to distinguish the risk-taking channel from the standard "financial accelerator" à la Bernanke et al. (1999). According to Bernanke and Gertler (1995), monetary policy may affect the external finance premium in credit markets via its impact on borrowers' balance sheets (i.e., balance sheet channel). A lower interest rate environment tends to boost borrowers' creditworthiness by reducing their debt payments and increasing their net worth, which in turn may lead to a higher demand for credit in order to support investment and spending. Our empirical setup controls for these demand-side effects by including the annual change in the residential property price index (divided by the GDP deflator) as a measure of the value of borrowers' collateral (*house prices*).[16]

Table S1 in the supporting material reports the correlation coefficients for the explanatory variables, suggesting that multicollinearity is unlikely to affect the parameter estimates.[17]

3.3 | Econometric model

The equation to be estimated has the following functional form:

$$y_{i,k,t} = \alpha + \beta y_{i,k,t-1} + \eta x_{k,t} + \theta x_{k,t} \times z_{i,k} + \lambda W_{i,k,t} + \tau U_{k,t} + \phi_k + \psi_t + \varepsilon_{i,k,t} \quad (2)$$

with $i = 1, \ldots, N$, $k = 1, \ldots, 17$ and $t = 1, \ldots, T$, where N is the number of banks, k is the country, and T is the final year. The risk-taking behavior, $y_{i,k,t}$, for bank i headquartered in country k at time t is proxied by either *risky assets* or *LLPs*.[18] Since evidence is found of a relatively high persistence of risk over time (e.g., Delis & Kouretas, 2011), we include the lagged dependent variable among the regressors.

The variable $x_{k,t}$ is the main measure of monetary policy, namely the overnight interbank rate. In line with the risk-taking channel literature (Borio & Zhu, 2012), we would expect the coefficient η to be negative. The differential effects of interest rates on banks' appetite for risk owing to ownership structure are captured by interacting the monetary policy variable with an ownership dummy, $z_{i,k}$, which equals 1 for stakeholder banks as a group (or for cooperative and savings banks separately) and 0 otherwise.

A potential problem with the inclusion of interaction effects in a multiple regression equation is the multicollinearity between the multiplicative term and its constituents. To address this problem, we mean-center the interest rate variable prior to forming the product term. This approach involves transforming the variable $x_{k,t}$ to deviations from its mean and calculating the product term using these deviations. Besides alleviating multicollinearity issues (Iacobucci et al., 2016), mean-centering facilitates interpretation of the constituent term coefficients, in that they will reflect the conditional effect of one term when the other term is at its raw mean (Burks et al., 2019). Consistent with theoretical predictions, we anticipate the parameter θ to be positive. As central banks loosen monetary conditions, cooperative and savings banks are expected to take on less risk compared with their commercial peers.

[14] Besides separating changes in bank risk that are due to demand rather than supply factors, the inclusion of these demand-side controls allows us to isolate the monetary policy component of interest rate changes (Gambacorta & Mistrulli, 2004).

[15] In unreported regressions, stock market conditions are captured by the annual change in the total return index (divided by the GDP deflator). The results are available upon request.

[16] In alternative specifications, we follow Altunbas et al. (2014) and replace our *volatility* measure with the annual change in real stock market returns for the nonfinancial sector as a proxy for the value of corporates' collateral. The results are not tabulated to save space but are available upon request.

[17] Definitions and sources of all variables used in the analysis are detailed in Appendix A.

[18] As *risky assets* is bounded between 0 and 100, we allow the dependent variable to range from negative to positive infinity by employing its logarithmic transformation (i.e., $\ln[y_{i,k,t}/(100 - y_{i,k,t})]$). Similarly, the credit quality variable is constructed as the natural logarithm of the ratio between loan loss provisions and total loans to reduce the skewness of the *LLPs* distribution.

The bank-specific controls are contained in the vector $W_{i,k,t}$, while $U_{k,t}$ represents the set of industry- and macro-level variables. To account for unobserved country-specific factors and time-varying common shocks (e.g., shifts in credit demand through time) that may influence bank risk-taking, all econometric specifications include country, ϕ_k, as well as time, ψ_t, fixed effects.

The estimation of Equation (2) presents a number of empirical challenges. A major identification limitation when examining the monetary policy–bank risk nexus is that monetary conditions might be endogenous to the risk observed in the banking sector (Jiménez et al., 2014). Within this context, an endogeneity problem can arise if monetary policy actions are also determined by financial stability objectives. This observation might be particularly true since the onset of the financial crisis, as central banks' concerns regarding the financial situation of the banking sector led to a rapid expansion on the set of conventional and unconventional monetary policy measures (Altunbas et al., 2014).

Although one expects endogeneity not to be a major concern in the sample countries prior to the financial crisis, given that their central banks had primarily an inflation-targeting objective, this potential issue can be mitigated further by the use of an appropriate estimation method. From an econometric standpoint, endogeneity implies that the interest rate variable, $x_{k,t}$, may be correlated with the error term, $\varepsilon_{i,k,t}$, thereby biasing our estimates. In addition, the inclusion of the lagged dependent variable on the right-hand side may induce autocorrelation in the residuals and render the ordinary least squares (OLS) estimator biased and inconsistent even if the idiosyncratic errors are not serially correlated (Baltagi, 2013).

To alleviate these concerns and obtain consistent and unbiased estimates of the interplay between monetary policy, ownership structure, and bank risk-taking, we estimate Equation (2) using the system generalized method of moments (GMM) estimator. By building a "stacked" system of equations in both levels and differences, the system GMM allows for unobserved heterogeneity, simultaneity, and the dynamic relationship between dependent and independent variables (Wintoki et al., 2012). Therefore, it ensures the efficiency and consistency of the estimated parameters, provided that there is no second-order serial correlation and that the instrument set is valid. Details about the dynamic panel data estimator employed in this paper are reported in Appendix B.

4 | RESULTS

4.1 | Risky assets

4.1.1 | Full period

Table 4 presents the results of the main empirical estimations when bank risk-taking is proxied by *risky assets*.[19] The results with bank risk-taking measured by *LLPs* are provided in Table 5 and discussed in the next subsection.[20] The Arellano–Bond test for autocorrelation in the errors rejects the presence of second-order serial correlation, *AR*(2), while the Hansen test of overidentifying restrictions confirms the validity of the instrument set.

The coefficient on *overnight rate* for the full period is negative and strongly significant, suggesting that lower interest rates alter the composition of commercial banks' portfolios toward riskier positions. This evidence is consistent with a risk-taking channel that operates via the risk decisions of shareholder banks. The interaction term between monetary policy and the stakeholder bank dummy takes a positive and highly significant coefficient, indicating that the effects of monetary conditions on the riskiness of financial intermediaries are lower for stakeholder banks ($-0.299 + 0.038 = -0.261$). These results offer preliminary support for our initial hypothesis in that banks with alternative ownership structures appear to respond differently to changes in interest rates.

[19] Before running the estimations, we use panel unit-root tests to ensure that the continuous variables included in the model are stationary. The results of Fisher-type (Choi, 2001) tests strongly reject the null hypothesis that all panels contain a unit root.

[20] We consider only the first lag of the dependent variable because the coefficient on the second lag is found to be not statistically significant.

TABLE 4 Main estimations: risky assets

Dependent variable:	*Risky assets*		
	1999–2011	1999–2007	2008–2011
Panel A: Key variables			
Lagged risky assets	0.874***	0.706***	0.553***
	(0.047)	(0.044)	(0.046)
Overnight rate	−0.299***	−0.262***	0.049
	(0.062)	(0.062)	(0.047)
Overnight rate × Stakeholder	0.038***	0.063***	−0.074***
	(0.014)	(0.022)	(0.014)
Central bank assets			0.001
			(0.009)
Central bank assets × Stakeholder			0.017***
			(0.005)
Panel B: Bank-level controls			
Size	0.008	−0.036	0.139**
	(0.031)	(0.035)	(0.068)
Capitalization	−0.008	0.007	−0.022
	(0.008)	(0.011)	(0.013)
Deposits	0.007**	0.007	0.003
	(0.003)	(0.004)	(0.003)
OBS items	0.001	0.003	0.010
	(0.002)	(0.002)	(0.007)
Profitability	−0.153*	−0.410***	0.283***
	(0.091)	(0.104)	(0.082)
Efficiency	−0.020***	−0.040***	0.021***
	(0.007)	(0.007)	(0.005)
Income diversity	−0.087	1.428***	−1.819***
	(0.281)	(0.340)	(0.264)
Panel C: Industry-specific controls			
Concentration	−0.000***	0.000	0.000***
	(0.000)	(0.000)	(0.000)
Activity restrictions	−0.018	0.028	0.064***
	(0.014)	(0.035)	(0.021)
Capital stringency	0.024	−0.047**	0.014
	(0.015)	(0.022)	(0.033)
Supervisory power	0.007	−0.148***	0.020
	(0.010)	(0.031)	(0.021)
Deposit insurance	0.058**	0.124***	−0.060
	(0.024)	(0.026)	(0.069)
Private monitoring	0.014	−0.187***	−0.095*
	(0.022)	(0.034)	(0.053)

(Continues)

TABLE 4 (Continued)

Panel D: Macroeconomic controls			
Institutions	0.180	−0.026	−1.027***
	(0.163)	(0.164)	(0.326)
GDP growth	−0.043***	−0.109***	−0.007
	(0.007)	(0.015)	(0.008)
Inflation	0.017	−0.012	0.003
	(0.011)	(0.018)	(0.016)
Volatility	0.001	−0.030***	−0.005
	(0.002)	(0.006)	(0.004)
House prices	0.003	−0.003	0.013***
	(0.002)	(0.003)	(0.003)
Panel E: Diagnostics			
Country fixed effects	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes
No. of observations	40,256	26,407	13,849
No. of instruments	63	59	58
Wald χ^2 (*p*-Value)	0.000	0.000	0.000
AR(1)	0.000	0.000	0.000
AR(2)	0.162	0.240	0.140
Hansen χ^2 (*p*-Value)	0.139	0.239	0.187

Note: The table presents the results of the main empirical estimations with bank risk-taking proxied by *risky assets*. *Risky assets* is the ratio of risky assets to total assets; *Overnight rate* is the annual average of the daily overnight interbank rate; *Stakeholder* is a dummy that equals 1 for either cooperative or savings banks and 0 otherwise; *Central bank assets* is the ratio of central bank assets to nominal GDP; *Size* is the natural logarithm of real total assets; *Capitalization* is the ratio of equity to total assets; *Deposits* is the ratio of deposits to total liabilities; *OBS items* is the ratio of OBS items to total assets; *Profitability* is the ratio of profit before tax to total assets; *Efficiency* is the ratio of cost to total income; *Income diversity* is a measure of income diversification; *Concentration* is the Herfindahl–Hirschman Index of market concentration; *Activity restrictions* is an index of the extent to which banks can engage in a number of activities; *Capital stringency* is an index of the regulatory oversight of bank capital; *Supervisory power* is an index of the power of the supervisory authority to influence the behavior on the part of banks; *Deposit insurance* is an index of each country's explicit deposit insurance regime; *Private monitoring* is an index of the degree to which regulatory and supervisory policies affect the private monitoring of banks; *Institutions* is a composite measure of country-level governance; *GDP growth* is the annual growth rate of real GDP; *Inflation* is the annual change in the CPI; *Volatility* is the annual average of the daily historical volatility of the country's stock market index; *House prices* is the annual change in the residential property price index (divided by the GDP deflator). All econometric specifications include country as well as time fixed effects. Robust standard errors (clustered at the bank level) are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

With respect to the bank-specific variables, a lower deposits-to-total-liabilities ratio seems to reduce banks' capacity to take on risk, while less profitable but more efficient financial intermediaries tend to have a greater share of assets with non-negligible credit and market risk. By contrast, the results provide no evidence of a statistically significant relationship between other bank-level variables such as *capitalization* or *income diversity* and risky assets. In line with the concentration–stability view (Beck et al., 2006), financial intermediaries in more concentrated markets tend to have lower incentives to take on risk. Support is found for a moral hazard problem induced by explicit deposit insurance while other features of the regulatory environment do not appear to exert a material impact on the overall riskiness of bank portfolios. At the country level, the only variable with a statistically significant coefficient over the

1999–2011 period is *GDP growth*. Consistent with other empirical findings (Lee and Hsieh, 2013), financial intermediaries operating in countries with higher GDP growth hold less risky portfolios.

4.1.2 | Precrisis period

As we noted in Section 3, the last few years covered by the estimations saw the adoption by many central banks of unprecedented actions aimed at restoring financial stability. For this reason, we provide an insight into the functioning of the risk-taking channel during times of financial distress by distinguishing between two periods, namely the years before the outbreak of the crisis (i.e., 1999–2007) and the period after the bankruptcy of Lehman Brothers (i.e., 2008–2011).[21]

The results for the former period largely resemble those for the whole sample period. Lower interest rates are associated with an increase in risky assets by shareholder banks, with the coefficient on *overnight rate* being statistically significant at the 1% level. The impact of looser monetary policy on financial intermediaries' risk-taking is reduced for stakeholder banks as denoted by the positive and highly significant coefficient on the multiplicative term. This evidence is consistent with recent empirical findings (Ferri et al., 2014), according to which the loan supply of stakeholder banks prior to the start of the crisis was less influenced by changing monetary conditions compared with shareholder banks.

Again, we find that banks with lower profitability but greater efficiency have riskier balance sheets whereas the coefficient on *deposits* becomes insignificant over the precrisis period. As indicated by other studies (Hesse & Cihák, 2007), the results for the years prior to the crisis also show that higher income diversity tends to be associated with increased bank risk. At the industry level, greater stringency in terms of capital regulations, power of the supervisory authority, and market discipline seem to be effective in limiting the risk-taking incentives of banks while further support is provided for a risk-shifting effect associated with deposit insurance. Compared with the full period, market concentration is no longer important in explaining differences in banks' appetite for risk. Moreover, the results for the 1999–2007 period confirm that improved macroeconomic conditions, as captured by faster GDP growth, reduce the overall riskiness of bank portfolios. In accordance with theoretical predictions (Paligorova & Santos, 2017), there is evidence that lower stock market volatility offers financial intermediaries incentives to take on additional risk.

4.1.3 | Crisis period

Turning to the crisis period, we note several striking results. The coefficient on the *overnight rate* is insignificant, implying that a risk-taking channel is no longer operative for shareholder banks. This finding is not surprising, as the havoc wrought by the financial turmoil resulted in a marked increase in risk aversion and a widespread seizure of liquidity in financial markets (Acharya et al., 2009). In contrast, we find that standard monetary policy is still effective at influencing the composition of stakeholder banks' portfolios, as captured by the negative and highly significant coefficient on the interaction term between *overnight rate* and *stakeholder*. In showing that stakeholder banks' risk appetite varies less with interest rates than does that of shareholder banks, this evidence is consistent with the literature that points to a less cyclical behavior by stakeholder banks (e.g., Meriläinen, 2016, 2019).

To account for the effects of unconventional monetary policy on the functioning of the risk-taking channel, we add the ratio of central bank assets to GDP (*central bank assets*) and its interaction with the stakeholder bank dummy. The coefficient on *central bank assets* is positive but statistically insignificant, suggesting that nonstandard monetary policy plays a limited role in counteracting the shift by shareholder banks toward riskless assets. The interaction term reveals

[21] The validity of splitting the sample around 2008 is tested by replacing the vector of time fixed effects in the full-period estimates with a dummy variable that equals 1 for the crisis years and 0 otherwise. The coefficient on the dummy is strongly significant, possibly suggesting differences in the operation of the risk-taking channel between the crisis and noncrisis periods.

that the expansion of central bank assets is associated with a change in portfolio composition only for stakeholder banks. Similar evidence of a positive relationship between unconventional monetary policy measures and risky assets is put forward by Lambert and Ueda (2014) who consider US banks' balance sheet data after the start of the crisis and find that the ratio of risk-weighted assets to total assets tends to increase as central bank assets expand. Lambert and Ueda (2014) show that an expansion in central banks' balance sheets may also delay loss provisioning on existing loans, as discussed in more detail in Section 4.2.

Concerning the bank-level controls, we observe that larger financial intermediaries exhibit a greater exposure to asset risk. Contrary to the precrisis period, the results for the crisis years indicate that more profitable but less efficient banks are more likely to engage in risk-taking. The coefficient on *income diversity* turns negative in the years following the bankruptcy of Lehman Brothers, implying that more diversified banks responded to the reduced opportunities for income diversification in the aftermath of the crisis by decreasing the riskiness of their loan portfolios. Consistent with this observation, we find that financial intermediaries operating in banking systems characterized by greater regulatory restrictions on nonlending activities hold more assets with non-negligible credit and market risk. The results for the crisis period also provide evidence of a positive relationship between *concentration* and bank risk-taking, possibly reflecting a moral hazard problem caused by "too-big-to-fail" policies since the onset of the crisis (Mishkin, 1999).

Turning to the macroeconomic environment, the coefficients on *GDP growth* and *volatility* lose their significance when examined over the crisis period. In addition, we establish that the deterioration of a country's institutional environment that was observed in a number of economies after the outbreak of the crisis, captured by a drop in the *institutions* variable from 1.38 in 2006 to 1.31 in 2011, resulted in an increase in risky assets. The same conclusion cannot be drawn for the precrisis period, during which there is no evidence of an economically and statistically significant relationship between country-level institutions and the riskiness of the banking sector.[22] The results also reveal that the fall in house prices in the aftermath of the crisis led to a decrease in the share of risky assets in bank portfolios, suggesting that borrowers had to reduce their demand for credit as a consequence of their lower net worth.

4.2 | Loan loss provisions

4.2.1 | Full period

The results of Table 5, where bank risk-taking is proxied by *LLPs*, confirm and qualify the results based on *risky assets*. Over the full period, lower interest rates increase credit risk-taking by both shareholder and stakeholder banks, with this effect being more pronounced for shareholder banks. The results for the bank-level controls show that better capitalization is associated with higher credit quality whereas greater diversification across income sources translates into higher credit risk-taking. In turn, the regulatory environment has a bearing on banks' credit risk, yet at varying degrees. While the stringency of capital regulations is negatively linked to our measure of credit risk, greater power of the supervisory authority and stronger market discipline seem to encourage more loan loss provisioning by financial intermediaries. Concurrently, credit risk-taking is curtailed by faster rates of inflation, more volatile stock markets, and higher values of borrowers' collateral.

4.2.2 | Precrisis period

The moderating role of stakeholder banks with respect to the risk-taking channel is corroborated by the results for the precrisis period during which the credit risk decisions of stakeholder banks are found to be less affected by changes in interest rates. Less concentrated markets are likely to increase credit risk-taking by financial intermediaries while a

[22] A potential explanation for the result on the institutions–bank risk nexus is that our sample covers 17 Western European countries that are among the most financially and industrially developed economies in the world. These countries tend to be characterized by a strong institutional environment, which remained by-and-large stable in the years before the crisis (the mean value of the *institutions* variable over the 1999–2007 period is 1.38).

TABLE 5 Main estimations: loan loss provisions

Dependent variable:	*LLPs*		
	1999–2011	1999–2007	2008–2011
Panel A: Key variables			
Lagged LLPs	0.622***	0.306***	0.417***
	(0.100)	(0.117)	(0.153)
Overnight rate	−0.007***	−0.009***	−0.002
	(0.002)	(0.004)	(0.002)
Overnight rate × Stakeholder	0.002***	0.002**	0.001**
	(0.000)	(0.001)	(0.001)
Central bank assets			0.000
			(0.000)
Central bank assets × Stakeholder			−0.001***
			(0.000)
Panel B: Bank-level controls			
Size	−0.001	−0.001	−0.001
	(0.001)	(0.001)	(0.002)
Capitalization	−0.002***	0.000	−0.002***
	(0.000)	(0.000)	(0.001)
Deposits	0.000**	0.000	0.000**
	(0.000)	(0.000)	(0.000)
OBS items	−0.000	−0.000	−0.001***
	(0.000)	(0.000)	(0.000)
Profitability	0.001	−0.010***	0.008*
	(0.002)	(0.003)	(0.005)
Efficiency	0.000	−0.001***	0.000*
	(0.000)	(0.000)	(0.000)
Income diversity	0.039***	0.031***	0.007
	(0.008)	(0.011)	(0.007)
Panel C: Industry-specific controls			
Concentration	−0.000***	−0.000**	−0.000
	(0.000)	(0.000)	(0.000)
Activity restrictions	0.001	−0.001*	−0.003***
	(0.000)	(0.001)	(0.001)
Capital stringency	−0.002***	0.001	−0.000
	(0.000)	(0.001)	(0.001)
Supervisory power	0.001**	−0.003**	0.002**
	(0.000)	(0.001)	(0.001)
Deposit insurance	0.002**	0.001	−0.003
	(0.001)	(0.001)	(0.003)
Private monitoring	0.004***	−0.005**	0.001
	(0.001)	(0.002)	(0.002)

(Continues)

TABLE 5 (Continued)

Panel D: Macroeconomic controls			
Institutions	−0.002	0.004	−0.043***
	(0.005)	(0.003)	(0.015)
GDP growth	−0.000	−0.001**	0.000
	(0.000)	(0.001)	(0.000)
Inflation	−0.001***	−0.001*	0.000
	(0.000)	(0.000)	(0.001)
Volatility	−0.001***	−0.000*	−0.001***
	(0.000)	(0.000)	(0.000)
House prices	−0.000***	−0.000***	−0.001***
	(0.000)	(0.000)	(0.000)
Panel E: Diagnostics			
Country fixed effects	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes
No. of observations	38,414	25,024	13,390
No. of instruments	63	59	58
Wald χ^2 (*p*-Value)	0.000	0.000	0.000
AR(1)	0.000	0.000	0.000
AR(2)	0.514	0.947	0.994
Hansen χ^2 (*p*-Value)	0.102	0.279	0.190

Note: The table presents the results of the main empirical estimations with bank risk-taking proxied by *LLPs*. *LLPs* is the ratio of loan loss provisions to total loans; *Overnight rate* is the annual average of the daily overnight interbank rate; *Stakeholder* is a dummy that equals 1 for either cooperative or savings banks and 0 otherwise; *Central bank assets* is the ratio of central bank assets to nominal GDP; *Size* is the natural logarithm of real total assets; *Capitalization* is the ratio of equity to total assets; *Deposits* is the ratio of deposits to total liabilities; *OBS items* is the ratio of OBS items to total assets; *Profitability* is the ratio of profit before tax to total assets; *Efficiency* is the ratio of cost to total income; *Income diversity* is a measure of income diversification; *Concentration* is the Herfindahl–Hirschman Index of market concentration; *Activity restrictions* is an index of the extent to which banks can engage in a number of activities; *Capital stringency* is an index of the regulatory oversight of bank capital; *Supervisory power* is an index of the power of the supervisory authority to influence the behavior on the part of banks; *Deposit insurance* is an index of each country's explicit deposit insurance regime; *Private monitoring* is an index of the degree to which regulatory and supervisory policies affect the private monitoring of banks; *Institutions* is a composite measure of country-level governance; *GDP growth* is the annual growth rate of real GDP; *Inflation* is the annual change in the CPI; *Volatility* is the annual average of the daily historical volatility of the country's stock market index; *House prices* is the annual change in the residential property price index (divided by the GDP deflator). All econometric specifications include country as well as time fixed effects. Robust standard errors (clustered at the bank level) are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

stricter regulatory environment in terms of scope of banking operations, power of the supervisory agency, and private monitoring tends to reduce credit risk. The results for the years before the crisis also confirm that a boost in house prices raises the value of borrowers' collateral and improves credit quality.

4.2.3 | Crisis period

Consistent with the results for *risky assets*, the estimations for the crisis period indicate that standard monetary policy has an impact only on the risk behavior of stakeholder banks. However, Table 5 reports an opposite sign on the interaction term between *overnight rate* and *stakeholder*, implying that stakeholder banks responded to the extremely

low interest rate environment following the collapse of Lehman Brothers by increasing the share of risk-related assets in their portfolios (Table 4) and delaying their loan loss provisioning (the same pattern is reproduced in Tables S2–S9 in the supplementary material). This result suggests that the accommodative monetary policy in the aftermath of the crisis might have boosted borrowers' creditworthiness and reduced the need for stakeholder banks to add to their loan loss reserves.[23] By contrast, it is possible that the rapid expansion of shareholder banks' balance sheets prior to the crisis, exemplified by a 6% increase in the average share of risky assets held in their portfolios between 1999 and 2007 against a 1% increase for stakeholder banks, left them with a plethora of poor quality assets that were little if at all affected by the decrease in interest rates in the aftermath of the crisis.[24] Alternatively, the delay in loan loss provisioning could be taken as evidence of income-smoothing on the part of stakeholder banks in an effort to restore their profitability, which was weakened by the prolonged period of low interest rates. Although profit maximization is not their ultimate goal, profitability is central to stakeholder banks' business model in that retained earnings constitute their primary source of capitalization, as opposed to shareholder banks, which generally face fewer obstacles in raising capital (Llewellyn, 2017). By delaying provisions for loan losses, stakeholder banks might have thus sought to preserve their ability to build up capital at a time of financial distress.[25]

Similarly, nonstandard monetary policy is found to influence credit risk-taking only for stakeholder banks, with an increase in central bank assets leading to a decline in their loan loss provisioning. The opposite sign on the interaction term between *central bank assets* and *stakeholder* compared with Table 4, confirmed by Tables S2–S9 in the supplementary material, is consistent with Lambert and Ueda (2014), who show that an expansion in central banks' balance sheets may delay loss provisioning on existing loans while increasing risky assets. According to Lambert and Ueda (2014), there are two possible explanations for the negative relationship between unconventional monetary policy and loan loss provisions. First, banks' incentives to engage in "loan evergreening" practices, whereby banks rollover existing loans or issue new loans to troubled borrowers to prevent them from becoming nonperforming, may be higher within a context of highly accommodative monetary policy. Alternatively, unconventional monetary policy may support economic activity and improve borrowers' creditworthiness, which in turn may lead banks to decrease their loan loss provisioning. Therefore, it is possible that nonstandard monetary policy reinforced the positive impact of lower interest rates in the aftermath of the crisis on the quality of stakeholder banks' portfolios while such impact was not observed for shareholder banks due to their holding of poor quality assets that were marginally if at all affected by unconventional monetary policy. A third explanation that is plausible within the context of our research refers to stakeholder banks' expectations about the effects of nonstandard monetary policy on their profitability. Insofar as stakeholder banks were concerned that nonstandard monetary policy measures, such as quantitative easing, would have flattened the yield curve and reduced their net interest income, they might have postponed provisions for loan losses to maintain their ability to accumulate capital through retained earnings.

Looking at the control variables for the crisis period, we see evidence that financial intermediaries with a higher share of deposits to total liabilities have a higher credit risk exposure whereas *capitalization* and *OBS items* are negatively associated with *LLPs*. At the industry level, we qualify the results based on *risky assets* by showing that banks sought to alleviate the potentially negative effects of greater activity restrictions on their profitability, which was already under pressure due to the outbreak of the crisis and the ensuing extremely low interest rate environment, by delaying loan loss provisioning. This evidence points to income-smoothing in the form of provisions for loan losses by Western European banks in the aftermath of the crisis. We also find that this effect was at least in part offset by the decline in house prices, which diminished the value of borrowers' collateral and resulted in an increase in loan loss provisions by banks to address the deterioration in credit quality.

[23] The average ratio of loan loss provisions to total loans for stakeholder banks decreased from 0.69% in the precrisis period to 0.53% in the crisis period.

[24] We wish to thank an anonymous reviewer for pointing this out.

[25] The average ratio of equity-to-total assets of stakeholder banks increased by 8% between the precrisis and crisis periods (compared with a 3% increase for shareholder banks).

4.3 | Robustness tests

To evaluate the robustness of the results, we perform the following tests: (1) we split stakeholder banks into cooperative and savings banks; (2) we include loans and advances to banks in the definition of risky assets; (3) we replace the *risky assets* and *LLPs* proxies with the *Z-score* as an alternative measure of bank riskiness; (4) we quantify conventional monetary policy using the central bank's official rate (*central bank rate*) instead of the overnight interbank rate; (5) we exclude banks that are listed on the stock exchange;[26] (6) we drop banks that are ultimately owned by the government or another public authority; and (7) we run the analysis on a smaller sample that excludes German banks as they dominate the sample. The results of these tests are presented in Tables S2–S9 in the supplementary material. The coefficients on the variables of interest are similar to those reported in Tables 4 and 5, leaving our findings qualitatively unchanged.

5 | CONCLUSIONS

Recent years have witnessed a revived interest in the far-reaching effects of bank risk-taking on financial stability and economic performance. This paper contributes to a better understanding of how financial intermediaries' appetite for risk is influenced by the monetary conditions prevailing in the economy. Theory suggests that a key determinant of firms' risk-taking is their ownership structure, which ultimately impacts the extent to which multiple stakeholder claims find recognition alongside those by shareholders. By building a large panel of commercial, cooperative, and savings banks across Western Europe, we find robust evidence that heterogeneity of ownership types accounts for a differential impact of monetary policy on financial intermediaries' risk-taking.

While the risk-taking channel is shown to be operative for both shareholder- and stakeholder-oriented banks, the results indicate that the effects of lower interest rates on bank risk are greater for shareholder banks. Comparison of the analyses before and after the onset of the global financial crisis shows that these results are driven by the years prior to the bankruptcy of Lehman Brothers, during which commercial banks are found to adjust the riskiness of their portfolios to changes in interest rates more actively than cooperative and savings banks. The results for the period since the outbreak of the crisis highlight that standard monetary policy is no longer effective in changing the proportion of risk-related assets held by shareholder banks, possibly as a consequence of the sharp increase in risk aversion and the average loss of trust in counterparties brought about by the market turmoil. Conversely, we find that stakeholder banks responded to the accommodative monetary policy in the aftermath of the crisis by continuing to adjust the share of risky assets in their portfolios along with their loan loss provisioning. The observed reaction of stakeholder banks to the unprecedented set of conventional and unconventional monetary policy measures points to fewer procyclical risk-taking policies on the part of cooperative and savings banks relative to their commercial peers.

These results feed into an intense academic and policy debate over the causes of the 2008 crisis. Our evidence concurs with the increasing role of monetary authorities on macroprudential regulation and supervision, as epitomized by the creation under the responsibility of the European Central Bank (ECB) of the European Systemic Risk Board (ESRB) in late 2010. In addition, this study finds that the heterogeneity of ownership types in the European banking sector is important in explaining the effects of monetary policy on bank risk-taking. Therefore, the findings call for a closer monitoring of the ownership composition of the banking sector when setting monetary policy, as bank ownership is shown to influence the functioning of the risk-taking channel. Such monitoring may be particularly important for the euro area as it recovers from the COVID-19 pandemic, in that dissimilarities across countries may account for a differential impact of the common monetary policy on financial and economic outcomes.

The results presented in this paper could be extended in a number of important ways. First, future research might examine how various features of financial intermediaries' ownership structures (e.g., concentrated ownership)

[26] Although most of the banks included in the sample are not publicly quoted, over 13% of shareholder banks are listed on the stock exchange. This group of banks accounts for the overwhelming majority of total assets held by shareholder banks in the sample.

influence the functioning of the risk-taking channel. Second, efforts could be directed at examining the impact that conversion of financial cooperatives to joint-stock banks has on their risk appetite and ensuing response to fluctuations in monetary policy. To this end, one might consider a smaller sample of depository institutions than the sample built in this study and construct time-varying proxies for bank ownership. Third, a fruitful line of inquiry could be to extend the results of this research by developing measures capturing the ownership composition of the banking sector that might serve as valuable instruments for monetary authorities and other banking regulators. We are currently working on this major endeavor.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

DATA AVAILABILITY STATEMENT

Additional material is available in the Supporting Information section online.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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APPENDIX A: VARIABLE DEFINITIONS AND SOURCES

Table A1

TABLE A1 Variable definitions and sources

Variable	Definition	Source
Bank risk-taking		
Risky assets	Ratio of risky assets to total assets. Risky assets are calculated as the difference between total assets and the sum of loans and advances to banks, government securities, and cash.	Bankscope; authors' calculations
LLPs	Ratio of loan loss provisions to total loans. Loans are defined as residential mortgage loans, other mortgage loans, other consumer loans, corporate and commercial loans, and other loans minus reserves for loan losses.	Bankscope; authors' calculations
Z-score	$\ln[\frac{\mu(ROA)+CAR}{\sigma(ROA)}]$.	Bankscope; authors' calculations
Monetary policy		
Overnight rate	Annual average of the daily overnight interbank rate.	Datastream; national data; authors' calculations
Central bank rate	Annual average of the daily central bank rate.	Datastream; IFS; authors' calculations
Central bank assets	Ratio of central bank assets to nominal GDP. For the Norges Bank, central bank assets are computed as the difference between total assets and investments in the *Government Pension Fund Global*.	National data; IFS; authors' calculations
Ownership structure		
Stakeholder	Dummy that equals 1 for either cooperative or savings banks and 0 otherwise.	Bankscope; authors' calculations
Cooperative	Dummy that equals 1 for cooperative banks and 0 otherwise.	Bankscope; authors' calculations
Savings	Dummy that equals 1 for savings banks and 0 otherwise.	Bankscope; authors' calculations
Bank-level controls		
Size	Natural logarithm of total assets (divided by the GDP deflator).	Bankscope; WDI; authors' calculations
Capitalization	Ratio of equity to total assets.	Bankscope; authors' calculations
Deposits	Ratio of deposits to total liabilities. Deposits include total customer deposits, deposits from banks, and other deposits and short-term borrowings.	Bankscope; authors' calculations

(Continues)

TABLE A1 (Continued)

Variable	Definition	Source
OBS items	Ratio of OBS items to total assets.	Bankscope; authors' calculations
Profitability	Ratio of profit before tax to total assets.	Bankscope; authors' calculations
Efficiency	Ratio of overheads to total operating income.	Bankscope; authors' calculations
Income diversity	$1 - \lvert \frac{\text{Net interest income} - \text{Other operating income}}{\text{Total operating income}} \rvert$.	Bankscope; authors' calculations
Industry-specific controls		
Concentration	Herfindahl–Hirschman Index of market concentration. The index is calculated as the sum of squared market shares of all banks in the country in terms of total assets.	Bankscope; authors' calculations
Activity restrictions	Index that captures the extent to which national regulations restrict banks from engaging in: (1) securities activities, (2) insurance activities, (3) real estate activities, and (4) ownership of nonfinancial firms.	BRSS; Barth et al. (2001, 2004, 2006, 2012); authors' calculations
Capital stringency	Index that measures the stringency of regulatory capital requirements.	BRSS; Barth et al. (2001, 2004, 2006, 2012); authors' calculations
Supervisory power	Index that proxies for the power of the supervisory authority to influence the behavior on the part of banks.	BRSS; Barth et al. (2001, 2004, 2006, 2012); authors' calculations
Deposit insurance	Index that describes the explicit deposit insurance regime adopted in the country.	BRSS; Barth et al. (2001, 2004, 2006, 2012); authors' calculations
Private monitoring	Index that quantifies the incentives for private investors to monitor and exert effective governance over banks.	BRSS; Barth et al. (2001, 2004, 2006, 2012); authors' calculations
Macroeconomic controls		
Institutions	Simple average of six country-level governance indicators, namely "voice and accountability," "political stability and absence of violence," "government effectiveness," "regulatory quality," "rule of law," and "control of corruption."	WGI; Kaufmann et al. (2010); authors' calculations
GDP growth	Annual growth rate of real GDP.	WDI
Inflation	Annual change in the CPI.	WDI
Volatility	Annual average of the daily historical volatility of the country's stock market index with a 30-day window.	Bloomberg; authors' calculations
House prices	Annual change in the residential property price index (divided by the GDP deflator).	BIS; ECB; WDI; authors' calculations

Note: BRSS is the *Bank Regulation and Supervision Survey* by the World Bank (Barth et al., 2001, 2004, 2006, 2012); IFS are the *International Financial Statistics* by the IMF; WDI are the *World Development Indicators* by the World Bank; WGI are the *Worldwide Governance Indicators* by the World Bank (Kaufmann et al., 2010).

APPENDIX B: ESTIMATION METHOD

This paper uses the system generalized method of moments (GMM) estimator that was introduced by Holtz-Eakin et al. (1988) and Arellano and Bond (1991) and further developed by Arellano and Bover (1995) and Blundell and Bond (1998). The system GMM is preferred over the difference GMM due to the improvement in efficiency when the autoregressive parameter is particularly high and the time series dimension of the underlying data is moderately small (Blundell & Bond, 1998). Unlike the difference GMM, the system GMM also allows for time-constant unobserved effects (i.e., country fixed effects, ϕ_k, in Equation 2) to be included.

The dynamic panel GMM estimator reduces the endogeneity bias that might affect the estimation of the regression parameters by relying on a set of "internal instruments," that is, instruments based on lagged values of the explanatory variables (Levine et al., 2000). In line with Arellano and Bover (1995) and Blundell & Bond (1998), it is possible to distinguish three types of variables: (1) endogenous variables, which are correlated with both current and past realizations of the error; (2) predetermined variables, which are independent of contemporaneous disturbances but can be influenced by past ones; and (3) exogenous variables, which are uncorrelated with the error term. In the system GMM, endogenous and predetermined (but not strictly exogenous) variables are instrumented by their own lags in levels in the first-difference equation and by their lagged first differences in the level equation (i.e., GMM-style instruments) while strictly exogenous regressors are instrumented by themselves (i.e., IV-style instruments). This approach generates a system of equations that takes the following form:

$$\begin{bmatrix} y_{i,k,t} \\ \Delta y_{i,k,t} \end{bmatrix} = \alpha + \beta \begin{bmatrix} y_{i,k,t-1} \\ \Delta y_{i,k,t-1} \end{bmatrix} + \eta \begin{bmatrix} x_{k,t-j} \\ \Delta x_{k,t-j} \end{bmatrix} + \theta \begin{bmatrix} x_{k,t-j} \times z_{i,k} \\ \Delta x_{k,t-j} \times z_{i,k} \end{bmatrix} + \lambda \begin{bmatrix} W_{i,k,t-j} \\ \Delta W_{i,k,t-j} \end{bmatrix} + \tau \begin{bmatrix} U_{k,t-j} \\ \Delta U_{k,t-j} \end{bmatrix} + \phi_k + \psi_t + \varepsilon_{i,k,t} \quad (3)$$

where j is the number of lags. Besides the lagged dependent variable and the monetary policy variables, we treat as endogenous all bank-specific characteristics with the exception of *size*. Therefore, for endogenous variables, their second and longer lags are available as instruments, while for variables that are predetermined but not strictly exogenous, the first and longer lags can be employed. We consider as predetermined *size* and the set of regulatory indices, ruling out correlation with contemporaneous disturbances but not feedbacks from past shocks. This treatment implies that banks observe their size and the regulatory environment when deciding on their optimal level of risk exposure. It is also generally acknowledged that size, together with other balance sheet quantities, is often difficult or costly for banks to adjust in the short term (Bassett et al., 2020), suggesting that it might be affected by bank risk at least with a lag.[27] To avoid overfitting, the proxy for market concentration and all macroeconomic controls are taken as exogenous.

We verify the validity of the instrument set by conducting two main diagnostic tests that are standard after GMM estimation. The first test is the Arellano–Bond test for autocorrelation of order two, $AR(2)$, in the idiosyncratic disturbance term, $\upsilon_{i,k,t}$, where the null hypothesis is that there is no second-order correlation in the residuals in differences. While autocorrelation of order one, $AR(1)$, is expected in differences due to $\Delta\upsilon_{i,k,t}$ being mathematically related to $\Delta\upsilon_{i,k,t-1}$ (Roodman, 2009), second-order correlation in differences would make some lags invalid as instruments. The second test is the Hansen test of overidentifying restrictions, with the null hypothesis that the instruments are orthogonal to the error term (i.e., they are exogenous). The validity of the instruments is confirmed if one fails to reject the null hypothesis for both tests.

Following Roodman (2009), we prevent instrument proliferation by using a collapsed instrument matrix and limiting lag depth.[28] We use the two-step estimator with Windmeijer (2005) finite-sample corrected standard errors clustered by bank.

[27] A similar treatment of endogenous and predetermined variables in risk equations can be found in Conlon et al. (2020) and Delis & Kouretas (2011). Further support for the treatment of bank size as a predetermined variable within a dynamic panel GMM estimation is provided by Beltratti and Paladino (2015) and Danisman and Tarazi (2020).

[28] Regressions are performed using the *xtabond2* command in Stata. The *collapse* option indicates that *xtabond2* should create one instrument for each variable and lag distance instead of one for each time period, variable, and lag distance.

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