BRITISH JOURNAL of MANAGEMENT
BRITISH ACADEMY OF MANAGEMENT
Check for updates
British Journal of Management, Vol. 34, 2334–2353 (2023)
DOI: 10.1111/1467-8551.12708

Internally-Assessed Bank Capital Requirements and Loan Portfolio Spreads

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How the choice of more risk-sensitive capital requirements by some banks influences average borrowing costs for their customers remains an open question. By exploiting cross-country manually collected capital requirement data, we find higher portfolio loan spreads in banks that compute a larger share of these requirements for the loan portfolio through internal rating-based (IRB) models. This result is driven by larger IRB adopters operating in credit markets with low competition from banks computing capital requirements with the less risk-sensitive standardized models, by IRB adopters in credit markets where borrowers have more limited funding opportunities, and by IRB adopters in markets characterized by lower levels of political connectedness. Our results contrast with theoretical predictions suggesting that the heterogeneity in risk weights induced by IRB models should reduce average borrowing costs for bank customers. Instead, we show that IRB adopters do not fully incorporate the decrease in capital requirements obtained with these models into their pricing policies when competitive and political pressures are low.

Introduction

It is a widely held view that the level of riskiness underlying managerial decisions will affect the realized profitability (Delis, Hasan and Tsionas, 2015). In the context of banks, managerial decisions are influenced, among other things, by the applicable capital regulation (Ayadi *et al.*, 2021). Depending on how risk-sensitive the regulatory framework is, bank managers might apply different business strategies, possibly achieving different performance outcomes (Nguyen, Nguyen and Sila, 2019). With this paper, we are the first to uncover how the use of more sensitive methodologies to assess credit risk, by some banks, influences their lending spreads, and how this relationship varies depending on the type of banking system and the level of political connectedness.

The presence of regulations that link bank capital to lending risk with the purpose of ensuring bank stability is a key peculiarity of the banking industry (Berger and Bouwman, 2013). Since the adoption in 2006 of the revised regulatory framework known as Basel II, banks can use internal rating-based (IRB) models to quantify their capital requirements for the loan portfolio. With these models, banks estimate the probability of default (PD) of each borrower and, often, other credit risk parameters.[1]

The general consensus emerging from previous studies is that IRB models reduce the capital requirements of a bank and increase the heterogeneity of the requirements that a bank applies across different borrowers (Abbassi and Schmidt, 2018; Behn, Haselmann and Wachtel, 2016; Benetton, 2021; Glancy and Kurtzman, 2022; Plosser and Santos, 2018). Theoretical studies suggest that we should then potentially observe a decrease in the loan portfolio spread of banks opting for IRB models (Repullo and Suarez, 2004; Ruthenberg and Landskroner, 2008). This decrease materializes if the heterogeneity in capital requirements generated by IRB models (namely,

[1]We provide an extensive institutional background in Section A of the Online Appendix.

penalizing riskier borrowers and rewarding safer ones) is properly priced in lending contracts and if competitors in the credit market employ the less risk-sensitive standardized approach to quantify capital requirements. Ultimately, a bank's average margins should decrease with the use of IRB models, signalling a reduction in average borrowing costs (Repullo and Suarez, 2004).

In this paper we test the empirical validity of the above theoretical arguments. To this end, we offer the first analysis on how IRB models are associated with the spread of the loan portfolio of IRB adopters relative to non-adopting banks and document how this association is influenced by the competitive pressure from standardized banks, by the type of lending relationship and by the level of political connectedness.[2] Our study enhances, therefore, our understanding of whether IRB models matter for bank performance and of the potential business consequences of regulatory restrictions introduced from 2022 on their use (see Basel Committee on Banking Supervision, 2017; EBA, 2019; Federal Register, 2014).

We conduct our analysis using a unique cross-country dataset covering the period from 1992 to 2016, including 2,191 banks located in 40 high-income countries. From the year of the adoption of Basel II in each country, and for each bank, we manually collect information on the use of the IRB approach and measure the relative importance of this approach in quantifying a bank's capital requirements for credit risk. Therefore, differently from previous cross-country studies on IRB adopters (Beltratti and Paladino, 2016; Cucinelli *et al.*, 2018; Mariathasan and Merrouche, 2014; Vallascas and Hagendorff, 2013), our focus is on measuring the share of risk-weighted assets (RWAs) of credit exposures computed using IRB models (over the total RWAs for credit risk, which can be computed using both the standardized approach and the IRB methodologies). We term this ratio 'IRB Intensity' and use it to capture how *intensively* our sampled banks employ IRB models to quantify the credit risk used to comply with regulatory objectives.

In the theoretical arguments that postulate an impact of IRB models on the loan portfolio spread, high-risk borrowers should avoid credit relationships with IRB banks, as they can obtain cheaper credit from standardized banks, while safer borrowers would obtain cheaper funding from IRB banks compared to the previous regulatory regime. From this perspective, we should empirically observe lower capital requirements for IRB banks compared to Basel I and an improvement of the quality of their loan portfolio. Examining if this is the case in our sample, we document that IRB models indeed reduce capital requirements, but we only find partial evidence indicating that this effect is associated with an improvement in loan portfolio quality.

We next move to our main focus and examine whether the reduced capital requirements achieved by IRB banks decrease the loan portfolio spread because of lower average borrowing costs for bank customers. We estimate panel data models based on conventional analyses on the determinants of a bank's loan portfolio spread (defined as in Abedifar, Molyneux and Tarazi, 2018), with the addition of our measure of how much banks intensively employ IRB models. Against the theoretical priors discussed previously, we find that as banks rely more heavily on IRB models to compute the capital requirements for credit risk, the spread of the loan portfolio increases and does not decrease. Our key conclusion holds under a number of alternative settings and is robust to endogeneity. We then provide several tests to understand the rationale behind the positive association between spread and IRB Intensity.

Overall, our empirical findings reveal that the introduction of more risk-sensitive capital requirements has affected banks' business management, with a consequent improvement of banks' lending spreads as banks rely more heavily on IRB models for regulatory purposes. The significant reduction of capital requirements for IRB adopters could potentially be due to a strategic use of risk-based models, namely IRB banks underestimating their risk exposures in an attempt to save capital (Begley, Purnanandam and Zheng, 2017; Colliard, 2019). Although the enhancement of banks' profitability is usually desirable from a regulatory standpoint (being suggestive of bank viability), if this is achieved via risk under-reporting, then our results are supportive of regulatory interventions aimed at mitigating banks' discretion in

[2]We use the phrase 'standardized banks' or 'SA adopters' to indicate banks exclusively adopting the standardized approach (SA) to quantify the capital requirements for credit risk. Those adopting (at least in part) IRB models are termed 'IRB adopters' or 'IRB banks'.

determining their RWAs. The phased-in implementation of Basel III reforms – ultimately aimed at restoring reliability in the calculation of RWAs and enhancing the comparability of banks' capital ratios – should be leaning towards this outcome. However, the implications of such changes for a bank's performance are not easily predictable. Indeed, it might well be that IRB banks will still be able to charge borrowers with higher spreads – despite the mitigated risk-sensitivity of capital requirements – if they hold a dominant position in the lending market and do not face political pressures.

Our paper contributes to recent work highlighting the importance of within-bank heterogeneity of risk weights for the pricing decisions of IRB banks in certain lending categories (Benetton, 2021; Benetton *et al.*, 2021; Glancy and Kurtzman, 2022). The consensus is that higher risk weights lead to more penalizing pricing decisions in line with models where the additional costs due to increased capital requirements are somehow charged to borrowers since equity is a more expensive funding source for banks. We expand this work by looking at the implications of risk-weight heterogeneity across banks competing for the same borrowers and in the presence of potential frictions in the way borrowers and lenders match. To this end, we build on the theoretical work of Repullo and Suarez (2004) and Ruthenberg and Landskroner (2008).

Finally, and more generally, our study is linked to the literature on IRB models and bank behaviour. This literature focuses on the impact of these models on the regulatory risk weights and regulatory capital (Beltratti and Paladino, 2016; Mariathasan and Merrouche, 2014; Plosser and Santos, 2018; Vallascas and Hagendorff, 2013) and highlights the procyclicality issues arising from their adoption (Behn, Haselmann and Wachtel, 2016; Repullo and Suarez, 2013). Different from our analysis, none of these studies offers evidence on whether the use of the IRB models results in any effect for the risk–return trade-off in the traditional intermediation function of a bank, despite this trade-off being closely related to how banks manage their exposure to credit risk.

Literature and hypotheses

Several empirical studies have highlighted how within-bank variation in risk weights generated by the use of IRB models affect loan rates (Benetton *et al.*, 2021) or loan volumes (Behn, Haselmann and Wachtel, 2016; Fraisse, Lé and Thesmar, 2020). It is a widely held view that borrowers with higher capital requirements are required to pay higher borrowing costs (Benetton, 2021; Benetton *et al.*, 2021; Glancy and Kurtzman, 2022). This finding can be explained using models where equity is a more expensive funding source for banks and the additional costs due to capital requirements are charged to borrowers (Kashyap, Stein and Hanson, 2010; Slovik and Cournède, 2011).

The effect of IRB models on the heterogeneity of risk weights is at the core of theoretical frameworks on how these models influence the loan portfolio spread (Repullo and Suarez, 2004; Ruthenberg and Landskroner, 2008) and the distribution of market shares between large and small banks in the lending market (Hakenes and Schnabel, 2011). The influence is due to the higher risk sensitivity of IRB models compared to standardized models that should result in an increase in price discrimination across borrowers, with higher rates applied to riskier borrowers and lower rates to safer ones, with implications for bank–borrower matching (Repullo and Suarez, 2004; Ruthenberg and Landskroner, 2008).

Specifically, in the model of Repullo and Suarez (2004), based on a perfectly competitive credit market, riskier borrowers should avoid matching with IRB banks and search for cheaper lending opportunities from standardized banks. Ruthenberg and Landskroner (2008) achieve a similar conclusion in a setting wherein banks operate under uncertainty in an imperfectly competitive market and when they consider both corporate and retail borrowers. In these theoretical frameworks, if the impact of capital requirements is fairly reflected in the portfolio pricing policy of a bank, IRB banks should then observe a decrease in their loan portfolio spreads accompanied by an improved quality of the same portfolio (and consequently improved regulatory capital ratios independently of any regulatory arbitrage).

While IRB models lower capital requirements for safer borrowers, and this should potentially result in lower rates for these borrowers compared to the pre-adoption period, there are no reasons forcing adopters to offer these borrowers lower rates than standardized banks. Indeed, IRB banks might still attract these borrowers, or maintain existing lending relationships, by simply matching the pricing conditions of competing standardized banks.

The above arguments imply that IRB banks might selectively incorporate the impact of capital requirements across risk categories in such a way as to increase, and not decrease, the overall performance of the loan portfolio. Ultimately, how the use of IRB models influences the loan portfolio spread via an impact on borrowing costs is ex ante unclear and remains an unanswered question. Answering this question would increase our understanding of the full range of implications of IRB models on the banking business and whether lower capital requirements benefit bank borrowers.

Therefore, based on the arguments from the aforementioned literature, we propose the following hypotheses:

H1a: The greater the IRB Intensity, the lower the bank's spread.
H1b: The greater the IRB Intensity, the higher the bank's spread.

The models proposed by Repullo and Suarez (2004) and Ruthenberg and Landskroner (2008), although based on different designs of the lending market, implicitly assume no frictions in the selection of lenders by borrowers. Deviations from this assumption might affect how IRB lenders incorporate the heterogeneity in risk weights in pricing decisions. More specifically, these theoretical frameworks require that riskier borrowers have no constraints or disincentives in selecting an alternative lender when loan rates by IRB banks increase. However, risky borrowers might find it difficult to switch to a different lender, especially in banking markets wherein the competitive pressure from standardized banks is not sufficiently strong. Furthermore, in these theoretical settings, borrowers that avoid credit relationships with IRB banks implicitly signal to outsiders that they are riskier than their competitors; some risky borrowers might prefer to avoid the reputational damage from this signal. We therefore formulate our second hypothesis as follows:

H2: The lower the competitive pressure from standardized banks, the greater the bank's spread charged by IRB adopters.

In addition to finding it difficult to switch lender when the competitive pressure from standardized banks is not sufficiently strong, risky borrowers might also struggle to turn to a different bank when relationship lending is predominant and pricing is not always the main driver of lender–borrower matching (Berger and Udell, 2002). More generally, in markets wherein relationship lending is the main technology, banks have the ability to privately observe proprietary information about the borrower (Berger *et al.*, 2021; Cowling and Sclip, 2022) which cannot be transferred to other lenders, thereby determining a lock-in effect and, consequently, a switching cost for the borrower (Degryse and Ongena, 2005; Degryse and Van Cayseele, 2000). In such a setting, wherein banks gain monopoly power over the borrower relative to competing lenders, it is also likely that borrowing costs increase as the bank–firm relationship matures (Degryse and Van Cayseele, 2000; Ioannidu and Ongena, 2010; Kysucky and Norden, 2016). We therefore hypothesize:

H3: The greater the importance of relationship lending, the greater the bank's spread charged by IRB adopters.

As opposed to the above, borrowers could be favoured in contexts wherein banks are characterized by a higher degree of political connectedness. Indeed, managerial decisions in politically connected banks may follow logics that deviate from the optimum, in an attempt to favour borrowers. In other words, politically connected institutions are more likely to pursue political objectives at the banks' cost, thereby undermining bank performance. For instance, there is evidence that political connections may squeeze bank interest margins (Carretta *et al.*, 2012; Micco, Panizza and Yanez, 2007; Papadimitri and Pasiouras, 2023). In contrast, borrowers may be penalized when the degree of political connectedness is lower. Indeed, banks that are not confronted with political pressures can achieve better performance outcomes, through their lending function, by charging borrowers with higher spreads. We thus hypothesize:

H4: The lower the level of political connectedness, the greater the bank's spread charged by IRB adopters.

Data and methodology

The sample of banks

Our dataset contains cross-country yearly data on banks' balance sheets and income statements for the period spanning from the year a country adopted Basel I (which varies country by country) to 2016. The cross-country dimension of our study ensures the presence of a large number of IRB banks in the sample. Furthermore, it gives us the opportunity to exploit cross-country differences to assess the potential drivers of our findings. However, we reduce the influence of omitted country controls and confounding factors, by focusing only on high-income countries (as defined by the World Bank) and requiring that these countries have adopted Basel II by the end of the sample period. Furthermore, as discussed in the 'Dependent variable' section below, our econometric setting employs country × year fixed effects to control for time-varying country factors.[3]

We take accounting data from BankScope (for the period up to 2014) and from Orbis-Bank Focus (for 2015 and 2016). Both databases provide accounting data in a standardized manner, thus favouring cross-country comparisons. Since our focus is on the regulatory measurement of capital requirements for credit risk, we select only banks involved in lending and subject to capital requirements (commercial, cooperative, savings and mortgage banks).

To avoid duplicates from banks that are consolidated within the balance sheet of another bank, and contamination effects due to differences in how banks within the same group, but located in different countries, measure capital requirements, we keep only accounting information from the unconsolidated annual report as in Lepetit, Saghi-Zedek and Tarazi (2015) and De Mooij and Keen (2016). This choice allows us to achieve a more precise assessment of the impact that the use of the IRB approach has on the return of a bank's loan portfolio and to also tightly link the loan portfolio to a specific lending market. We include consolidated statements only when unconsolidated data are not available (Lepetit, Saghi-Zedek and Tarazi, 2015). This choice affects 15% of our sample.[4]

Finally, we select banks that (based on a yearly country ranking as defined by BankScope/Orbis-Bank Focus) are classified among the top 50 largest banks within a country by total assets at least once throughout the sample period. This criterion leads to some countries having more than 50 banks in the sample as banks enter and exit the yearly country ranking. Equally, some countries have less than 50 banks in the sample because of the small number of banks in their banking system. Our sample selection reduces the degree of concentration of the sample in a small number of countries and restricts the number of annual reports we have to inspect to construct the key variable for our analysis.[5] Furthermore, provided that large banks are typically the ones most likely to adopt the IRB methodologies (Behn, Haselmann and Vig, 2022; Gornall and Strebulaev, 2018), the use of such a size filter – by limiting the tail of non-IRB adopters – offers the advantage of reducing the heterogeneity between adopters and non-adopters of IRB models.[6]

Our final sample consists of 25,020 bank-year observations from 2,191 banks chartered in 40 countries and represents (on average) about 80% of the total bank lending in the selected countries. Table 1 provides the distribution of the total number of observations and the number of banks by country.

The new IRB database

Our key explanatory variable is a measure of the importance of the IRB models to assess the capital requirements for credit risk. To construct this variable, we compile a unique dataset on the

[3]To mitigate potential concerns related to the sampled countries being heterogeneous along some dimensions (e.g., institutional background), for robustness we run our baseline tests utilizing a different country grouping. Specifically, we employ a subsample of banks chartered in OECD countries only (therefore excluding the Bahamas, Bahrain, Croatia, Cyprus, Hong Kong, Kuwait, Malta, Qatar, Russia, Saudi Arabia, Singapore and the United Arab Emirates). Unreported results reveal our key findings are corroborated when we employ such a subsample.

[4]Our results remain similar if we exclude these banks from the sample.

[5]The sample also excludes 4% of observations for which we were unable to gather information on the credit risk approach adopted with Basel II.

[6]While we acknowledge that some large banks in 'country A' might still be small relative to banks in 'country B', this does not represent a problem in our setting. Indeed, these cross-country differences are not relevant in our empirical setup provided that, with the inclusion of country × year fixed effects, we are modelling within-country differences.

Table 1. Sample distribution by country

	Banks		Observations	
	Number	Percentage	Number	Percentage
Australia	57	2.60	562	2.25
Austria	89	4.06	1,139	4.55
Bahamas	32	1.46	242	0.97
Bahrain	14	0.64	168	0.67
Belgium	81	3.70	860	3.44
Canada	89	4.06	778	3.11
Croatia	49	2.24	545	2.18
Cyprus	17	0.78	121	0.48
Czech Republic	38	1.73	475	1.90
Denmark	76	3.47	1,152	4.60
Finland	23	1.05	208	0.83
France	143	6.53	1,563	6.25
Germany	131	5.98	1,866	7.46
Greece	30	1.37	316	1.26
Hong Kong	32	1.46	281	1.12
Iceland	22	1.00	124	0.50
Ireland	22	1.00	158	0.63
Israel	16	0.73	197	0.79
Italy	107	4.88	1,367	5.46
Japan	80	3.65	1,302	5.20
Kuwait	7	0.32	140	0.56
Luxembourg	102	4.66	1,106	4.42
Malta	13	0.59	129	0.52
Netherlands	63	2.88	446	1.78
Norway	73	3.33	870	3.48
Poland	69	3.15	746	2.98
Portugal	35	1.60	396	1.58
Qatar	5	0.23	81	0.32
Republic of Korea	34	1.55	303	1.21
Russian Federation	64	2.92	495	1.98
Saudi Arabia	11	0.50	226	0.90
Singapore	21	0.96	209	0.84
Slovakia	22	1.00	241	0.96
Slovenia	27	1.23	330	1.32
Spain	105	4.79	1,219	4.87
Sweden	57	2.60	755	3.02
Switzerland	128	5.84	1,363	5.45
United Arab Emirates	19	0.87	369	1.47
United Kingdom	78	3.56	704	2.81
United States	110	5.02	1,468	5.87
Total	**2,191**	**100.00**	**25,020**	**100.00**

adoption of Basel I and Basel II at the country level by gathering information from various sources including Barajas, Chami and Cosimano (2005). Section B of the Online Appendix describes in detail the construction of the database. The date of implementation of Basel I defines the beginning of our sample period for each country. The adoption date of Basel II identifies the period from which we retrieve manually, for each bank, the credit risk measurement model that is employed for regulatory purposes.

From the inspection of the annual reports, we identify (i) what approach (or approaches) a bank has adopted year by year and (ii) what share of the credit portfolio has been allocated to each approach. Our key explanatory variable (**IRB Intensity**) is defined as follows:

$$\text{IRB Intensity}_{i,t} = \frac{\text{RWA}_{\text{IRB\_Credit\_Risk}_{i,t}}}{\text{RWA}_{\text{Total\_Credit\_Risk}_{i,t}}} \quad (1)$$

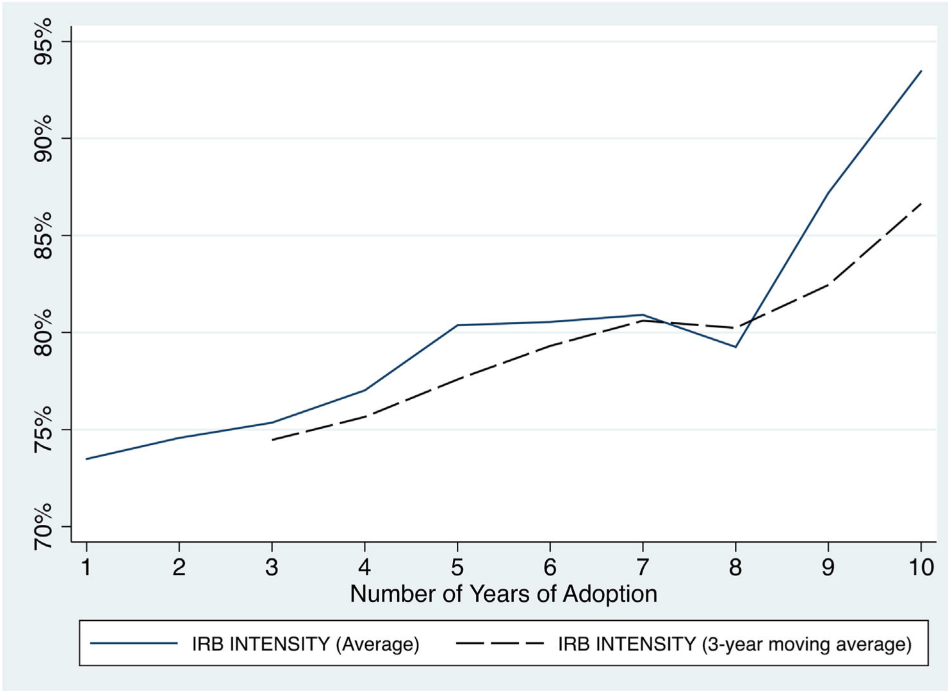

Figure 1. Evolution of the importance of the IRB approach to measure credit risk [Colour figure can be viewed at wileyonlinelibrary.com]
The figure shows the evolution of the measures of IRB Intensity, in terms of years of implementation, by IRB adopters. The vertical axis plots the average and 3-year moving average of IRB Intensity based on the number of years of implementation at the bank level.

where the numerator is the value of the RWA of credit exposures computed using IRB models by a bank *i* at time *t*, while the denominator is the total RWA for credit risk. A value of zero indicates that banks do not employ the IRB approach and a value of one that a bank computes capital requirements for credit risk using only the IRB approach. Compared to a simple categorization based on an IRB dummy variable, our IRB variable allows us to achieve a more refined distinction not only between IRB adopters and other banks, but also within the sample of adopters. For instance, in 2016 two large banks, such as HSBC and Banco Santander, are both classified as IRB adopters in our sample. However, while the first bank has a value of IRB Intensity close to 80%, the second reports a value well below 50%.

Approximately 32% of the sample belongs to a period where banks can employ the IRB approach. Figure 1 reports the yearly average and the 3-year moving average of IRB Intensity based on the number of years of adoption by each bank. We construct this figure starting from the first year we classify a bank as an IRB adopter. As a result, the first values we report in Figure 1 are the average of IRB Intensity during the first year of adoption and the average in the first 3 years of adoption by the subsample of IRB adopters.[7]

The figure shows that the IRB adopters increasingly use the IRB approach for regulatory purposes. There is, therefore, not only cross-sectional variation in how banks use IRB models, but also time-series variation.

Dependent variable

The dependent variable is the difference between interest income scaled by total earning assets and interest expenses scaled by interest-bearing liabilities (**Spread**). A similar measure has been used in several previous studies (see, e.g., Abedifar, Molyneux and Tarazi, 2018).

[7]For instance, consider a Japanese bank and a British bank that started adopting the IRB methodologies in 2006 and 2008, respectively. The values of IRB Intensity for those two banks, observed in those years, will thus be used to compute the 'Year 1' mean of the IRB Intensity variable. The values observed in the following years will then contribute to calculate the 'Year 2' mean, 'Year 3' mean, and so on.

Table 2. Summary statistics

		Observations	Mean	SD	Min	Median	Max
Panel A: Key explanatory variable							
IRB Intensity	Risk-weighted assets (RWAs) (of the credit exposures) obtained from the IRB methods, over the total RWAs of the credit exposures	25,020	0.062	0.219	0.000	0.000	1.000
Panel B: Dependent variables							
Spread	Difference between interest income scaled by total earning assets and interest expense scaled by interest-bearing liabilities	25,020	0.020	0.018	−0.028	0.017	0.109
Loan Spread	Difference between a bank's interest income on loans scaled by gross loans and interest expense scaled by interest-bearing liabilities	17,156	0.054	0.110	−0.027	0.028	0.888
Panel C: Bank controls							
Size	Log transformation of bank total assets (in constant 2012 thousand US dollars)	25,020	15.584	2.121	7.542	15.653	21.922
Equity	Equity over total assets	25,020	0.091	0.079	0.008	0.071	0.631
Deposits	Customer deposits over total assets	22,608	0.545	0.259	0.001	0.601	0.933
Liquidity	Liquid assets over total assets	22,608	0.208	0.188	0.001	0.150	0.896
NII	Non-interest income over total earning assets	22,608	0.015	0.024	−0.008	0.009	0.220
LLP	Loan loss provisions over gross loans	22,608	0.008	0.016	−0.024	0.004	0.126
Cost-to-Income	Overheads over total operating income	22,608	0.651	0.297	0.043	0.622	2.394
Market Leader	A dummy that takes a value of one when the ratio of gross loans of bank *i* at year *t* over the sum of bank loans at the country level (taken from the World Bank) in year *t* is above the 75th percentile of the yearly sample distribution	22,608	0.266	0.442	0.000	0.000	1.000

In additional tests we use an alternative, and more refined, measure of the portfolio lending spread; namely, we calculate **Loan Spread** as the difference between a bank's interest income on loans scaled by gross loans and interest expenses scaled by interest-bearing liabilities (similar to Carbó Valverde and Rodríguez Fernández, 2007; Lepetit *et al.*, 2008). This measure is, however, available only for a much smaller number of observations in our sample (17,156) and this would amplify the risk that our findings are driven by selection bias. As a result, we identify Spread as our main dependent variable. Panel B of Table 2 reports descriptive statistics for the dependent variables.

Econometric approach

We use a panel within estimator that controls for unobserved bank heterogeneity caused by factors that remain constant across the sample period at the bank level. This approach is well suited to capturing variations in the dependent variables at the level of individual banks over time. We adjust standard errors for heteroscedasticity and cluster them at the bank level to remove any estimation bias from within-bank group correlation. More formally, we estimate the following specification:

$$\mathrm{Y}_{i,t} = \alpha_i + \delta \mathrm{IRB\ Intensity}_{i,t-1} + \beta \mathrm{X}_{i,t-1} + \mathrm{Country} \times \mathrm{Year} + \varepsilon_{i,t} \quad (2)$$

where $\mathbf{Y}_{i,t}$ is one of the spread variables described in the previous section, for bank i at time t; $\boldsymbol{\alpha}_i$ is the bank-specific intercept; $\mathbf{IRB\ Intensity}_{i,t-1}$ is our IRB variable and is lagged by one year to reduce endogeneity concerns and simultaneity biases; $\mathbf{X}_{i,t-1}$ is a vector of (lagged) bank control variables; **Country × Year** is a vector of country × year fixed effects; $\boldsymbol{\varepsilon}_{i,t}$ is an idiosyncratic error. The

Table 3. t-Tests

Bank characteristics	(A) IRB adopters	(B) SA adopters	t-Test (A−B)
Size	17.616	15.545	2.071***
Equity	0.072	0.101	−0.029***
Deposits	0.511	0.607	−0.096***
Liquidity	0.216	0.201	0.015***
NII	0.009	0.014	−0.005***
LLP	0.006	0.007	−0.001***
Cost-to-Income	0.745	0.713	0.032***
Market Leader	0.501	0.194	0.307***
Loans Ratio	0.559	0.617	−0.058***

This table presents t-tests of differences in means – for various bank characteristics – between banks adopting (in part or in full) the IRB approach and banks exclusively adopting the SA approach. Size is the log transformation of bank total assets in 2012 US dollars. Equity is the ratio between equity capital and total assets. Deposits is the ratio of customer deposits scaled by total assets. Liquidity is the ratio of liquid assets divided by total assets. NII is the share of total operating income due to non-interest income activities. LLP is the ratio of loan loss provisions scaled by gross loans. Cost-to-Income is computed as overheads divided by total operating income. Market Leader is a dummy that takes a value of one when the ratio of gross loans of bank *i* at year *t* over the sum of bank loans at the country level (taken from the World Bank) in year *t* is above the 75th percentile of the yearly sample distribution. Loans Ratio is the ratio of gross loans divided by total assets. *, ** and *** denote statistical significance at the 10%, 5% and 1% level, respectively.

inclusion of country × year fixed effects allows us to focus on the impact of an increasing use of IRB models on Spread for a bank operating in a country in a given year.

Panel C of Table 2 provides summary statistics of the bank controls included in Equation (2). These include: the logarithmic transformation of bank total assets measured in constant thousands of US dollars at year 2012 (**Size**); the ratio between equity and total assets (**Equity**); the ratio between deposits and total assets (**Deposits**); the ratio of liquid assets to total assets (**Liquidity**); the non-interest income share (**NII**); the ratio between bank overheads and total operating income (**Cost-to-Income**); a dummy – capturing a bank's dominant position in the loan market – that takes the value of one when the ratio of gross loans of bank *i* at year *t* over the sum of bank loans at the country level (taken from the World Bank) in year *t* is above the 75th percentile of the yearly sample distribution (**Market Leader**); the ratio between loan loss provisions and gross loans (**LLP**).[8]

IRB versus SA adopters: key differences

Before discussing the main results of our empirical investigation, we first highlight the key differences between IRB and SA adopters emerging from our dataset. Essentially, we take the post-Basel I period of our sample and compute t-tests of differences in means – for the various bank controls described in the previous section – between banks adopting (in part or in full) the IRB approach and banks exclusively adopting the standardized approach.

Table 3 reports the results of these tests, whose key highlights are the following. Consistently with previous studies (*inter alia* Behn, Haselmann and Vig, 2022), we observe that IRB adopters are significantly larger than standardized banks. Interestingly, the share of deposits over total assets is significantly lower in IRB banks relative to SA adopters (51% vs. 61%). Furthermore, while lending is the dominant business in both types of bank, the share of gross loans over total assets is significantly lower in IRB banks (56%) compared to SA adopters (62%).

Baseline empirical results

Preliminary analyses: Do IRB adopters obtain benefits in terms of capital requirements?

The shared expectation of theoretical models built on the heterogeneity of risk weights is that IRB adopters should benefit from a decrease in the total capital requirements, at least in part, due to changes in the pool of borrowers that are willing to establish, or maintain, lending relationships with

[8]Table OA1 of the Online Appendix shows that multicollinearity does not appear to be a major concern in our analysis.

Table 4. IRB Intensity, capital requirements and portfolio lending risk

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Capital requirements				Lending quality			
	Total Capital Ratio		Tier 1 Ratio		LLR		LLP	
IRB $Intensity_{t-1}$	0.023***	0.017***	0.026***	0.027***	−0.005**	−0.005**	−0.000	−0.000
	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)
$Size_{t-1}$	−0.034***	−0.023***	−0.032***	−0.025***	−0.001	−0.001	0.001**	0.001***
	(0.01)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
$Equity_{t-1}$					−0.010	−0.015	−0.005	−0.006
					(0.01)	(0.01)	(0.01)	(0.01)
$Deposits_{t-1}$		−0.057***		−0.036**		−0.011***		0.000
		(0.01)		(0.01)		(0.00)		(0.00)
$Liquidity_{t-1}$		0.074***		0.051***		0.004		−0.007***
		(0.02)		(0.02)		(0.00)		(0.00)
NII_{t-1}		0.239*		0.179		−0.024		−0.002
		(0.13)		(0.14)		(0.03)		(0.02)
LLP_{t-1}		−0.166		−0.011				
		(0.11)		(0.11)				
Cost-to-$Income_{t-1}$		−0.004		−0.008*		0.005***		0.001
		(0.00)		(0.00)		(0.00)		(0.00)
Market $Leader_{t-1}$		0.000		0.000		0.000		−0.000
		(0.00)		(0.00)		(0.00)		(0.00)
Constant	0.744***	0.582***	0.689***	0.589***	0.050***	0.058***	−0.008	−0.015*
	(0.12)	(0.07)	(0.11)	(0.08)	(0.02)	(0.02)	(0.01)	(0.01)
Observations	12,840	12,015	10,083	9,610	24,986	22,601	23,429	22,179
R-squared	0.24	0.26	0.27	0.28	0.29	0.32	0.22	0.22
Number of banks	1,496	1,463	1,243	1,220	2,190	2,112	2,123	2,098
Error cluster	Bank	Bank	Bank	Bank	Bank	Bank	Bank	Bank
Bank FE	YES	YES	YES	YES	YES	YES	YES	YES
Country × year FE	YES	YES	YES	YES	YES	YES	YES	YES

This table shows regression results for the fixed-effects model concerning the impact of the IRB approach on the Total Capital Ratio (measured as Tier 1 capital (i.e., shareholder funds plus perpetual non-cumulative preference shares) + Tier 2 capital (i.e., subordinated debt, hybrid capital, loan loss reserves and valuation reserves) over risk-weighted assets and off balance sheet risks) – columns (1) and (2), the Tier 1 Ratio (measured as Tier 1 capital (i.e., shareholder funds plus perpetual non-cumulative preference shares) over risk-weighted assets and off balance sheet risks) – columns (3) and (4), the LLR (loan loss reserves over gross loans) – columns (5) and (6), and the LLP (loan loss provisions scaled by gross loans) – columns (7) and (8). IRB Intensity is the share of risk-weighted assets of credit exposures measured utilizing the IRB methodologies. The set of bank-specific controls includes Size (log transformation of bank total assets in 2012 US dollars), Equity (the ratio between equity capital and total assets), Deposits (customer deposits scaled by total assets), Liquidity (liquid assets divided by total assets), NII (the share of total operating income due to non-interest income activities), Cost-to-Income (overheads divided by total operating income), Market Leader (a dummy that takes a value of one when the ratio of gross loans of bank *i* at year *t* over the sum of bank loans at the country level (taken from the World Bank) in year *t* is above the 75th percentile of the yearly sample distribution). LLP (loan loss provisions scaled by gross loans) is included, as a control, in columns (2) and (4). Heteroscedasticity-robust standard errors, clustered at the bank level, are reported in parentheses. All specifications control for bank and country × year fixed effects. *, ** and *** denote statistical significance at the 10%, 5% and 1% level, respectively.

IRB banks. In turn, IRB models should then influence the return of the loan portfolio. Therefore, as a first step it is worth understanding if the expected impact of IRB models on capital requirements and lending quality predicted by these theory models is present in our sample.

Accordingly, we start by estimating regressions as described in the previous section using the following dependent variables: (i) the total regulatory capital ratio (Total Capital Ratio); (ii) the Tier 1 capital ratio (Tier 1 Ratio). These two variables are available for about half of our sample. We report summary statistics for these dependent variables in Table OA2 of the Online Appendix. As explanatory variables we use the same set of controls discussed in the 'Data and methodology' section, in addition to bank and country × year fixed effects.

We initially estimate the models only controlling for bank size and then we include the full set of explanatory variables. As shown in Table 4, we find that an increasing use of IRB models results in an improvement in the regulatory capital ratios for the adopting banks. In Table OA3 of the Online Appendix, we show that this result holds when we add the lag value of the equity ratio as a control. This latter finding excludes the possibility that our results are driven by pre-existing differences in the capital structure of adopters and non-adopters. Along these lines, in the same table of the Online Appendix, we document that IRB Intensity is not associated with variation in a bank's equity ratio.

Next, we assess whether the improved capital requirements for IRB adopters are, at least in part, due to the improved quality of borrowers that match with adopters. To this end, we estimate regressions with loan portfolio risk measures as dependent variables. As lending risk variables, we employ the ratio between loan loss reserves and total loans (LLR) and the ratio between loan loss provisions and total loans (LLP). These two ratios are forward-looking indicators of credit risk, and as such are more suitable than measures of lending risk based on non-performing loans to capture the risk implications from the adoption of IRB models. However, we recognize that these two variables can be affected by a bank's accounting choices, which can partially distort their ability to capture the riskiness of the loan portfolio. Although we have to keep in mind these limitations, the analysis reported from columns (5) to (8) of Table 4 does not seem to entirely support the argument that the reduced capital requirements are due to IRB adopters specializing in better quality borrowers. We only observe a significant negative impact of IRB Intensity when the dependent variable is LLR. However, we cannot exclude that our lending risk variables do not offer a sufficiently granular picture of the riskiness of a bank's loan portfolio, as measured by the PD of borrowers for regulatory purposes.

Taken together, our findings on regulatory capital ratios confirm the presence of generalized benefits produced by IRB models in terms of capital requirements, but these benefits do not seem to necessarily be linked to an improved quality of bank borrowers in the adopting banks. Our main purpose is now to establish to what extent these capital requirement benefits are transferred to bank borrowers via a reduced average spread of bank loan portfolios.

The IRB approach and loan portfolio spreads

We report the results on the relationship between Spread and IRB Intensity in Table 5. We start with a baseline specification, shown in column (1), where Spread is the dependent variable, IRB Intensity is the key explanatory variable and Size and Equity are the only controls. We then add further controls in the next column. Both models include bank fixed effects and country × year fixed effects.

We consistently find a positive association between Spread and IRB Intensity: banks that increasingly measure their capital requirements for credit risk with the IRB approach show a higher Spread.[9] This result, therefore, goes against the predictions of models focusing on the heterogeneity of capital requirements within and across banks operating in a given banking market. In terms of economic impact, the estimated coefficients indicate that adopting the IRB approach to quantify the credit risk of the entire portfolio (i.e., when the IRB Intensity is equal to one) leads to a 20 basis point increase in Spread. This corresponds to a 10% rise, given that the average Spread in the sample is equal to 2%.

To further validate our results, we next restrict the estimation period to 6 years prior to and 6 years post the Basel II adoption in each country, with the purpose of mitigating concerns over confounding factors arising in the pre-adoption period. The results, reported in column (3), remain substantially unchanged.[10]

[9] Additional analyses – not reported for the sake of brevity – reveal that our key finding (i.e., the positive association between the use of IRB models and Spread) is also observed when we employ a dummy variable (taking the value of one for the years a bank employed the IRB approach to measure capital requirements) instead of IRB Intensity.

[10] Another important aspect to consider in our setting – given the relatively long dataset – is whether the relationship between IRB Intensity and Spread changes during turbulent times. Indeed, at least a couple of widespread crises occurred during our observed period (i.e., the Global Financial Crisis and the Eurozone Sovereign Debt Crisis – see, e.g., Berger, Makaew and Turk-Ariss, 2023). We conjecture two possible outcomes for our main relationship of interest, during turbulent times. A first view suggests a further increase of Spread. This is motivated by the fact that, if PDs go up, then the pricing of loans should increase to reflect such risk. In this case, the resulting greater riskiness would, in turn, translate into a widening of IRB banks' spreads during turbulent times. A second view instead conjectures that Spread should not

Table 5. IRB Intensity and loan portfolio spread

	(1) Spread	(2) Spread	(3) Spread	(4) Spread	(5) Spread	(6) Spread	(7) Loan Spread	(8) Loan Spread
			−6, +6 Estimation window	Tighter size matching between IRB adopters and non-adopters	Additional fixed effects	Additional fixed effects		
IRB Intensity$_{t-1}$	0.002***	0.002***	0.001**	0.001**	0.001**	0.001**	0.014**	0.011**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)
Size$_{t-1}$	0.000	−0.000	−0.000	−0.000	−0.000	0.000	0.004	0.009
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)
Equity$_{t-1}$	0.012**	0.022***	0.015***	0.012*	0.022***	0.022***	−0.005	−0.017
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.04)	(0.04)
Deposits$_{t-1}$		0.009***	0.007***	0.009***	0.009***	0.009***		0.014
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)		(0.01)
Liquidity$_{t-1}$		−0.002*	−0.003**	−0.003***	−0.002	0.000		0.052***
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)		(0.02)
NII$_{t-1}$		−0.033**	−0.022	−0.036**	−0.038**	−0.031**		−0.046
		(0.02)	(0.02)	(0.01)	(0.02)	(0.02)		(0.11)
LLP$_{t-1}$		0.037***	0.010	0.043***	0.036***	0.037***		0.146
		(0.01)	(0.01)	(0.01)	(0.01)	(0.01)		(0.10)
Cost-to-Income$_{t-1}$		−0.003***	−0.002***	−0.003***	−0.003***	−0.002***		0.001
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)		(0.01)
Market Leader$_{t-1}$		0.001	0.000	0.001*	0.001*	0.000		−0.013**
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)		(0.01)
Constant	0.012*	0.014**	0.019**	0.022***	0.021**	0.013*	−0.047	−0.143
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.12)	(0.11)
Observations	25,020	22,608	12,458	20,440	22,608	22,608	17,156	15,865
R-squared	0.24	0.29	0.23	0.32	0.31	0.31	0.13	0.13
Number of banks	2,191	2,113	1551	1,959	2,113	2,113	1697	1,662
Error cluster	Bank	Bank	Bank	Bank	Bank	Bank	Bank	Bank
Bank FE	YES	YES	YES	YES	YES	YES	YES	YES
Country × year FE	YES	YES	YES	YES	YES	YES	YES	YES
Size quintile × country FE					YES			
Gross loan/assets quintile × country FE						YES		

This table shows regression results for the fixed-effects model concerning the impact of the IRB approach on the Spread measured as the difference between interest income scaled by total earning assets and interest expense scaled by interest-bearing liabilities – columns (1) to (6) – and Loan Spread measured as the difference between a bank's interest income on loans scaled by gross loans and interest expense scaled by interest-bearing liabilities – columns (7) and (8). IRB Intensity is the share of risk-weighted assets of credit exposures measured utilizing the IRB methodologies. Size is the log transformation of bank total assets in 2012 US dollars. Equity is the ratio between equity capital and total assets. Columns (2) to (6) and column (8) also include Deposits (customer deposits scaled by total assets), Liquidity (liquid assets divided by total assets), NII (the share of total operating income due to non-interest income activities), LLP (loan loss provisions scaled by gross loans), Cost-to-Income (overheads divided by total operating income), Market Leader (a dummy that takes a value of one when the ratio of gross loans of bank *i* at year *t* over the sum of bank loans at the country level (taken from the World Bank) in year *t* is above the 75th percentile of the yearly sample distribution). Heteroscedasticity-robust standard errors, clustered at the bank level, are reported in parentheses. All specifications control for bank and country × year fixed effects. Specification in column (5) also includes size quantile × country FE. Specification in column (6) also includes gross loans/assets quantile × country FE. *, ** and *** denote statistical significance at the 10%, 5% and 1% level, respectively.

A potential additional issue is the size heterogeneity between IRB adopters and other banks. Unreported tests show that the median logarithmic transformation of total assets for IRB banks is equal to 17.1, while it is only 15.1 for other banks. This size difference might then hide other differences between the two groups of banks that we do not fully control for. To rule out this possibility, in column (4) we run our regressions by excluding non-adopters in the lowest 10% of the non-adopter sample distribution and adopters in the higher 10% of the adopter sample distribution. Our results remain unchanged. More importantly, in column (5) we re-estimate the model with the addition of *country × size quintile* fixed effects. In this setting, we are, therefore, focusing on the effect of IRB models in banks operating in the same country and the same size category. This test confirms our baseline findings.

One further source of heterogeneity that we might not fully account for is the business model of the sampled banks, as the asset portfolio composition can also affect the value of the spread. In an attempt to mitigate this concern, we repeat the estimation of our baseline model with the addition of *country × gross loan/assets quintile* fixed effects. In this setting, we are therefore focusing on the effect of IRB models in banks operating in the same country and in the same quintile of the loan to asset ratio distribution. Although this approach is extremely conservative, we still observe that Spread is positively associated with IRB Intensity.

Finally, it might also be argued that our measure of the average lending price in the loan portfolio is very imprecise, being based on total earning assets. Although our sample focuses on lending-oriented banks, and this should reduce the importance of this critique, in additional tests – reported in the last two columns of Table 5 – we find that our results are confirmed when we use Loan Spread (defined in the 'Dependent variable' section) as the dependent variable.

Overall, more intensive use of the IRB approach for computing capital requirements for credit risk increases the return of the loan portfolio. From the preliminary tests discussed in the previous section, it seems that IRB adopters achieve capital requirement benefits, but these benefits do not seem to be fully priced at the loan portfolio level. The positive association between Spread and IRB Intensity does not conform, therefore, to the predictions of theoretical models in which the heterogeneity of regulatory risk models within the banking system should induce a decrease in the average return of the loan portfolio of IRB adopters.

Addressing endogeneity

A potential concern in our analyses is dynamic endogeneity, wherein past values of Spread influence the choice of IRB models by banks (see Wintoki, Linck and Netter, 2012). Specifically, it might be argued that banks with past high Spread might find it preferable to use IRB models as they have lending relationships with riskier borrowers for which borrowing costs should further increase with Basel II.

To address this issue, we estimate a dynamic panel data model via system generalized methods of moments (GMM) (Blundell and Bond, 1998). This empirical setting allows us to mitigate concerns due to dynamic endogeneity by using internal instruments. The set of instruments needs to comply with the identification of the GMM estimation method. In our case, this is achieved by utilizing from the third to the sixth lag difference of bank characteristics as instruments in the level equation and from the third to the sixth lag of bank characteristics as instruments in the difference equation. Therefore, consistently with consolidated practice in the literature, in the GMM model all bank explanatory variables are treated as endogenous, while the year fixed effects are exogenous. As reported in Table 6, the GMM specification – whose diagnostic tests highlight the

widen further. This is motivated by at least a couple of reasons. (i) PDs are based on past data and hence default rates are normally underestimated during turbulent times (Behn, Haselmann and Vig, 2022). In other words, IRB models do not instantly adjust to account for new PDs. (ii) The mapping from PDs to RWAs is concave in the IRB setting, which implies lower sensitivity when PDs increase (see Figure OA1 in the Online Appendix). To empirically test which one of the above two conjectures holds true, we interact our IRB Intensity variable with a crises dummy that equals one for the years a country experienced a crisis (following the definition provided by Laeven and Valencia, 2018). We report the results of this test in Table OA4 in the Online Appendix. Given the non-significance of the interaction term in Table OA4, our empirical finding leans towards our second conjecture, that is during turbulent times loan portfolio spreads do not widen further compared to normal times.

Table 6. IRB Intensity and loan portfolio spread – system GMM specification

	(1) Spread
IRB Intensity$_{t-1}$	0.003**
	(0.00)
Spread$_{t-1}$	0.803***
	(0.04)
Observations	22,177
Number of banks	2,106
Bank-level controls	YES
Bank FE	YES
Country FE	YES
Year FE	YES
Number of instruments	139
Hansen (p-value)	0.182
AR(2) (p-value)	0.379

This table show regression results for the system GMM specification (Blundell and Bond, 1998) concerning the impact of the IRB approach on the Spread measured as the difference between interest income scaled by total earning assets and interest expense scaled by interest-bearing liabilities. IRB Intensity is the share of risk-weighted assets of credit exposures measured utilizing the IRB methodologies. The set of bank-specific controls includes Size (log transformation of bank total assets in 2012 US dollars), Equity (the ratio between equity capital and total assets), Deposits (customer deposits scaled by total assets), Liquidity (liquid assets divided by total assets), NII (the share of total operating income due to non-interest income activities), LLP (loan loss provisions scaled by gross loans), Cost-to-Income (overheads divided by total operating income), Market Leader (a dummy that takes a value of one when the ratio of gross loans of bank *i* at year *t* over the sum of bank loans at the country level (taken from the World Bank) in year *t* is above the 75th percentile of the yearly sample distribution). Heteroscedasticity-robust standard errors are reported in parentheses. The model specification includes bank, country and year fixed effects. *, ** and *** denote statistical significance at the 10%, 5% and 1% level, respectively.

validity of the setting – shows that our baseline result holds.[11]

In Section C of the Online Appendix, we discuss a number of additional tests that we carry out in an attempt to mitigate further endogeneity concerns. Overall, we consistently show that endogeneity is not a concern in our study.

[11]It is worth noting that the model does not include country × year fixed effects, but only country and year fixed effects. This choice is necessary to ensure convergence of the GMM estimator.

What drives our key result?

(A lack of) competition from standardized banks

The decrease in the loan portfolio spread predicted in Repullo and Suarez (2004) for IRB adopters is motivated by the competition stemming from standardized banks in a perfectly competitive market. Hence, our results might indicate a lack of sufficient competitive pressure on IRB banks from standardized banks operating in the same credit market. Therefore, when the competition from standardized banks becomes significant, we could observe empirical results aligned with the predictions of the highlighted theoretical framework.

To test if variation in competitive pressure from standardized banks matters for our findings, for each country c we approximate the aggregate market share of standardized banks in the lending market each year t as follows:

$$\text{SD\_MARKET\_SHARE}_{c,t} = \frac{\sum_i^n \text{Credit}_{i,t}}{\text{TotalPrivateCredit}_{c,t}} \quad (3)$$

where the numerator is the sum of the lending provided by n standardized banks in country c and the denominator is the total private lending by domestic banks in the same country. We then repeat the analysis by splitting the sample into countries with low competitive pressure from standardized banks (*market share below the sample median*) and high competitive pressure from standardized banks (*market share above the sample median*). Table 7 shows the results of this test.

We find that the positive association between Spread and IRB Intensity is confined to the subsample of countries where the competition from standardized banks is lower. Nevertheless, it is worth noting that even in countries where competition by standardized banks is stronger, there is no evidence of a lower Spread for banks adopting the IRB model. This result might suggest that, in these markets, IRB banks, on average, mimic the pricing policy of standardized banks.

Ultimately, while higher competition from standardized banks seems to affect the possibility of IRB adopters achieving a higher spread of the loan portfolio, it never results in a reduced spread of the loan portfolio of IRB banks compared to standardized banks.

Table 7. IRB Intensity and loan portfolio spread – split by the market share of standardized approach (SA) adopters

	(1)	(2)
	Market share of SA adopters	
	Low	High
IRB Intensity$_{t-1}$	0.002***	0.001
	(0.00)	(0.00)
Constant	0.018**	0.008
	(0.01)	(0.01)
Observations	11,305	11,303
R-squared	0.31	0.29
Number of banks	1,577	1,422
Error cluster	Bank	Bank
Bank-level controls	YES	YES
Bank FE	YES	YES
Country × year FE	YES	YES

This table shows regression results for the fixed-effects model concerning the impact of the IRB approach on the Spread measured as the difference between interest income scaled by total earning assets and interest expense scaled by interest-bearing liabilities. IRB Intensity is the share of risk-weighted assets of credit exposures measured utilizing the IRB methodologies. The set of bank-specific controls includes Size (log transformation of bank total assets in 2012 US dollars), Equity (the ratio between equity capital and total assets), Deposits (customer deposits scaled by total assets), Liquidity (liquid assets divided by total assets), NII (the share of total operating income due to non-interest income activities), LLP (loan loss provisions scaled by gross loans), Cost-to-Income (overheads divided by total operating income), Market Leader (a dummy that takes a value of one when the ratio of gross loans of bank *i* at year *t* over the sum of bank loans at the country level (taken from the World Bank) in year *t* is above the 75th percentile of the yearly sample distribution). Results reported in columns (1) and (2) concern regressions run, respectively, on subsamples below and above the sample median of the market share of banks exclusively adopting the standardized approach for credit risk (SA adopters). Heteroscedasticity-robust standard errors, clustered at the bank level, are reported in parentheses. All specifications control for bank and country × year fixed effects. *, ** and *** denote statistical significance at the 10%, 5% and 1% level, respectively.

Type of borrowers in an IRB bank's portfolio

The IRB approach is applied to both retail and corporate clients. The latter tend to be larger firms that plausibly have more opportunities to find alternative funding sources in the market. Larger corporations are also potentially penalized more from the increased risk sensitivity of capital requirements due to the IRB adoption and, as a result, they might have stronger incentives to match with standardized banks. It follows that IRB adopters with more corporate clients should consequently exhibit a lower increase in Spread if our results are driven by the ability of these adopters to avoid transferring capital requirement advantages to borrowers. In other words, the general increase in Spread experienced by IRB adopters should be mitigated when banks hold a greater share of corporate loans in their portfolio. This could be explained by IRB banks trying to favour their larger customers in an attempt to refrain them, for example, from switching to a different lender or raising funds in the market.

To find support for the argument above, we interact the mean-centred IRB variable with the mean-centred ratio between corporate loans and total assets, which is also added as a further control in our baseline specification. The results reported in column (1) of Table 8 show that the increase in Spread for IRB adopters declines as the proportion of corporate loans in their loan portfolio increases. Column (2) shows that the results are virtually the same when we add *country × gross loan/assets quintile* fixed effects to exclude the possibility that we are capturing a broader and more general lending effect.

Additionally, we achieve a similar conclusion in column (3), where we repeat the test by adding, as a further control, the ratio between total loans and total assets in addition to *country × gross loan/assets quintile* fixed effects.

Types of lending relationships

In countries where relationship banking is the prevalent lending technology, IRB adopters should be less likely to lose risky borrowers due to their pricing policy. It is primarily in these credit markets that IRB adopters should then be capable of achieving higher spreads. To validate this argument, we employ a couple of country-based measures to capture the importance of relationship banking in a credit market.

We identify bank-based financial systems and market-based financial systems using two variables: (i) the ratio between domestic private credit and domestic GDP and (ii) the ratio between stock market capitalization and domestic GDP. We define economies as bank-based when the first (second) ratio is above (below) the sample median. The remaining countries are defined as market-based economies. We then repeat the analysis separately for the two groups of countries. Our intuition is that relationship lending is more likely to be a key lending technology in bank-based

Table 8. The IRB approach and spread – interactions with corporate lending

	(1)	(2)	(3)
IRB Intensity$_{t-1}$	0.002**	0.002**	0.002**
	(0.00)	(0.00)	(0.00)
(Corporate Loans/Total Assets)$_{t-1}$	0.001	0.000	0.000
	(0.00)	(0.00)	(0.00)
IRB Intensity$_{t-1}$ × (Corporate Loans/Total Assets)$_{t-1}$	−0.003***	−0.003***	−0.003***
	(0.00)	(0.00)	(0.00)
(Gross Loans/Total Assets)$_{t-1}$			0.008*
			(0.00)
Constant	0.011	0.007	0.000
	(0.01)	(0.01)	(0.01)
Observations	10,209	10,209	10,209
R-squared	0.30	0.33	0.33
Number of banks	1,371	1,371	1,371
Error cluster	Bank	Bank	Bank
Additional bank-level controls	YES	YES	YES
Bank FE	YES	YES	YES
Country × year FE	YES	YES	YES
Gross loan/assets quintile × country FE		YES	YES

This table shows regression results for the fixed-effects model concerning the impact of the IRB approach on the Spread measured as the difference between interest income scaled by total earnings asset and interest expense scaled by interest-bearing liabilities. IRB Intensity is the mean-centred share of risk-weighted assets of credit exposures measured utilizing the IRB methodologies. Corporate Loans/Total Assets is the mean-centred share of corporate loans over total assets. Gross Loans/Total Assets – which is included in column (3) – is the ratio of gross loans scaled by total assets. The set of bank-specific controls includes Size (log transformation of bank total assets in 2012 US dollars), Equity (the ratio between equity capital and total assets), Deposits (customer deposits scaled by total assets), Liquidity (liquid assets divided by total assets), NII (the share of total operating income due to non-interest income activities), LLP (loan loss provisions scaled by gross loans), Cost-to-Income (overheads divided by total operating income), Market Leader (a dummy that takes a value of one when the ratio of gross loans of bank *i* at year *t* over the sum of bank loans at the country level (taken from the World Bank) in year *t* is above the 75th percentile of the yearly sample distribution). Heteroscedasticity-robust standard errors, clustered at the bank level, are reported in parentheses. All specifications control for bank and country × year fixed effects. Specifications in columns (2) and (3) also include gross loans/assets quantile × country FE. *, ** and *** denote statistical significance at the 10%, 5% and 1% level, respectively.

economies wherein pricing conditions are not the main driver of lending relationships. Along these lines, the results, reported in Table 9, show that our findings are confined to bank-based economies.

Political connectedness

IRB adopters could also be able to widen their spreads in countries characterized by lower levels of political connections of banking institutions. There is evidence, indeed, that political connections normally squeeze bank interest margins (Carretta *et al.*, 2012; Micco, Panizza and Yanez, 2007; Papadimitri and Pasiouras, 2023). Hence, a lower level of political connectedness may be conducive to greater spreads for IRB adopters.

Following Papadimitri and Pasiouras (2023), we use the measure developed by Braun and Raddatz (2010) to identify countries characterized by low and high levels of connectedness between banks and politicians. In line with our intuition, results reported in Table 10 reveal that the relationship between IRB Intensity and Spread is confined to economies with lower levels of political connectedness of banking institutions.

Conclusions

We employ a unique cross-country dataset on IRB models validated by domestic regulators and test the empirical validity of theoretical predictions that expect an income loss for the loan portfolio of IRB banks due to riskier borrowers shifting to standardized banks and to the lower rates applied to safer borrowers.

Although we are able to confirm the widely held view that IRB models reduce capital requirements for the adopting banks, we do not find clear

Table 9. IRB Intensity, loan portfolio spread and lending relationships

	(1) Domestic credit	(2)	(3) Stock market capitalization	(4)
	Low	High	Low	High
IRB Intensity$_{t-1}$	0.002	0.001**	0.003***	0.001
	(0.00)	(0.00)	(0.00)	(0.00)
Constant	0.012	0.012	0.003	0.020**
	(0.01)	(0.01)	(0.01)	(0.01)
Observations	11,228	11,380	11,087	11,521
R-squared	0.26	0.34	0.32	0.20
Number of banks	1,325	1,339	1,363	1,521
Error cluster	Bank	Bank	Bank	Bank
Bank-level controls	YES	YES	YES	YES
Bank FE	YES	YES	YES	YES
Country × year FE	YES	YES	YES	YES

This table shows regression results for the fixed-effects model concerning the impact of the IRB approach on the Spread measured as the difference between interest income scaled by total earning assets and interest expense scaled by interest-bearing liabilities. IRB Intensity is the share of risk-weighted assets of credit exposures measured utilizing the IRB methodologies. The set of bank-specific controls includes Size (log transformation of bank total assets in 2012 US dollars), Equity (the ratio between equity capital and total assets), Deposits (customer deposits scaled by total assets), Liquidity (liquid assets divided by total assets), NII (the share of total operating income due to non-interest income activities), LLP (loan loss provisions scaled by gross loans), Cost-to-Income (overheads divided by total operating income), Market Leader (a dummy that takes a value of one when the ratio of gross loans of bank *i* at year *t* over the sum of bank loans at the country level (taken from the World Bank) in year *t* is above the 75th percentile of the yearly sample distribution). Results reported in columns (1) and (2) concern regressions run, respectively, on subsamples below and above the sample median of domestic credit over GDP. Results reported in columns (3) and (4) concern regressions run, respectively, on subsamples below and above the sample median of stock market capitalization over GDP. Heteroscedasticity-robust standard errors, clustered at the bank level, are reported in parentheses. All specifications control for bank and country × year fixed effects. *, ** and *** denote statistical significance at the 10%, 5% and 1% level, respectively.

Table 10. IRB Intensity, loan portfolio spread and political connectedness

	(1) Political connectedness	(2)
	High	Low
IRB Intensity$_{t-1}$	0.001	0.002***
	(0.00)	(0.00)
Constant	0.011	0.020**
	(0.01)	(0.01)
Observations	9,572	13,036
R-squared	0.30	0.28
Number of banks	957	1,156
Error cluster	Bank	Bank
Bank-level controls	YES	YES
Bank FE	YES	YES
Country × year FE	YES	YES

This table shows regression results for the fixed-effects model concerning the impact of the IRB approach on the Spread measured as the difference between interest income scaled by total earning assets and interest expense scaled by interest-bearing liabilities. IRB Intensity is the share of risk-weighted assets of credit exposures measured utilizing the IRB methodologies. The set of bank-specific controls includes Size (log transformation of bank total assets in 2012 US dollars), Equity (the ratio between equity capital and total assets), Deposits (customer deposits scaled by total assets), Liquidity (liquid assets divided by total assets), NII (the share of total operating income due to non-interest income activities), LLP (loan loss provisions scaled by gross loans), Cost-to-Income (overheads divided by total operating income), Market Leader (a dummy that takes a value of one when the ratio of gross loans of bank *i* at year *t* over the sum of bank loans at the country level (taken from the World Bank) in year *t* is above the 75th percentile of the yearly sample distribution). Results reported in columns (1) and (2) concern regressions run, respectively, on subsamples of countries whose financial institutions are characterized by high and low levels of political connectedness. Heteroscedasticity-robust standard errors, clustered at the bank level, are reported in parentheses. All specifications control for bank and country × year fixed effects. *, ** and *** denote statistical significance at the 10%, 5% and 1% level, respectively.

evidence to support the theoretical claim that the decrease should be at least in part due to an improved lending quality resulting from the matching of IRB banks with better quality borrowers. More importantly, despite the reduced capital requirements of IRB adopters, and in sharp contrast to theoretical predictions, we find an increase in the average lending spreads when banks increasingly rely on IRB models to compute the capital requirements for credit risk.

Additional tests show that the higher average spreads for IRB adopters seem to be present in credit markets where the adopters have significant market power and are consequently sheltered from the competition of standardized banks. We also document that IRB banks benefit from the presence of borrowers facing constraints in selecting alternative lenders. Furthermore, IRB adopters enjoy greater spreads when political connectedness is low. Jointly, these tests indicate that IRB adopters exploit market frictions, and independence from political power, to avoid passing on the benefits of reduced capital requirements to their portfolio of borrowers, while possibly increasing borrowing costs charged to riskier borrowers. As a result, their competitive advantage in terms of capital requirements compared to standardized banks translates into an average loan spread improvement.

Our results offer important insights for both managers and policymakers. From a policymaking standpoint, our findings support the need to provide SA and IRB adopters with a level playing field. This would contain the benefits that the latter type of adopters enjoy in terms of reduced capital requirements and enhanced margins, compared to the former. The most recent Basel III reforms seem to lean towards addressing these shortcomings, by restoring credibility in the computation of RWA and improving the comparability of banks' capital ratios (Basel Committee on Banking Supervision, 2017).

Finally, our analyses offer valuable insights into the managerial implications of changes to the regulatory framework. Indeed, bank managers will have to revise their decision-making process to account for the new restrictions in the use of IRB models enforced from 2022 through the implementation of the Basel III reforms. These restrictions will clearly impact on the competitive benefits that IRB adopters enjoy in terms of capital requirements compared to standardized banks. More specifically, the phased-in implementation of an aggregate 'output floor' – according to which, by January 2027, banks' RWAs obtained via IRB models will be no lower than 72.5% of RWAs generated by the standardized approach – will place a limit on the regulatory capital benefit that IRB banks can derive relative to SA adopters (Basel Committee on Banking Supervision, 2017).[12] However, the implications of these changes for bank borrowers are less obvious from our results. Indeed, IRB banks not facing significant competitive pressures and political interference do not seem to anchor their pricing strategy in the lending market to the capital requirements computed via internal ratings. Future studies could therefore explore whether the phased-in regulatory changes will have been effective in addressing the shortcomings that emerged from our research, regardless of the institutional features characterizing the market being considered.

[12]The use of such a backstop therefore aims at reducing the variability of RWAs between IRB and SA banks, by limiting the extent to which the former type of banks can lower their capital requirements relative to the latter.

Acknowledgements

I would like to thank Douglas Cumming (Editor) and three anonymous reviewers for extensive insightful comments and suggestions. I am particularly grateful to Kevin Keasey and Francesco Vallascas for their guidance. I am also thankful to Nadia Massoud, Vincenzo Capizzi, Jens Hagendorff, Robert Hudson, Mark Rhodes, Xing Huan, Yiyuan Zhou, as well as conference participants at the 32nd Australasian Finance and Banking Conference held in Sydney (Australia) in December 2019 and at the Financial Management & Accounting Research Conference held in Limassol (Cyprus) in June 2022, for constructive and helpful comments on earlier versions of this paper. Special thanks go to Adolfo Barajas, Ralph Chami and Thomas Cosimano who kindly shared their valuable dataset on Basel I implementation dates.

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