Does Bank Efficiency Influence the Cost of Credit?

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Abstract

Using a large sample of firms from nine European countries, this study examines the relationship between bank efficiency and the cost of credit for borrowing firms. We hypothesize that bank efficiency – the ability of banks to operate at lower costs – is associated with lower loan rates and thus lower cost of credit. Combining firm-level and bank-level data, we find support for this prediction. The effect of bank efficiency on the cost of credit varies with firm and bank size. Bank efficiency reduces cost of credit for SMEs, but does not exert a significant influence for micro companies and large firms. Furthermore, the effect is driven by large banks, where improvements in cost efficiency tend to be strongly associated with lower cost of credit. Overall, our results indicate that measures that increase bank efficiency can foster access to credit.

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1. Introduction

Cost efficiency of banks is a broad measure of bank performance that has frequently been utilized in the empirical banking literature in the last two decades. It measures the ability of a bank to operate at lower cost by comparing its cost structure to that of a best-practice bank. A vast literature on bank efficiency has focused on measuring the level and determinants of bank efficiency around the world[1] with the goal of improving the performance of financial institutions.[2]

Surprisingly, while the determinants of bank efficiency have been systematically explored, the consequences of bank efficiency have received much less attention. Exceptions are papers focusing on the impact of bank efficiency on financial stability (e.g., Berger and DeYoung, 1997, Roman et al., 2016), economic growth (Lucchetti, Papi and Zazzaro, 2001; Hasan, Koetter and Wedow, 2009) and the transmission of monetary policy (Havranek, Irsova and Lesanovska, 2016). One important omission to this list is the effect of bank efficiency on the cost of credit. This omission is rather surprising because economic theory naturally predicts that a greater ability of banks to operate with lower marginal cost should be associated with lower "prices" – lower loan rates and thus lower cost of credit. If correct, this argument would imply that a key instrument for facilitating firms' access to credit is to improve bank efficiency.

This paper aims to fill a gap in the literature by investigating how bank efficiency affects the cost of credit in nine Western European countries. A major challenge in analyzing the impact of bank efficiency on the cost of credit is obtaining firm-level information on lending banks, so that efficiency at the bank level and cost of credit at the firm level can be linked. The last wave of the Amadeus database provides such information, allowing us to identify which banks lend to each borrowing firm. Thus, we can combine firm-level data from the Amadeus database with bank-level data from the

[1] See for instance Berger, Hasan and Zhou (2009) on China, Fuji, Managi and Matousek (2014) on India, Goddard, Molyneux and Williams (2014) on Latin America.

[2] For instance, Bonin, Hasan and Wachtel (2005) focus on the effects of ownership structure, Berger and Bonaccorsi di Patti (2006) on the role of capital structure, and Barth et al. (2013) on the impact of bank regulation.

Bankscope database to build a large sample of 240,000 firms from nine European countries.

To perform our investigation, we model cost of credit as a function of bank efficiency and a set of firm- and country-specific control variables. We measure bank efficiency with a stochastic frontier approach commonly used in works on the banking industry (e.g., Lensink, Meesters and Naaborg, 2008; Berger, Hasan and Zhou, 2009). We use different specifications of the stochastic frontier approach designed for a cross-country analysis by testing the influence of country-specific variables controlling for the environmental conditions in the frontier. We also investigate whether the effect of bank efficiency on the cost of credit is contingent on firm and bank size, and perform several robustness checks to examine the robustness of our results to different specifications of key variables and subsamples.

We face two key challenges in our investigation. First, while we can identify the lending banks for each firm, we do not have information on the share of each bank in the loans to the company. Therefore, we must assign to each bank an equal weight in its importance for a firm. This is an important limitation, but we address it by conducting additional estimations on the subsample of firms that use only one bank, for which therefore this problem does not exist. One-bank firms represent about 40% of the sample and thus provide a large enough sample to perform alternative estimations.

Second, measuring cost of credit at the firm level is difficult. Information on individual loans can be found in credit registries but is limited to single-country datasets, or can be obtained for large loans in a cross-country framework. These data sources are problematic if one wishes, as we do, to analyze cost of credit in a number of countries for a wide spectrum of firm size. To overcome these challenges, we therefore measure the cost of credit by calculating the ratio of interest expenses to total bank debt using firm-level data. This indicator measuring the implicit interest rate charged by banks has also been used by Carbo-Valverde, Rodriguez-Fernandez, and Udell (2009) and Fungacova, Shamshur and Weill (2017).

Our paper contributes to two debates in the literature. First, we augment the vast literature on bank efficiency by investigating the impact of the cost efficiency of banks on the cost of credit for firms. Second, we improve our understanding of how bank behavior

shapes access to credit. Several studies have investigated how bank competition and concentration influence access to credit (e.g., Beck, Demirgüc-Kunt and Maksimovic, 2004). Our work departs significantly from the existing empirical literature by focusing on the role of bank efficiency.

This work has important implications. From a normative perspective, the finding that greater efficiency reduces cost of credit provides support for policies aimed at improving bank efficiency. From a positive perspective, our findings help explain observed differences in the cost of credit across European countries. Our results also suggest that convergence in cost efficiency across European countries would facilitate convergence in the cost of credit for firms.

The paper proceeds as follows. Section 2 presents the data. Section 3 explains the efficiency scores and the econometric model. Section 4 reports the results. Section 5 concludes.

2. Data

To study whether bank efficiency affects firm cost of credit, both firm-level data and bank-level data need to be collected. The firm-level data come from the Amadeus database provided by Bureau van Dijk, which contains comprehensive financial information on public and private companies across Europe. The vast majority of firms in Amadeus report unconsolidated financial statements; consolidated statements are provided mainly by the large companies only. In our dataset, we use unconsolidated financial statements to avoid double counting firms and subsidiaries or operations abroad and exclude firms that report only consolidated statements. We exclude firms operating in the financial intermediation sector and insurance industries (NACE codes 64–66) because they have a different liability structure and cannot be similarly taken into account in our investigation explaining cost of credit.

The bank-level data used to compute bank efficiency come from the Bankscope database. We further match bank-level information to firm-level information by taking advantage of the recent Amadeus update that includes information about lending banks

for each firm. We link both databases by carefully checking the identity of lending banks and matching it to banks available in Bankscope.

We focus on old EU countries for our investigation since these countries represent a consistent sample of developed countries without the specific characteristics of new EU countries. Namely new EU countries are former or still transition countries with specific populations of firms and particular features for the banking sector, e.g. the massive market share of foreign banks, which can raise cost of credit and impede access to credit.

Firm-level information on the lending banks is available for nine old EU countries: Austria, France, Germany, Greece, Ireland, the Netherlands, Portugal, Spain, and the United Kingdom. We have a cross-section of firms for the year 2015 since information on the lending banks is only available for the last wave of Amadeus.

The key firm-level variable is *Cost of credit.* It is defined as the difference between the ratio of financial expenses divided by bank debt and the country's nominal short-term interest rate, where bank debt is the sum of short-term bank debt ("loans") and long-term bank debt ("long-term debt"). This measure of the implicit interest rate, which accords with Carbo-Valverde, Rodriguez-Fernandez, and Udell (2009),[3] has been used to measure cost of credit by Fungacova, Shamshur and Weill (2017). It captures the cost of credit well because the vast majority of our sample consists of micro and small enterprises that lack access to non-bank funding sources, so their financial expenses are mainly loan expenses.

We consider two firm-level control variables taken from the literature. The first is *Firm size* measured as the log of total assets as firms of different size can differ in their financing patterns. The second is *Tangibility*, defined as the ratio of tangible fixed assets to total assets. A greater share of tangible fixed assets that could serve as collateral can contribute to easier access to credit.

To check whether the impact of bank efficiency on the cost of credit is influenced by firm size, we further consider separately micro firms (i.e. firms with fewer than ten employees or a turnover or total assets less than 2 million euros), small and medium-sized firms (either less than 250 employees or a turnover less than 50 million euros or

[3] Carbo-Valverde, Rodriguez-Fernandez, and Udell (2009) compute the loan interest spread as the difference between the ratio of loan expenses to bank loans outstanding and the interbank interest rate.

balance sheet total less than 43 million euros) and large firms.[4] Micro firms (30 %), and small and medium-sized firms (67 %) together represent 97 % of the entire sample.

We consider four country-specific control variables. We control for banking development with *Private credit* defined as the ratio of private credit by deposit money banks and other financial institutions to GDP, which comes from the Global Financial Development Database. *GDP per capita* and *Inflation* take into account macroeconomic conditions and are both extracted from the World Development Indicators. *Rule of law* measures institutional quality and comes from the Worldwide Governance Indicators.

After dropping observations for which firm-level information or the identity of the lending bank(s) are not available, we have a sample of 377,925 firm-bank observations for about 240,000 firms. Descriptive statistics of all variables are presented in Table 1. Table 2 reports the number of banks per firm in the sample. The vast majority of firms use only a few banks: 40.6% of firms have only one bank, while 82.05% of firms have no more than three banks. The definitions of all variables are provided in the Appendix.

3. Methodology

3.1 Bank efficiency

Cost efficiency measures a difference between bank's actual cost and its optimal cost for producing the same bundle of outputs. This difference then provides information on inefficiencies in the production process and on the optimality of the chosen mix of inputs. To estimate cost efficiency scores, we utilize a stochastic frontier approach. This technique has been widely used in studies on banking efficiency (e.g., Bonin, Hasan and Wachtel, 2005; Berger, Hasan and Zhou, 2009). It decomposes the distance from the efficiency frontier into an inefficiency term and a random error, which represents random disturbances reflecting luck or measurement errors. We assume a normal distribution for the random error and a half-normal distribution for the inefficiency term. Following Jondrow et al. (1982), bank-specific estimates of inefficiency terms can then be calculated using the distribution of the inefficiency term conditional on the estimate of

[4] This classification is employed by the European Commission. For further details see http://ec.europa.eu/eurostat/web/structural-business-statistics/structural-business-statistics/sme

the composite error term (i.e., the sum of the inefficiency term and the random error).

We adopt the intermediation approach for the specification of banking inputs and outputs. This approach assumes that the bank collects deposits to transform them into loans with capital and labor. We consider two outputs in the cost function: loans and investment assets. We also employ three input prices. The price of funds is calculated as the interest rate paid on borrowed funds, the price of labor is defined as personnel expenses divided by total assets, and the price of physical capital is calculated as the ratio of other operating expenses to fixed assets. Total cost is the sum of the costs incurred for borrowed funds, labor, and physical capital. We employ the commonly-used translog form to model the cost frontier of banks. The cost frontier model we estimate is then formulated as follows:

$$\ln\left(\frac{TC}{w_3}\right) = \beta_0 + \sum_m \alpha_m \ln y_m + \sum_n \beta_n \ln\left(\frac{w_n}{w_3}\right) + \frac{1}{2}\sum_m \sum_j \alpha_{mj} \ln y_m \ln y_j + \frac{1}{2}\sum_n \sum_k \beta_{nk} \ln\left(\frac{w_n}{w_3}\right)\ln\left(\frac{w_k}{w_3}\right) + \sum_n \sum_m \gamma_{nm} \ln\left(\frac{w_n}{w_3}\right)\ln y_m + \varepsilon, \quad (1)$$

where TC is total cost, y_m is the m^{th} bank's output (m = 1, 2), w_n is the n^{th} input price (n = 1, 2), and w_3 is the price of borrowed funds. For simplicity of presentation, the indices for each bank have been dropped. Homogeneity conditions are imposed by normalizing total costs, price of labor and price of physical capital, by the price of borrowed funds.

An issue emerges when estimating a cross-country frontier for European countries: the inclusion of country-level variables in the frontier. Many cross-country studies on bank efficiency have estimated a common frontier pooling all banks without including country-level variables (e.g., Casu and Girardone, 2006; Fiordelisi, Marques-Ibanez and Molyneux, 2011).

However, Lozano-Vivas, Pastor and Pastor (2002) have pointed out that the omission of country-level variables in the estimation of the frontier leads to a misinterpretation of the cross-country differences in efficiency. These differences can be attributed to differences in managerial performance but they can also result from differences in environmental characteristics. For instance, a bank can benefit from a

greater income per capita in a country, which contributes to raise its outputs for exogenous reasons. Consequently, they conclude that estimating a common frontier without considering environmental conditions "is not able to compare the different banking systems on an equal footing" (Lozano-Vivas, Pastor and Pastor, 2002, p.73).

Therefore, a number of cross-country works on bank efficiency followed this paper by including country-level variables in the estimation of the frontier to provide a relevant analysis of cross-country differences in efficiency in Europe (e.g., Lensink, Meesters and Naaborg, 2008; Hasan, Koetter and Wedow, 2009).

In our study, we focus on the relationship between bank efficiency and cost of credit and, therefore, do not examine the causes of inefficiencies. Our hypothesis is that the more efficient bank can provide cheaper loans to its customers no matter if it is related to better managerial performance or better environment. Nonetheless, the frequent inclusion of country-level variables in the estimation of efficiency frontiers motivates us to test different specifications so that we assess the sensitivity of our findings to this choice.

We therefore estimate efficiency scores using three alternative specifications for the cost frontier. First, we estimate a common frontier without country-level variables. With this specification, efficiency scores measure the cost performance of each bank to a common frontier for all countries and do not account for the environmental differences across countries. Second, we estimate a common frontier including country fixed effects to control for cross-country differences. Third, a common frontier is estimated with country-level variables. We consider four country-level variables that have been used in former works estimating common frontiers with environmental variables (e.g., Lozano-Vivas, Pastor and Pastor, 2002; Hasan, Koetter and Wedow, 2009). These are the same country-level variables included in some of our regressions explaining cost of credit. With both latter specifications, efficiency scores measure the cost performance of each bank relative to a common frontier for all countries taking into account environmental differences across countries.

The descriptive statistics for the three types of efficiency scores are reported for the full sample in Table 1. We observe that the average bank efficiencies are of the same order of magnitude with respectively 73.8%, 75.7%, and 74.5% for the frontiers without

country variables, with country fixed effects, and with country control variables.

3.2 Econometric specifications

To analyze the relationship between bank efficiency and cost of credit, we run regressions of cost of credit on the efficiency score and a set of control variables:

$$y_{ij} = \alpha + \beta X_{ij} + \gamma Z_j + Efficiency_{ij} + \varepsilon_{ij}, \quad (2)$$

where y_{ij} is the cost of bank credit for firm *i* in country *j*; *X* is a set of firm-specific variables (*Firm size, Tangibility*); *Z* is a set of country-level variables (*Private credit, Rule of law, GDP per capita, Inflation*); *Efficiency* is the measure of bank efficiency, and ε is a random error term. We also include industry fixed effects in the estimations to control for the influence of the industry on the cost of credit. We estimate the equation (2) by including either country fixed effects or a set of country-level variables so that we test the robustness of our findings to different specifications.

The endogeneity problem is greatly reduced in our setting for the empirical investigation since bank efficiency is computed at the bank level, while cost of credit is a firm-level information obtained from a different data source. It is therefore unlikely that cost of credit can exert an impact on bank efficiency.

4. Results

This section reports the results. We first present the main estimations and then provide additional results by firm size and by bank size. We continue with several robustness tests.

4.1 Main estimations

Table 4 reports the results of the main estimations. We consider six different specifications based on the choice of the efficiency frontier and the inclusion of country control variables or country fixed effects.

We find that *Bank efficiency* is negatively related to the cost of credit. The estimated coefficient is significant in four specifications out of six tested. Therefore, our main conclusion is that bank efficiency has a negative influence on cost of credit. In other words, our findings support the view that higher bank efficiency is associated with the lower cost of credit. This is in line with the idea that a greater ability of banks to minimize their costs is transferred to borrowers through the cost of credit. Thus, our findings are of particular importance to the policy makers who aim to design policies favoring access to credit. Specifically, fostering bank efficiency could play an important role in the financing of the economy in whole.

The estimated coefficients of the firm-level control variables have the expected sign. *Size* is negatively related to cost of credit, which is consistent with the view that larger firms have lower cost of credit. Furthermore, *Tangibility* is negative as the greater tangibility of assets provides more collateral and contributes therefore to diminish cost of credit. When including country-level control variables, we point out that both *Private Credit* and *GDP per capita* have a negative impact on cost of credit. These findings accord with the view that greater financial development and economic development are associated with lower cost of credit, through lower information asymmetries (Godlewski and Weill, 2011). *Rule of law* is positive, which contrasts with the expectation that better institutional framework would reduce cost of credit, while *Inflation* is negative. It must however be stressed that our sample is a cross-section of firms from nine countries. As such, country-level variables intend to control for the influence of country-specific environment on the cost of credit, but should not be used to draw general conclusions on the relation between country variables and the cost of credit.

4.2 Estimations by firm size

Our main results show that bank efficiency exerts a negative influence on the cost of credit. We further investigate whether the effect of bank efficiency on the cost of credit varies with the size of a firm. This issue is of utmost interest since small firms are particularly affected by lower access to credit and have been shown to suffer the most

from higher loan rates charged by banks.[5] We therefore investigate whether higher bank efficiency is associated with the lower cost of credit for all types of firms.

We re-estimate our regressions by considering separately the following groups of firms: micro companies, SMEs, and large companies. We report the results by type of efficiency frontier in Tables 5 to 7. Overall the results on the relation between bank efficiency and cost of credit are consistent across the tested efficiency frontiers.

We find that bank efficiency is generally not significant for micro enterprises and for large companies. However, bank efficiency is significantly negative for SMEs in four out of the six tested specifications. We therefore support the view that the negative impact of bank efficiency on cost of credit is only observed for SMEs, while no relation can be found for micro enterprises and large companies.

The implications of these results are then straightforward. Greater bank efficiency is particularly beneficial for SMEs. It does not seem to facilitate access to credit for micro enterprises or large companies through lower cost of credit. While large firms can rely on other sources of financing, the design of policies favoring bank efficiency would not foster access to credit for all firms suffering from high loan rates. Still, we show that greater bank efficiency can facilitate access to credit for SMEs, even if micro enterprises do not benefit from this.

4.3 Estimations by bank size

Our main estimations indicate that greater bank efficiency contributes to lower cost of credit, i.e., clients of more cost-efficient banks benefit from their lower costs through cheaper loans. However, the literature has been widely debating the optimal bank size. Recent studies demonstrate the potentially detrimental influence of too large banks for financial stability (Vinals et al., 2013; Laeven, Ratnovski and Tong, 2014). We therefore investigate whether the transmission of bank efficiency to loan pricing varies by bank size.

[5] Based on a survey on managers mostly from small companies, Beck et al. (2006) show that « high interest rates » is the main financing obstacle for firms all around the world.

There is a number of reasons why banks of different sizes can differ in terms of transmission of their cost to loan prices. First, banks of different sizes differ in terms of clientele. Berger et al. (2005) and Berger, Bouwman and Kim (2017) show that large banks grant less loans to small businesses. They tend to specialize in lending to larger companies because they can use "hard", quantitative information obtained from audited financial statements. Small banks, instead, have a comparative advantage in lending to small companies by utilizing "soft", qualitative information gathered over the course of a relationship established with a small business. Second, large banks also differ from small banks in terms of their business model. As pointed out by Laeven, Ratnovski and Tong (2014), a greater size allows large banks to have a greater range of activities resulting in better diversification. Large banks can consequently be focusing on a different set of activities than small banks.

The pressure for a bank to transmit its lower costs to prices could vary significantly across clients and activities. Banks have incentives to transmit their lower costs to prices only in a competitive environment. In the absence of competition, banks can use lower costs to enhance profits rather than reduce bank prices, which would benefit their shareholders at the expense of clients. Different activities by small and large banks can be associated with different degree of competition and therefore would result in different transmission of their cost efficiency to cost of credit.

To test empirically whether the effect of bank efficiency on the cost of credit differs for large and small banks, we create a dummy variable *Large bank* that equals to one if a bank belongs to the Top 25% of banks in terms of assets and zero otherwise. We include this variable and the interaction term *Bank efficiency* × *Large bank* in the estimations. The interaction term captures the impact of bank size on the relationship between bank efficiency and cost of credit. Table 8 reports the results. We observe that the interaction term *Bank efficiency* × *Large bank* is negative in all estimations and significant in the specifications with country-specific control variables.

We therefore provide evidence that the impact of bank efficiency on the cost of credit is influenced by bank size. Specifically, higher efficiency of large banks contributes more to lower cost of credit than higher efficiency of small banks. From a

policy perspective, this conclusion suggests that gains in efficiency for large banks provide more benefits in terms of reduced cost of credit than gains in efficiency for small banks. As a consequence, authorities should particularly encourage efforts to improve efficiency in large banks.

4.4 Robustness tests

We perform a variety of robustness checks. First, we redo the estimations on the subsample of firms that use only one bank. A potential criticism of our investigation deals with the absence of information on the breakdown of loans by bank for each firm. As a consequence, we consider all the banks providing loans to a firm and look at the impact of their efficiency levels on the cost of credit of the firm. The composition of the sample is however such that the vast majority of firms maintain the relationship with rather small number of banks, which reduces this potential problem.

We can however allow for a clean identification at the cost of reducing the sample size by performing the estimations only for firms with one bank. These firms represent about 40% of the observations in our sample, so they provide a sample large enough to perform relevant estimations. These estimations are displayed in Table 9. We observe a significantly negative coefficient for bank efficiency in all estimations, meaning that greater efficiency of banks is associated with the lower cost of credit for firms. These results are not only consistent with the results obtained on the full sample, but also, as expected, stronger – the estimated coefficient is negative and significant in all six specifications.

Second, we utilize an alternative measure for the cost of credit. Following Fungacova, Shamshur and Weill (2017), we redefine cost of credit as interest paid divided by total debt, since information on interest paid is available in the Amadeus database for a large number of firms. The results are reported in Table 10. We still observe that the estimated coefficient of bank efficiency is negative in all estimations, but it is significant only in estimations with country fixed effects. Therefore, these results generally align with our main estimations and thus provide additional support for our key finding.

Third, we perform the estimations excluding France and Spain. As approximately 70% of firms are located in these countries, one can wonder if our findings are preserved when we exclude firms from these countries. Table 11 displays these estimations. We point out that the coefficient on bank efficiency is negative and significant in all estimations. Therefore, our selection of countries does not drive the main results.

5. Conclusion

In this paper we examine the impact of bank efficiency on the cost of credit. We combine firm-level data with bank-level data so that we can identify the level of efficiency of banks lending money to each firm. We are then able to perform estimations on a large sample of 240,000 companies from nine European countries.

Our key finding is that higher bank efficiency is associated with lower cost of credit. Therefore, we support the view that a greater ability of banks to minimize costs is transferred to borrowing firms through lower cost of credit. This conclusion is robust to the alternative definition of the cost of credit, the alternative specifications of the frontier, the country sample composition, the set of control variables, and the restriction of the sample to one-bank firms.

We also observe that the impact of bank efficiency on cost of credit differs with the size of the firm. Namely, bank efficiency diminishes cost of credit only for SMEs, while the relation is not significant for micro companies and large companies. Finally, we find that greater cost efficiency is transmitted to lower cost of credit mainly by large banks.

The normative implications of our findings are that taking measures that enhance efficiency of banks, and in particular of large banks, could diminish cost of credit for firms. Therefore, policies favoring bank efficiency should be implemented to facilitate access to credit. Literature on bank efficiency has identified a large set of determinants including bank ownership, and capital structure. Authorities can therefore design policies enhancing bank efficiency to foster access to credit and thus to improve the financing of the economy.

From a positive perspective, our work can help understanding the cross-country differences in cost of credit. Namely, bank efficiency plays a role in cost of credit and as

such should be taken into account next to the degree of competition or the development of banking markets.

In addition to these implications, our results are of importance for researchers since they provide a major reason to investigate the level and the determinants of bank efficiency. Our research is an initial step toward understanding of the effects of bank efficiency on cost of credit. Further work is needed to check the relevance of our results with alternative datasets, in particular in emerging and developing countries, where companies suffer the most from the high cost of credit.

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Table 1.
Descriptive statistics

This table provides descriptive statistics for the variables used in the estimations. Definitions of variables are provided in the Appendix.

	Obs	Mean	Std. Dev.	Min	Max
Firm-level variables					
Firm size	377 925	0.808	1.616	-5.036	5.048
Tangibility	377 925	0.258	0.238	0.000	0.975
Cost of credit	377 925	0.069	0.083	0.000	0.619
Country-level variables					
Private credit	377 925	113.6	14.4	77.5	134.7
Rule of law	377 925	1.104	0.337	0.242	1.935
GDP per capita	377 925	32 301	7 462	21 969	51 258
Inflation	377 925	-0.197	0.504	-1.736	0.897
Bank Efficiency					
No country controls	377 925	0.738	0.071	0.135	0.969
Country fixed effects	377 925	0.757	0.072	0.141	0.970
Country-level controls	377 593	0.745	0.074	0.133	0.969

Table 2.
Number of banks per firm

This table provides descriptive statistics for the number of banks used by firms. Definitions of variables are provided in the Appendix.

Banks	Frequency	Percent	Cumulative percent
1	153 438	40.6	40.6
2	84 921	22.47	63.07
3	71 713	18.98	82.05
4	36 615	9.69	91.73
5	18 740	4.96	96.69
6	8 052	2.13	98.82
7	2 854	0.76	99.58
8	1 027	0.27	99.85
9	387	0.1	99.95
10	138	0.04	99.99
11	40	0.01	100
Total	377 925	100	

Table 3.
Bank efficiency scores and sample composition by country

This table provides the descriptive statistics for the three types of efficiency scores and the number of observations, banks, and firms by country.

	No country controls		Country fixed effects		Country-level variables		Obs.	Banks	Firms
	Mean	Std dev.	Mean	Std dev.	Mean	Std dev.			
Austria	0.744	0.085	0.766	0.081	0.751	0.084	3 696	238	2 143
Germany	0.757	0.108	0.747	0.107	0.759	0.108	18 281	1 257	9 474
Spain	0.751	0.065	0.780	0.061	0.765	0.062	183 401	180	94 933
France	0.735	0.066	0.736	0.069	0.731	0.065	79 815	214	79 815
United Kingdom	0.788	0.113	0.791	0.110	0.792	0.113	12 229	52	12 188
Greece	0.643	0.027	0.791	0.016	0.590	0.029	14 848	10	6 556
Ireland	0.809	0.059	0.841	0.055	0.828	0.111	1 674	23	1 673
Netherlands	0.598	0.135	0.661	0.121	0.610	0.134	235	17	182
Portugal	0.712	0.044	0.706	0.046	0.727	0.042	65 420	115	33 699

Table 4.
Main estimations

This table presents the results of OLS regressions examining the relation between cost of credit and bank efficiency. Definitions of variables are provided in the Appendix. Standard errors (in brackets) are robust to arbitrary heteroskedasticity. *, **, and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

	Dependent variable = Cost of credit					
	No country controls		Country FEs		Country-level controls	
Bank efficiency	-0.009***	-0.003	-0.011***	-0.006***	-0.009***	0.002
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Firm size	-0.002***	-0.002***	-0.002***	-0.002***	-0.002***	-0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Tangibility	-0.046***	-0.044***	-0.046***	-0.044***	-0.046***	-0.044***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Private credit		-0.000***		-0.000***		-0.000***
		(0.000)		(0.000)		(0.000)
Rule of law		0.019***		0.019***		0.020***
		(0.002)		(0.002)		(0.002)
GDP per capita		-0.000***		-0.000***		-0.000***
		(0.000)		(0.000)		(0.000)
Inflation		-0.026***		-0.026***		-0.026***
		(0.001)		(0.001)		(0.001)
Constant	0.079***	0.111***	0.080***	0.112***	0.082***	0.109***
	(0.008)	(0.010)	(0.008)	(0.010)	(0.010)	(0.010)
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	No	Yes	No	Yes	No
R^2	0.038	0.036	0.038	0.036	0.038	0.036
N	379,599	377,925	379,599	377,925	377,950	377,593

Table 5.
Estimations by firm size: Efficiency frontier with no country variables

This table presents the results of OLS regressions examining the relation between cost of credit and bank efficiency. Efficiency scores are estimated with a cross-country stochastic frontier with no country variables. Definitions of variables are provided in the Appendix. Standard errors (in brackets) are robust to arbitrary heteroskedasticity. *, **, and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

	Dependent variable = *Cost of credit*					
	Micro		SME		Large	
Bank efficiency	-0.007	-0.005	-0.009***	-0.003	-0.010	-0.013
	(0.004)	(0.004)	(0.003)	(0.002)	(0.010)	(0.010)
Firm size	-0.006***	-0.006***	-0.002***	-0.001***	0.004***	0.004***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
Tangibility	-0.043***	-0.043***	-0.047***	-0.045***	-0.048***	-0.050***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.004)	(0.004)
Private credit		-0.000		-0.000***		-0.000***
		(0.000)		(0.000)		(0.000)
Rule of law		0.033***		0.021***		-0.032***
		(0.012)		(0.002)		(0.008)
GDP per capita		-0.000		-0.000***		0.000***
		(0.000)		(0.000)		(0.000)
Inflation		-0.035***		-0.027***		-0.005
		(0.005)		(0.001)		(0.004)
Constant	0.046***	0.002	0.075***	0.117***	0.217***	0.256***
	(0.016)	(0.021)	(0.009)	(0.011)	(0.010)	(0.014)
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	No	Yes	No	Yes	No
R^2	0.046	0.046	0.037	0.036	0.080	0.076
N	112,652	112,425	254,127	252,754	12,820	12,746

Table 6.
Estimations by firm size: Efficiency frontier with country fixed effects

This table presents the results of OLS regressions examining the relation between cost of credit and bank efficiency. Efficiency scores are estimated with a cross-country stochastic frontier with country fixed effects. Definitions of variables are provided in the Appendix. Standard errors (in brackets) are robust to arbitrary heteroskedasticity *, **, and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

	Dependent variable = *Cost of credit*					
	Micro		SME		Large	
Bank efficiency	-0.007	-0.006	-0.010***	-0.006**	-0.014	-0.023**
	(0.004)	(0.004)	(0.003)	(0.003)	(0.011)	(0.011)
Firm size	-0.006***	-0.006***	-0.002***	-0.001***	0.004***	0.004***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
Tangibility	-0.043***	-0.043***	-0.047***	-0.045***	-0.048***	-0.050***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.004)	(0.004)
Private credit		-0.000		-0.000***		-0.000***
		(0.000)		(0.000)		(0.000)
Rule of law		0.033***		0.021***		-0.033***
		(0.012)		(0.002)		(0.008)
GDP per capita		-0.000		-0.000***		0.000***
		(0.000)		(0.000)		(0.000)
Inflation		-0.035***		-0.027***		-0.005
		(0.005)		(0.001)		(0.004)
Constant	0.046***	0.004	0.076***	0.118***	0.220***	0.260***
	(0.016)	(0.022)	(0.009)	(0.011)	(0.010)	(0.014)
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	No	Yes	No	Yes	No
R^2	0.046	0.046	0.037	0.036	0.080	0.076
N	112,652	112,425	254,127	252,754	12,820	12,746

Table 7.
Estimations by firm size: Efficiency frontier with country variables

This table presents the results of OLS regressions examining the relation between cost of credit and bank efficiency. Efficiency scores are estimated with a cross-country stochastic frontier with country variables. Definitions of variables are provided in the Appendix. Standard errors (in brackets) are robust to arbitrary heteroskedasticity *, **, and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

	Dependent variable = *Cost of credit*					
	Micro		SME		Large	
Bank efficiency	-0.007	-0.004	-0.008***	0.002	-0.011	-0.011
	(0.004)	(0.004)	(0.003)	(0.002)	(0.011)	(0.010)
Firm size	-0.006***	-0.006***	-0.002***	-0.001***	0.004***	0.004***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
Tangibility	-0.043***	-0.043***	-0.047***	-0.045***	-0.048***	-0.050***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.004)	(0.004)
Private credit		-0.000		-0.000***		-0.000***
		(0.000)		(0.000)		(0.000)
Rule of law		0.032***		0.022***		-0.032***
		(0.012)		(0.002)		(0.008)
GDP per capita		-0.000		-0.000***		0.000***
		(0.000)		(0.000)		(0.000)
Inflation		-0.034***		-0.027***		-0.005
		(0.005)		(0.001)		(0.004)
Constant	0.027	0.000	0.079***	0.115***	0.218***	0.254***
	(0.018)	(0.022)	(0.011)	(0.011)	(0.010)	(0.013)
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	No	Yes	No	Yes	No
R^2	0.046	0.046	0.037	0.036	0.080	0.076
N	112,460	112,425	252,753	252,449	12,737	12,719

Table 8.
The impact of bank size

This table presents the results of OLS regressions examining the relation between cost of credit and bank efficiency. Large bank is a dummy variable equal to one if the bank belongs to the top 25% of banks in terms of total assets and zero otherwise. Definitions of variables are provided in the Appendix. Standard errors (in brackets) are robust to arbitrary heteroskedasticity *, **, and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

	Top 25% of banks in terms of total assets					
	No country controls		Country FEs		Country-level controls	
Bank efficiency	-0.006**	0.009***	-0.006*	0.005	-0.004	0.014***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Bank efficiency × Large bank	0.000	-0.024***	-0.005	-0.018***	-0.004	-0.030***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Large bank	0.001	0.020***	0.005	0.015***	0.004	0.024***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Size	-0.002***	-0.002***	-0.002***	-0.002***	-0.002***	-0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Tangibility	-0.046***	-0.044***	-0.046***	-0.044***	-0.046***	-0.044***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Private credit		-0.000***		-0.000***		-0.001***
		(0.000)		(0.000)		(0.000)
Rule of law		0.024***		0.023***		0.027***
		(0.002)		(0.002)		(0.002)
GDP per capita		-0.000***		-0.000***		-0.000***
		(0.000)		(0.000)		(0.000)
Inflation		-0.028***		-0.027***		-0.030***
		(0.001)		(0.001)		(0.001)
Constant	0.077***	0.107***	0.076***	0.109***	0.078***	0.106***
	(0.008)	(0.010)	(0.008)	(0.010)	(0.011)	(0.010)
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	No	Yes	No	Yes	No
R^2	0.038	0.037	0.038	0.037	0.038	0.037
N	379,599	377,925	379,599	377,925	377,950	377,593

Table 9.
Robustness check: One-bank relationship firms only

This table presents the results of OLS regressions examining the relation between cost of credit and bank efficiency. The sample only includes firms with one bank. Definitions of variables are provided in the Appendix. Standard errors (in brackets) are robust to arbitrary heteroskedasticity *, **, and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

	Dependent variable = *Cost of credit*					
	No country controls		Country fixed effects		Country-level controls	
Bank efficiency	-0.010***	-0.009***	-0.012***	-0.010***	-0.009***	-0.006*
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Firm size	-0.000***	-0.000*	-0.000***	-0.000*	-0.000**	-0.000*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Tangibility	-0.046***	-0.045***	-0.046***	-0.045***	-0.046***	-0.045***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Private credit		-0.000***		-0.000***		-0.000***
		(0.000)		(0.000)		(0.000)
Rule of law		0.001		0.002		0.001
		(0.004)		(0.004)		(0.004)
GDP per capita		-0.000		-0.000		-0.000
		(0.000)		(0.000)		(0.000)
Inflation		-0.016***		-0.016***		-0.016***
		(0.002)		(0.002)		(0.002)
Constant	0.080***	0.117***	0.082***	0.118***	0.082***	0.116***
	(0.009)	(0.011)	(0.009)	(0.011)	(0.011)	(0.011)
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	No	Yes	No	Yes	No
R^2	0.030	0.029	0.030	0.029	0.030	0.029
N	155,110	153,438	155,110	153,438	153,465	153,109

Table 10.
Robustness check: Alternative measure of cost of credit

This table presents the results of OLS regressions examining the relation between cost of credit and bank efficiency. Cost of credit is measured by the ratio of interest paid to total debt. Definitions of variables are provided in the Appendix. Standard errors (in brackets) are robust to arbitrary heteroskedasticity *, **, and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

	Dependent variable = *Cost of credit*					
	No country controls		Country fixed effects		Country-level controls	
Bank efficiency	-0.005***	-0.001	-0.005***	-0.001	-0.005***	0.002
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Firm size	-0.004***	-0.003***	-0.004***	-0.003***	-0.004***	-0.003***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Tangibility	-0.031***	-0.029***	-0.031***	-0.029***	-0.031***	-0.029***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Private credit		-0.001***		-0.001***		-0.001***
		(0.000)		(0.000)		(0.000)
Rule of law		0.050***		0.051***		0.051***
		(0.001)		(0.001)		(0.001)
GDP per capita		-0.000***		-0.000***		-0.000***
		(0.000)		(0.000)		(0.000)
Inflation		-0.035***		-0.035***		-0.036***
		(0.001)		(0.001)		(0.001)
Constant	0.066***	0.130***	0.067***	0.130***	0.070***	0.129***
	(0.008)	(0.010)	(0.008)	(0.010)	(0.010)	(0.010)
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	No	Yes	No	Yes	No
R^2	0.043	0.041	0.043	0.041	0.042	0.041
N	373,230	371,567	373,230	371,567	371,593	371,240

Table 11.
Robustness check: Without France and Spain

This table presents the results of OLS regressions examining the relation between cost of credit and bank efficiency. We exclude France and Spain, both countries together representing 70% of observations. Definitions of variables are provided in the Appendix. Standard errors (in brackets) are robust to arbitrary heteroskedasticity *, **, and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

	Dependent variable = *Cost of credit*					
	No country controls		Country fixed effects		Country-level controls	
Bank efficiency	-0.008**	-0.013***	-0.009***	-0.014***	-0.008**	-0.013***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Firm size	-0.002***	-0.002***	-0.002***	-0.002***	-0.002***	-0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Tangibility	-0.034***	-0.035***	-0.034***	-0.035***	-0.035***	-0.035***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Private credit		-0.001***		-0.001***		-0.001***
		(0.000)		(0.000)		(0.000)
Rule of law		0.012***		0.009**		0.013***
		(0.005)		(0.005)		(0.005)
GDP per capita		-0.000		0.000		-0.000
		(0.000)		(0.000)		(0.000)
Inflation		-0.021***		-0.021***		-0.021***
		(0.002)		(0.002)		(0.002)
Constant	0.058**	0.132***	0.059**	0.131***	0.060***	0.132***
	(0.023)	(0.011)	(0.023)	(0.011)	(0.022)	(0.011)
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	No	Yes	No	Yes	No
R^2	0.074	0.073	0.074	0.073	0.074	0.073
N	116,383	114,709	116,383	114,709	114,743	114,386

Appendix

Variable	Definition
Bank efficiency	Cost efficiency score. Source: own computation.
Firm size	= log(total assets). Source: Amadeus.
Tangibility	= tangible fixed assets /total assets. Source: Amadeus.
Cost of credit	= (financial expenses /total debt) – country nominal short-term interest rate. Source: Amadeus and SDW.
Private credit	Private credit by deposit money banks to GDP. Source: Global Financial Development Database, World Bank.
Rule of law	This variable captures the extent to which agents have confidence in the rule of law and how well they expects members of society to abide by the rules. In particular, looks at the perceptions about the quality of enforcement of contract law and property rights, as well as the behavior of the police and the courts, and the frequency of crime and violence. Source: Worldwide Governance Indicators, World Bank.
GDP per capita	GDP per capita in USD. Source: World Development Indicators, World Bank.
Inflation	Consumer Price index growth rate. Source: World Development Indicators, World Bank