

New Developments in Financial Modelling

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Edited by

João O. Soares, Joaquim P. Pina
and Margarida Catalão-Lopes



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NEW DEVELOPMENTS IN FINANCIAL MODELLING: AN INTRODUCTION

JOÃO O. SOARES, JOAQUIM P. PINA
AND MARGARIDA CATALÃO-LOPES

This book gathers a selection of refereed papers from the 41st Meeting of the Euro Working Group on Financial Modelling, held at Lisbon, Portugal, on November 8-9, 2007. Thirty authors, from different countries and with diverse experiences, contribute with new insights on some of the most relevant topics of corporate finance, bearing in mind the great concern of the Euro Working Group with the practical consequences of the research undertaken by its members. These contributions have been grouped in five different thematic areas, corresponding to the five sections of the book: banking; corporate governance; portfolio selection; market microstructure and liquidity; risk and volatility in financial markets.

The first section – Banking – integrates three papers. The first paper, by Diana Bonfim, Qinglei Dai and Francesco Franco, studies the impact of the number of banks a firm borrows from on the price of credit. The paper uses information for Portuguese firms, for the period 1996-2004. The interest rate on bank loans is found to vary negatively with the number of bank relationships, a result which is robust across firm size. The second paper, by Filipa Lima, investigates the impact of product differentiation on banks' cost efficiency. In an empirical contribution applied to the Portuguese banking system, the author uses a parametric approach for a multi-output production function that also includes off-balance sheet outputs, and takes into account different loans and deposits' segments. Banks' dimension, the quality of the loans' portfolio and mergers are found to be relevant for the explanation of differences in efficiency across institutions and over time. The banking section ends with a paper by Maria Blangiewicz and Paweł Miłobędzki. This paper tests for a nonlinear mean reversion in the term structure of interest rates at the Polish interbank market, due to transaction costs. Transaction costs may be a more serious

problem in transition economies, such as the Polish, than in mature ones. The results obtained for the period January 2003-December 2006, however, are ambiguous. Co-integration tests show that the term spread is mean-reverting, but, despite the strong evidence of nonlinearity in mean-reversion, the use of a three-regime threshold vector error correction model to capture the transaction costs is of little success.

The second section – Corporate Finance – has two contributions. The first paper, by Lars Nordén and Therése Strand, investigates the behaviour of Swedish portfolio managers at firm's annual general meetings. From their research, the authors sustain that the behaviour of portfolio managers in these meetings is mainly determined by their goal of achieving notoriety, an attribute usually associated with large firms benefiting from wide media coverage and important stockholders. Another possible and more useful motivation – to intervene preferentially in cases of bad performance – seems to be neglected by the desire of 15 minutes of fame, according to this research. The second paper, by Jasper Blom and Marc Schauten, focuses another issue: the existence of a relation between the quality of corporate governance and the cost of debt. The authors collected data for the 300 largest European firms (FTSE Eurotop 300), concerning corporate governance performance (Denominator Rating for the period 2000-2004) and the cost of debt (yield of bonds issued during 2001-2205). Their analysis concludes that there is a negative relation between these two variables, which supports the idea that debt holders use the attribute 'quality of corporate governance' in their assessment of risk profile of each particular firm.

The third section – Portfolio Selection – integrates three contributions. The first paper, by Panagiotis Xidonas, Dimitrios Askounis and John Psarras, presents a multiple criteria approach for the selection of stock portfolios. This approach is based on a multi-stage procedure: first, the use of outranking methods for selecting an initial set of assets according to the preferences of the decision-makers in terms of several financial and market criteria; secondly, an usual Markowitz mean-variance optimization model, comprising some additional constraints; at a final stage, an outranking MCDA (Multiple Criteria Decision Analysis) model is still used in order to rank and restrict the efficient portfolios selected in the previous stage. This integrated methodology is applied to a sample of stocks from the Athens Stock Exchange. The second paper, by Jaap Spronk and Ghassan Chammas, focuses an interesting and rather new topic: the principles that guide Islamic equity investment. As pointed by

the authors, Sharia compliant investors seek additional objectives beyond those pursued by the traditional or conventional investors. They seek to incorporate their doctrine and ethics into asset choice. So, this paper details the multiple filters that have to be applied before an asset can be included in a Sharia compliant portfolio. Finally, the last paper of this section, by Andrzej Skulimowski, deals with the theoretical background for employing dynamic programming models in portfolio selection. This is an approach that entails an increased flexibility, since assets can be evaluated based on multiple criteria, and this evaluation can change and be adapted in response to external events or as a result of achieving certain goals.

Section four – Market Microstructure and Liquidity –integrates three papers. The first paper of this section, by Emmanuel Kopp, Michael Huetl, Otto Loistl and Johannes Prix, examines cross sectional liquidity in Xetra trading system of Frankfurt Stock Exchange. Systematic liquidity components are estimated by Projection-Pursuit principle and a multi-stage Principal Components Analysis (PCA) is proposed in order to overcome the lack of interpretation in standard PCA. Further, alternative trading related measures are taken into account, allowing to capture different information pieces from the entire limit order book. Intraday data has been selected, tick-by-tick from 6th to 13th of December of 2006, for all stocks in DAX-30. The findings point out that market wide liquidity factors are relevant for explaining individual stock liquidity. The paper by Theodoros Stamatiou focuses on volatility and price limits, drawing lessons from Athens Stock Exchange experience. Volatility and overreaction implications are analysed using daily data from June 2008 to May 2001. The range under scrutiny covers a “bubble” period and during the whole sample period there was a band of 8 per cent daily variation limit. The results show that price limits actually implied an increase in volatility and a decrease in liquidity in the days after hitting a limit. Market overreaction was also found, but only after hitting the Up limit. The paper closing this section, by Serkan Aran, studies the relation between liquidity and returns of small-cap stocks in Istanbul Stock Exchange. The findings are conclusive for an asymmetric relation between volume and return.

The fifth section – Risk and Volatility in Financial Markets – gathers three papers. The first one, by Dorra Hmaied, analyses the relationship between trading volume and volatility around takeover announcements in the Paris Bourse. The issue is analysed for the market for corporate control

and also takes into account the different means of payment. The findings, from mixture distributions methodology, are that both for *pre* and *post* bid periods a significant effect of volume in conditional volatility exists and differs according to the mean of payment, being weaker for cash offers, namely, in *post* bid period. The second paper, by António Afonso, Pedro Gomes and Philipp Rother, investigates the determinants in sovereign debt rating. This issue is crucial for pricing public debt, which besides being a reference for other assets and portfolio choice, may be central when countries have binding rules for deficit and debt limits, e.g. as in the European Union. Using data from Fitch Ratings, Moody's, and Standard & Poor's, covering 1995 to 2005, the authors apply a panel data approach, considering alternatively a linear model and an ordered probit. The findings indicate that the most relevant variables that emerge are: GDP per capita, GDP growth, government debt, government effectiveness indicators, external debt, external reserves and default history. The final paper, by Young Shin Kim, Svetlozar T. Rachev, Dong M. Chung, and Michele L. Bianchi, introduces a variant of the tempered stable distribution, which the authors call "modified tempered stable" (MTS) distribution, and develops a GARCH option pricing model with MTS innovations. The Modified Tempered Stable distribution is sufficiently flexible in describing the skewness and kurtosis of asset returns and has all moments finite. The authors argue that the MTS-GARCH model can be more realistic than the normal-GARCH model, and they use it to describe some stylized phenomena of financial markets, such as volatility clustering, leverage effect, skewness, and heavy tails of the return distribution.

This is a brief overview of all the matters that can be found within the chapters of this book. We believe that they constitute a rich and interesting set of new topics. So, we would like to reserve our last words to express our gratitude to all the authors and reviewers, including our colleagues Alain Chevalier and Wolfgang Kursten. The list of all the authors that contributed to this volume, as well as their contacts, can be found at the end of the book.

Good and pleasant readings!

CHAPTER ONE

THE NUMBER OF BANK RELATIONSHIPS AND THE COST OF BORROWING: AN EMPIRICAL STUDY

DIANA BONFIM, QINGLEI DAI
AND FRANCESCO FRANCO

Abstract

We construct a unique dataset containing 17,516 Portuguese small, medium and large firms and spanning from 1996 to 2004. Using this dataset we study the impact of the number of banks a firm borrows from on the cost of bank loans. We find that the average Portuguese firm borrows from three banks. The firm's interest rate on bank loans lowers as the firm borrows from more banks, controlling for relevant firm characteristics. When a firm borrows from one more bank, the interest rate on bank loans for this firm becomes 12 to 34 basis points lower, on average. This pattern holds across firm size categories. Our results are consistent with bank competition and bank risk diversification.

Keywords: banks, relationship banking, borrowing costs

1. Introduction

A frequently visited question by banking researchers is: what is the optimal number of banks for a firm to borrow from? This question is also important to firm managers because the answer to it is related to how to obtain the lowest cost of loans and how to ensure easy access to bank loans. In this study, we focus on the relationship between the interest rate charged by banks and the number of banks that the firm borrows from.

The classical delegated monitoring argument introduced by Diamond (1984) and tested by Petersen and Rajan (1994) says that in the presence of asymmetric information between firms and investors, a firm is best off borrowing from only one bank where the cost of borrowing is minimized. However, many other empirical works find that firms rarely keep exclusive bank relationships. For example, Ongena and Smith (2000) in a survey including 1079 firms across 20 European countries find that the majority of firms (85%) use more than one bank. They find that firms in countries with the French legal system, such as France, Italy, Spain and Portugal, have on average, more than 10 different bank relations. This observation has also been found in D'Auria, Foglia and Reedtz (1999). In our dataset we also find that the majority of Portuguese firms, including micro firms, borrow from several banks.

What makes monogamy with a bank undesirable? There are many theories attempting to provide an explanation, some of them with implications for borrowing costs.

First, in an exclusive bank relationship, the informationally privileged bank might exploit its bargaining power over the firm and extract rents from loan contracts (Sharpe 1990, Rajan 1992). This implies that micro and small firms with a unique lender pay a higher cost of borrowing.

Second, the refusal of a credit from the firm's only lender may provide a negative signal to the market which makes the exclusive bank relationship undesirable (Berger and Udell, 1998). Detragiache, Garella, and Guiso (2000) show that this is especially true in economies with high bankruptcy costs and low fragility of the banking sector .

Third, some predict that multiple bank relationships will occur when banks face financial constraints or monitoring costs (Dewatripont and Maskin 1995, Holmstrom and Tirole 1997, Carletti, Cerasi and Daltung 2007).

Fourth, multiple bank relationships might prevent the firm manager from strategic default by holding up the renegotiation process (Bolton and Scharfstein 1996).

Fifth, in the face of fierce competition, multiple arms-length lending might substitute relationship lending as analyzed by Boot and Thakor (2000). The authors predict that bank competition will lead to lower

interest rates and that firms will not commit to exclusive bank relationships. On the other hand relationship lending might protect banks from price competition.

Sixth, multiple bank relationships allow banks to diversify their lending risk (Carletti et al. 2007). The authors predict that the banks are more attracted to multiple-bank lending when the bank has lower equity, when the cost of monitoring is high, and when the profitability of the firm is low.

To answer the aforementioned question we use a unique dataset that spans from 1996 to 2004 and includes 42,263 Portuguese firm-year observations, referring to 17,516 different firms. We find that an average Portuguese firm borrows from three banks. The firm's interest rate on bank loans lowers as the firm borrows from more banks, controlling for relevant firm characteristics. When a firm borrows from one more bank, the interest rate on bank loans for this firm becomes 12 to 34 basis points lower, on average. This pattern holds regardless of the firm size. Moreover, we take seriously the idea that the number of bank relationships and the cost of borrowing may be simultaneously determined, introducing an endogeneity problem in our empirical analysis. For instance, the managerial ability may jointly influence the choice of the number of banks and the interest rate that banks charge. We address this issue by using an instrumental variable approach and find that our previous findings are robust.

Our finding is consistent with Carletti et al. (2007) that banks benefit from risk diversification brought by multiple-bank lending. The decreasing interest rate reflects that the reduction in risk level overcomes free-riding and duplication of monitoring costs. However, to the contrary of the prediction of Carletti et al. (2007) that the benefit of diversification is stronger with small opaque less profitable firms, we find that the negative correlation between the number of banks and the interest rate holds robust across all firm sizes. Specifically, even large mature profitable firms benefit from multiple lending.

The finding that the interest rate decreases in the number of banks can also be consistent with the competition argument by Boot and Thakor (2000) that when banks compete to gain clients, firms are able to borrow from multiple banks at lower costs. During the past two decades, the banking sector in Portugal has experienced a high degree of liberalization.

Most of the state-owned banks have become privatized. Many small banks coexist with large regional banks. Credit granted to the private sector has recorded a remarkable growth and interest rates decreased steadily (Ribeiro 2007). These developments should have contributed to increased competition in the Portuguese banking system, thus allowing firms to borrow from multiple banks at a lower cost.

Our results are comparable to findings from similar studies using European datasets. Degryse and Ongena (2007) literature review shows that in several European countries the cost of bank loans is either unaffected or reduced by 1 to 10 basis points per additional relationship, while in the US the cost of bank loans typically increases with the number of bank relationships.

Finally, this study is related to Farinha and Santos (2002) who also investigated the number of bank relationships in Portugal. They focus on one special event during a firm's borrowing history, i.e. when the firm switches from single to multiple bank relationships. The authors examine some of the determinants and implications of this corporate event and report that almost all firms start borrowing only from a single bank, but soon afterwards they diversify their creditor structure, most notably when growth opportunities are stronger. Our study is different in several ways. First, we look at the number of bank relationship rather than the event of switch from one to multiple banks. Second, we focus on the implication of bank relations on the firm's cost of borrowing which was not examined previously for Portugal. Third, our dataset covers a more recent sample period of 1996-2004, while Farinha and Santos (2002) use a dataset from 1980 to 1996.

Our paper proceeds as follows. In section 2 we describe the datasets used and present some relevant summary statistics. In section 3 we discuss the results obtained under a regression analysis framework, evaluating how does the number of bank relationships influences borrowing costs. In section 4 we discuss possible endogeneity problems in the regressions, given that the number of relationships and interest rates may be simultaneously determined, and we try to overcome this issue using an instrumental variable approach. Finally, in section 5 we present some concluding remarks.

2. Data and summary statistics

Two large datasets were used in this work. All information concerning the number of bank relationships comes from the Central Credit Register of Banco de Portugal. This extensive database includes information on all credit exposures above 50 euros, reported by all Portuguese credit institutions monthly. The reporting is mandatory. The main objective of this database is to disseminate information among participating institutions, in order to improve their credit risk assessment on current and potential borrowers. Participating banks can observe, for each borrower, the number of bank relationships this borrower has, the total outstanding debt, as well as the status of the loans (e.g. whether there is debt overdue). This information sharing mechanism may have important implications in reducing the asymmetric information problem in a borrower-lender relationship¹. Unfortunately, this database does not include any information regarding loan maturity, collateral or interest rates. Given that our main objective is to evaluate the role of the number of bank relationships in firms' borrowing costs, we obtain information on the cost of borrowing from another large dataset: the Central Balance Sheet Database of Banco de Portugal. This database provides detailed yearly accounting information, including firm age, economic sector, profitability, leverage, etc., for a large sample of Portuguese firms. Reporting to the Central Balance Sheet Database is not compulsory and, as a consequence, this database covers only a limited (but large) sample of Portuguese firms. Nevertheless, the sample is considered to be representative, though its representativeness may be somewhat poorer for smaller firms.

Using end of year data for the period comprised between 1996 and 2004, the Central Credit Register includes 3,990,802 records². Taking into account data for the same period of time, the Central Balance Sheet Database includes 202,364 records. Merging the two databases, we obtain 154,682 common observations, comprising 38,342 firms. Even though both databases were created before 1996, several important fields of the

¹ It is possible to know whether credit has become overdue, if it was renegotiated or if it is an off-balance sheet risk, such as the unused part of a credit line or a bank guarantee.

² Banks do not report information on a strict loan by loan basis, given that it is possible to aggregate loans granted to the same firm with similar status. We aggregated loans by firm, in order to count the number of bank relationships. Hence, each record is defined as a firm-year pair.

Central Balance Sheet Database are available only from 1996 onwards, thus imposing this year as a starting point for our analysis.

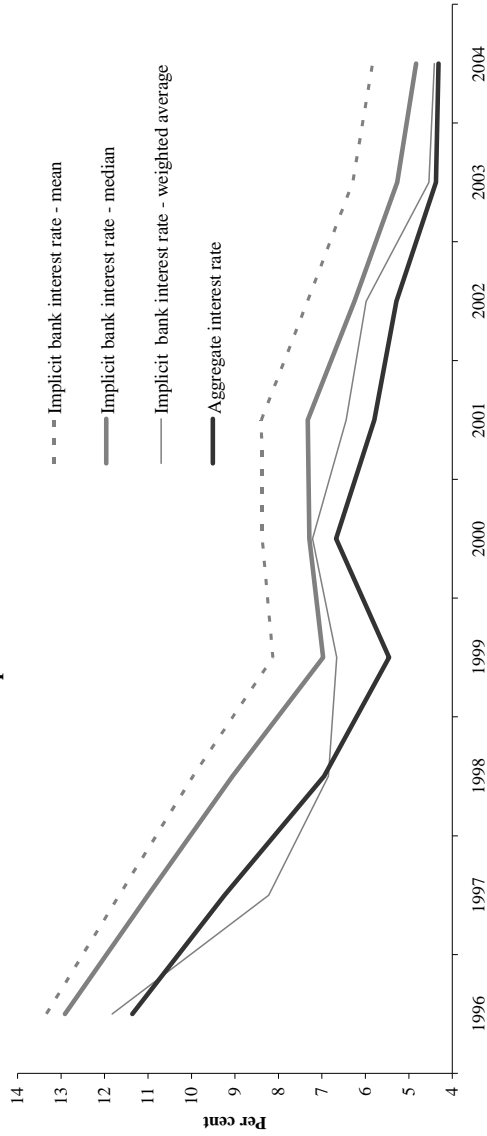
In our study, we only analyse lending relationships between firms and banks, excluding all lending relationships with non-monetary credit institutions, such as leasing companies³.

To measure the cost of borrowing, we construct different implicit interest rates using the firms' balance sheet information. We perform several checks to evaluate the reliability of our interest rate measures. Our preferred measure of the interest rate is the interest paid on bank loans as a percentage of total debt to credit institutions. We provide a detailed description of our filters in the data appendix. Our final dataset is an unbalanced panel data containing 42,263 observations, 17,516 firms, between 1996 and 2004.

Figure 1 shows the average, median and weighted mean of our measure of interest rate against the aggregate interest rate on all outstanding debts to non-financial corporations in Portugal disclosed by Banco de Portugal. The weighted average of the implicit interest rate appears to track remarkably well the aggregate interest rate statistics. The correlation between the two series is 0.96.

³ Non-monetary credit institutions are usually small and specialized credit institutions (sometimes included in large universal banking groups), which do not offer checking accounts. Hence, even though these non-bank credit institutions can hold long term relationships with the firms they grant credit to, they will hardly be able to establish exclusive relationships with firms, given that they can offer them only a limited set of financial services. Moreover, the pricing of debt granted by these institutions may be supported by standards very different from those applied by banking institutions, which can benefit from the monitoring of firms' deposits.

Figure 1
Implicit interest rate measures

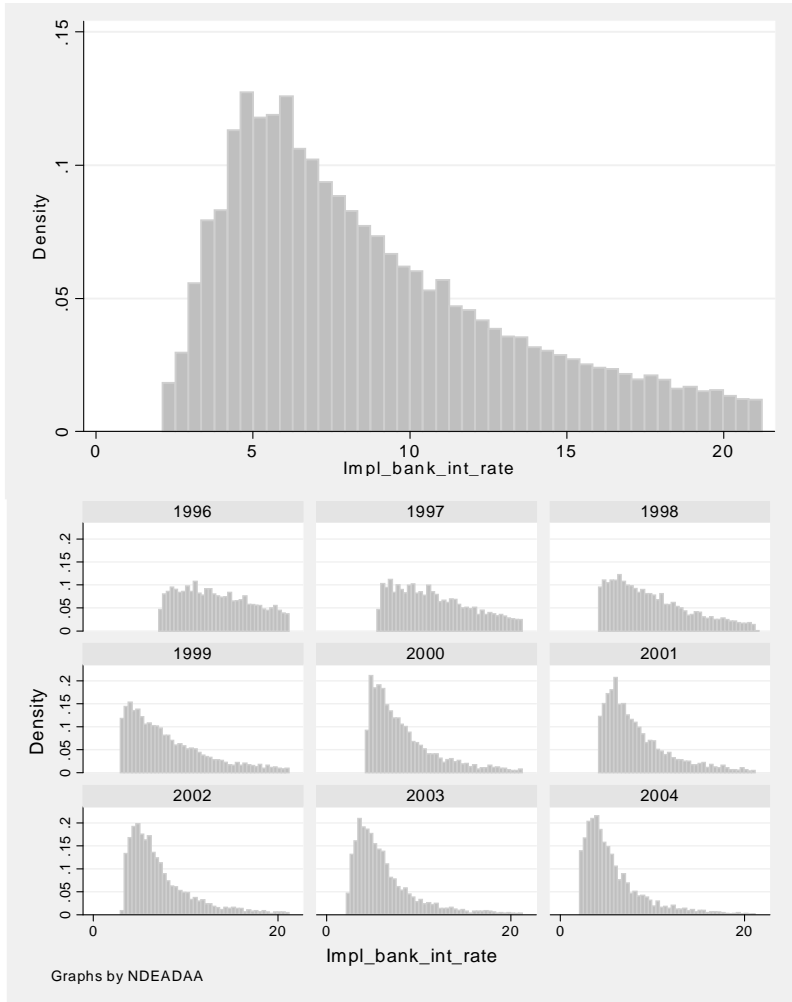


Notes: The aggregate interest rate is the interest rate on outstanding amounts of loans to non-financial corporations disclosed by Banco de Portugal in its Monetary and Financial Statistics. This interest rate is a weighted average of interest rates reported by banks. Implicit interest rates were computed using data from the Central Balance Sheet Database held by Banco de Portugal, which includes detailed accounting information for a large sample of Portuguese companies. This interest rate was computed as the amount of interest paid on bank loans as a percentage of total debt to credit institutions at the end of the year.

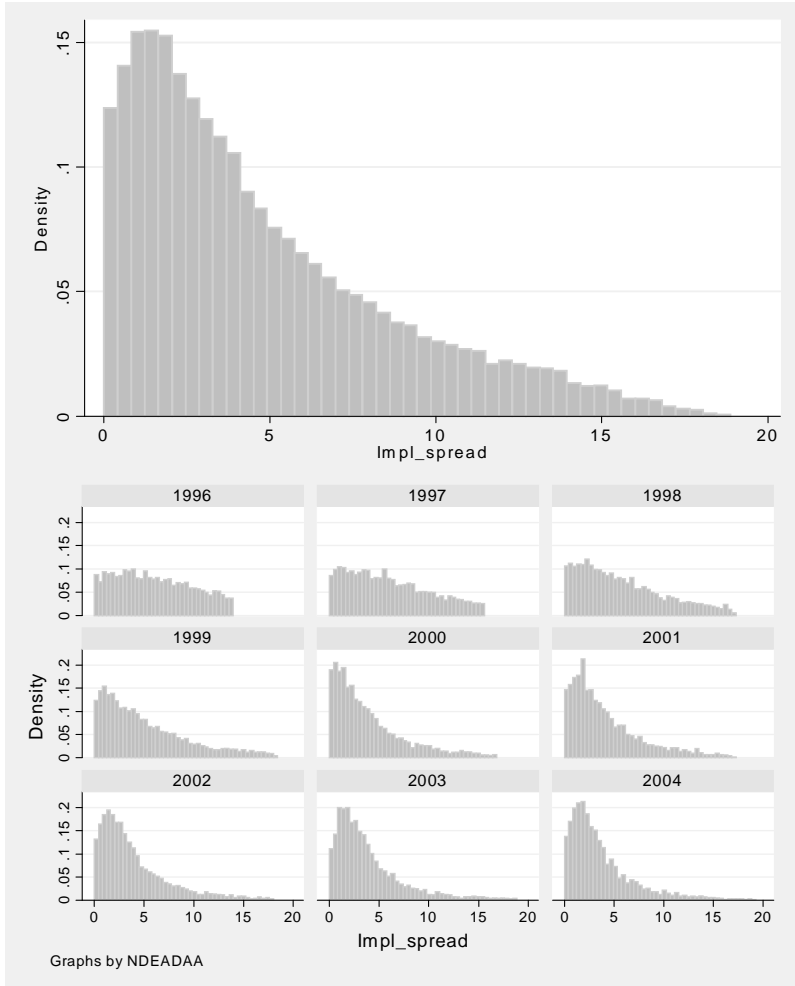
The upper panel of Figure 2 (*a* and *b*) shows histograms of both the implicit bank interest rate and the implied spread over the entire sample. The implied spread on banks loans is defined as the difference between the implicit interest rate and a money market interest rate (3-month Euribor). In the lower panel of Figure 2 we present the histograms of both the implicit interest rate and the spread for each year in our sample⁴. Overall the relatively high correlation between our measure and the aggregate interest rate on loans makes us confident about our measure of interest rate on bank loans.

⁴ The results reveal that the distribution of interest rates and spreads across firms changed significantly between 1996 and 2004. Whereas in the earlier years of the sample period interest rates and spreads showed an almost uniform distribution, exhibiting a large dispersion in borrowing costs across firms; in the latter years of the sample period the distribution became closer to a log-normal. In these latter years, there was not only a decrease in average interest rates paid by firms, but also a substantial decline in their dispersion.

Figure 2a
Implicit bank interest rate



Note: Empirical distribution of the implicit interest rate on bank loans, computed as interest paid to banks as a percentage of total debt to credit institutions for each firm. As interest rates show a steady downward trend during our sample period, we also present the empirical distribution of the implied spread on banks loans, defined as the difference between the implicit interest rate and a money market interest rate (3-month Euribor).

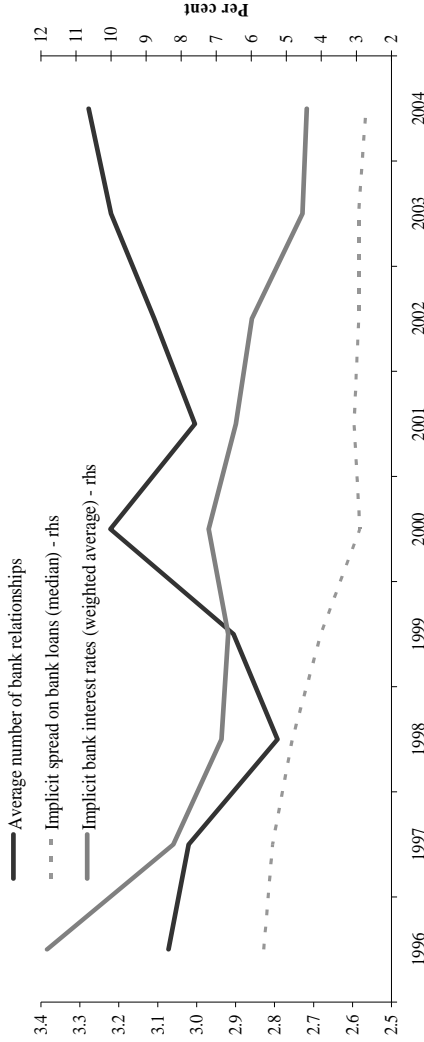
Figure 2b**Implicit spread on bank loans**

Note: Empirical distribution of the implicit interest rate on bank loans, computed as interest paid to banks as a percentage of total debt to credit institutions for each firm. As interest rates show a steady downward trend during our sample period, we also present the empirical distribution of the implied spread on banks loans, defined as the difference between the implicit interest rate and a money market interest rate (3-month Euribor).

We now turn to some preliminary analysis on the linkage between the cost of debt and the number of bank relationships. Approximately one quarter (26 per cent) of the firms hold one exclusive lending relationship. Across time there was a significant drop in the percentage of firms with unique relationships: from almost 30 per cent in 1996 to nearly 20 per cent in 2004. Figure 3 shows that the average number of bank relationships did not vary significantly over time, ranging between 2.8 and 3.3 across the sample period⁵.

⁵ The figure shows that the average number of bank relationships exhibits an increasing trend starting in 1998. The observed decrease in 2001 is probably due to the strong merger and acquisition activities during this period in the Portuguese banking system.

Figure 3
Number of relationships and implicit bank interest rates

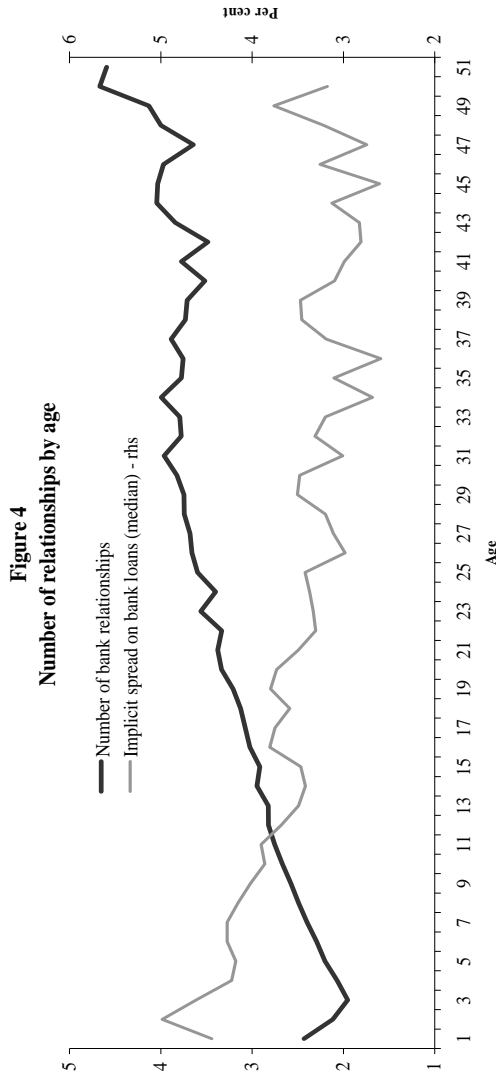


Notes: The implicit interest rate was computed using data from the Central Balance Sheet Database held by Banco de Portugal, which includes detailed accounting information for a large sample of Portuguese companies. This interest rate was computed as the amount of interest paid on bank loans as a percentage of total debt to credit institutions at the end of the year. The implicit spread on banks loans was defined as the difference between the implicit interest rate and a money market interest rate (3-month Euribor). The number of relationships was computed using information from the Central Register of Banco de Portugal, which includes data on all loans granted in Portugal above 50 euros. The number of bank relationships was computed as the number of different banks which were lending to a given firm at the end of each year. These two databases were matched, which means that these two indicators refer to the same sample of firms.

Figure 4 shows that the number of lending relationships increases steadily with the firm age. Start-up firms have, on average, 2 or 3 lending relationships, whereas older firms hold a more diversified credit structure. Furthermore, younger firms pay higher interest rates than older firms, as expected.

Table 1 reports the distribution of the number of bank relationships together with the implicit interest rate and proxies for firm size and maturity such as the number of employees and firm age⁶. Columns two and three show that firms with a single banking relationship pay a higher interest rate than firms with 2 or 3 relations. Columns four to seven show that the number of bank relationships is positively related to size proxied by firm age and the number of employees.

⁶ To ease the reading of the table we exclude the firms with more than 15 relationships.



Notes: The implicit interest rate was computed using data from the Central Balance Sheet Database held by Banco de Portugal, which includes detailed accounting information for a large sample of Portuguese companies. This interest rate was computed as the amount of interest paid on bank loans as a percentage of total debt to credit institutions at the end of the year. The implicit spread on banks loans was defined as the difference between the implicit interest rate and a money market interest rate (3-month Euribor). The number of relationships was computed using information from the Central Register of Banco de Portugal, which includes data on all loans granted in Portugal above 50 euros. The number of bank relationships was computed as the number of different banks which were lending to a given firm at the end of each year. These two databases were matched, which means that these two indicators refer to the same sample of firms.

We further construct a measure of firm size following a definition suggested by the European Commission that uses the number of employees and sales volumes and the results in four different size categories: micro, small, medium and large⁷. We end up with 12,417 micro, 18,703 small, 8,918 medium and 2,225 large firms. Table 2 displays the number of bank relationships and the implicit interest rate for these four categories. Micro and small firms hold respectively, on average, 2 and 3 bank relationships, medium-sized firms borrow from more than 4 banks, while larger firms have 6 different bank relationships. Table 2 also shows that the implicit interest rate decreases with the firm size.

Table 1

Number of bank relationships	Implicit bank interest						
	Obs.	rates		Age		Employees	
		Mean	Median	Mean	Median	Mean	Median
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	10,880	9.4	8.4	14.3	10	20	8
2	10,497	9.0	7.9	16.4	12	33	13
3	7,361	8.6	7.5	18.8	15	49	21
4	4,938	8.4	7.1	21.4	17	72	31
5	3,172	8.2	7.0	22.4	18	100	41
6	1,999	7.9	6.7	24.2	19	134	60
7	1,318	7.8	6.6	25.2	20.5	168	75
8	739	8.2	7.0	26.9	22.5	209	97
9	466	7.9	6.9	29.0	23	244	120
10	284	8.5	7.2	32.6	27	302	151
11	164	9.1	7.5	33.8	29	329	194
12	76	7.7	6.8	30.4	25	873	215
13	66	8.7	7.4	36.3	28.5	788	290
14	29	9.3	8.3	34.4	27	676	470
15	25	9.1	9.9	49.2	47	1143	828
Total	42263	8.8		18.6		66	

Notes: Interest rate were computed as the amount of interest paid on bank loans as a percentage of total debt to credit institutions at the end of the year. The number of relationships was computed as the number of different banks which were lending to a given firm at the end of each year. To ease the reading of the table we exclude firms with more than 15 relationships.

⁷ Micro firms are defined as those than less 10 employees and less than 2 millions euros of sales volumes. Small firms are those with less than 50 employees and less than 10 millions euros of sales volumes. Median firms are those with less than 250 employees and less than 50 millions euros of sales volumes. All remaining firms are considered to be large firms.

Table 3 shows that the average and median number of bank relationships and the implicit interest rate for different economic sectors. The lowest number of relationships is seen in agriculture, fishing and tourism. In turn, mining, manufacturing and public services firms show a higher average number of relationships. The differences in estimated interest rates across sectors seem to be more significant. Agriculture and transport firms apparently have to pay interest rates slightly above those of other firms, whereas utilities, real estate firms or public services firms face lower debt servicing costs.

Table 2
Number of relationships and interest rates by firm size

	Number of observations	Number of bank relationships		Implicit bank interest rate	
		Mean	Median	Mean	Median
Micro	12417	1.8	2.0	9.6	8.7
Small	18703	2.8	2.0	8.9	7.8
Medium	8918	4.4	2.0	7.8	6.6
Large	2225	6.2	6.0	7.3	6.2
Total	42263	3.1	2.0	8.8	7.7

Notes: The implicit interest rate was computed using data from the Central Balance Sheet Database held by Banco de Portugal, which includes detailed accounting information for a large sample of Portuguese companies. This interest rate was computed as the amount of interest paid on bank loans as a percentage of total debt to credit institutions at the end of the year. The number of relationships was computed using information from the Central Register of Banco de Portugal. The number of bank relationships was computed as the number of different banks which were lending to a given firm at the end of each year. The definition of firm size was based on the European Commission Recommendation of 6 May 2003 (2003/361/EC), by taking into account the number of employees and sales volume. More precisely, micro firms were defined as those with less than 10 employees and less than 2 million euro of business volume; small firms were those with less than 50 employees and less than 10 million euro of business volume; medium firms were those with less than 250 employees and a business volume below 50 million euro. All remaining firms were considered to be large firms.

Table 3
Number of relationships and interest rates by firm size

	Number of observations	Number of bank relationships		Implicit bank interest rate	
		Mean	Median	Mean	Median
Agriculture	1627	2.5	2.0	9.2	8.2
Commerce	12721	3.9	3.0	8.9	7.8
Construction	5526	4.2	3.0	8.9	7.8
Education	156	3.4	3.0	7.1	5.7
Fishing	155	2.8	2.0	8.7	7.5
Healthcare	156	4.0	3.0	7.3	6.4
Manufacturing	17145	4.4	4.0	8.9	7.8
Mining	505	4.6	4.0	8.4	7.1
Other public services	226	4.4	4.0	6.8	5.6
Real estate	1311	3.9	3.0	6.4	5.4
Tourism	638	3.0	2.0	7.8	6.6
Transports and communications	1900	4.3	3.0	9.2	8.1
Utilities	197	3.8	3.0	5.9	4.8
Total	42263	3.1	2.0	8.8	7.7

Notes: The implicit interest rate was computed using data from the Central Balance Sheet Database held by Banco de Portugal, which includes detailed accounting information for a large sample of Portuguese companies. This interest rate was computed as the amount of interest paid on bank loans as a percentage of total debt to credit institutions at the end of the year. The number of relationships was computed using information from the Central Register of Banco de Portugal. The number of bank relationships was computed as the number of different banks which were lending to a given firm at the end of each year.

To conclude our descriptive analysis we perform mean comparison tests to evaluate if interest rates are statistically different for firms with many relationships (above the 4th quartile of the distribution of the number of relationships) and for firms with few relationships (below the 1st quartile of the same distribution). Table 4 reports that in the full sample interest rates paid by these two groups of firms are indeed different. Firms with fewer relationships pay, on average, higher interest rates. We also performed these tests for the four size categories. Both for micro and for small firms, interest rates are statistically higher for firms with fewer relationships. For medium-sized firms, the mean comparison tests performed suggest that there are no significant differences in interest rates for firms in the 1st and in the 4th quartile of the distribution of the number of relationships. Finally, for large firms interest rates are significantly higher with many bank relations.

Table 4

	Average interest rate for firms with few relations	Average interest rate for firms with many relations	Mean comparison test		
			Ho: diff = 0		
			diff	t-ratio	Pr(T > t)
All firms	9.5	8.2	1.27	22.44	0.00
Micro	9.9	9.4	0.44	5.44	0.00
Small	9.0	8.7	0.29	3.92	0.00
Medium	7.9	7.8	0.04	0.43	0.67
Large	6.9	8.1	-1.17	-5.54	0.00

Note: Firms with few relations were defined as those included in the first quartile of the distribution of the number of relationships. In turn, firms with many relations were considered to be those in the fourth quartile of the same distribution.

3. Regressions

The descriptive analysis performed above suggests that firms that have one or few lending relationships pay, on average, higher interest rates, most notably if they are smaller firms. In this section, we perform regression analysis and control for several firm characteristics which may influence interest paid on bank loans and have been extensively used in similar studies. For instance, it is reasonable to consider that profitability, collateral, leverage or the firm's credit risk are taken into account by banks when pricing loans. We define *Turnover* as sales and services as a percentage of the firm's assets and use it as a proxy for the firm profitability. More profitable firms are able to generate larger cash-flows with their activity, and may face lower funding costs. Next we define *Tangible assets as % of debt* to proxy for collateral. *Leverage* is defined as debt to credit institutions over assets to control for the influence of the outstanding debt on the interest rate. *Credit risk* is a dummy variable which takes the value one whenever the firm is in default at the end of the year. *Debt coverage*, calculated as net profits over debt to credit institutions, is another measure of the firm's financial health. All firm-specific variables are lagged by one year. This choice is motivated by the fact that the banks can only observe the previous year balance sheet. Table 5 reports summary statistics for the dependent and independent variables. Table 6 contains the correlation matrix of the regressors.