
RELATIONSHIP BANKING AND HETEROGENEITIES IN
INTEREST RATE SETTING

Manuel Afonso Lopes Gouveia Lança

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Supervised by
Dr. Manuel Duarte Rocha
Dr. Sujiao Zhao

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Abstract: Since 2014, Portuguese and other euro area banks have been acting in a macroeconomic scenario favourable to increased risk-taking. This scenario is characterized both by economic expansion and the adoption of unprecedented non-standard monetary policy measures. One dimension of bank risk-taking derives from the asymmetry of information on borrower creditworthiness. This market imperfection prompts the emergence of agency costs, which are reflected in the interest rate a borrower faces. Relationship banking is a means to mitigate such costs by accumulating and reusing soft information on borrower creditworthiness. Using data for Portugal, we explore whether, in the bank risk-taking environment of recent years, banks have decreased lending rates by more to those (riskier) firms on which they have less soft information *ex-ante*, *i.e.* firms less reliant on relationship banking. Our findings do not confirm this hypothesis.

JEL codes: E43, E52, G21

Keywords: bank rates; bank risk-taking; relationship banking; information asymmetries

Resumo: Desde 2014, bancos portugueses e de outros países da zona euro têm vindo a actuar num contexto macroeconómico favorável ao aumento da tomada de risco. Este cenário caracteriza-se tanto pela expansão económica como pela adopção de medidas não convencionais de política monetária sem precedente. Uma dimensão de tomada de risco pela banca decorre das assimetrias de informação sobre a qualidade de crédito dos devedores. Esta imperfeição de mercado despoleta custos de agência, que são reflectidos na taxa de juro que um devedor suporta. A banca de relação é um meio para mitigar tais custos através da acumulação e reutilização de *soft information* relativamente à qualidade creditícia dos devedores. Utilizando dados para Portugal, exploramos se, no contexto de maior tomada de risco pela banca dos últimos anos, os bancos diminuíram mais as taxas de juro dos empréstimos àquelas firmas (mais arriscadas) sobre a qual têm menos *soft information ex-ante*, *i.e.* firmas menos dependentes da banca de relação.

Códigos JEL: E43, E52, G21

Palavras-chave: taxas de juro bancárias; tomada de risco pela banca; banca de relação; assimetrias de informação

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1. Introduction

Bank risk-taking in the euro area has been increasing since 2014, supported by two major factors. One is economic expansion (Bernanke and Gertler (1989), Ruckes (2004)), the other an atypical monetary policy scenario, characterized by the introduction of non-standard measures aimed precisely at increasing bank risk-taking as a means to achieve price stability. According to Draghi (2015), «our purchases reduce returns on safer assets. This encourages investors to shift to riskier, higher yielding assets».

One source of credit risk for banks arises from asymmetries of information on borrowers' creditworthiness. This kind of market failure may prompt conflicts of interest between lenders and borrowers, and thus give way to higher loan spreads via agency costs (Boot (2000)). Relationship banking is a way in which lenders mitigate such agency costs. By acquiring customer-specific information on the borrowers that is difficult to codify and transmit in transaction-oriented lending, banks make lending to these borrowers a less risky enterprise (Rajan (1992)).

The present work aims at understanding whether, in a period of increased and prolonged bank risk-taking, relationship banking causes heterogeneities in interest rate setting on loans to non-financial corporations. There may be heterogeneities under such scenario, as riskier borrowers are likely to benefit more from decreasing agency costs than safer borrowers (Bernanke *et al.* (1996), (Matsuyama (2007))). To be more precise, when moving to higher yielding assets, banks may determine more pronounced decreases in loan spreads to applicants whose characteristics they don't know *ex-ante*.

The effects of relationship banking on interest rate setting have been addressed in previous works, but are not a subject of consensus. Some argue relationship banking incentivizes banks to decrease spreads by more to concerned firms, given the mitigation of agency costs that it allows (Berger and Udell (1995)). Other authors maintain that relationship banking may enable banks to extract rents from firms on which they have an informational monopoly (Sharpe (1990)).

Our key contribution amounts to considering bank risk-taking as liable to affect the link between relationship banking and interest rate setting. To the best of our knowledge, this possibility had not been proposed so far. But it is relevant to understand if, in a bank risk-taking environment, relationship banking remains useful for firms as a means to mitigate agency costs. Such understanding is even more opportune with the strong possibility that recent non-standard monetary policy measures become regular policy

instruments (Friedman (2014), Constâncio (2018)), and therefore the risk-taking behaviour they induce becoming more frequent.

The first objective of this dissertation is to propose, from a theoretical standpoint, how increased bank risk-taking can affect the link between relationship banking and interest rate setting. Secondly, to identify the variables that better account for relationship banking characteristics between banks and firms. To that end, the major strands of the relationship banking literature are reviewed below. The third objective is to measure and test the impact of these variables on interest rate changes at the bank-firm pair level.

The test of our hypothesis was inconclusive. In our sample, increased bank risk-taking has no statistically significant impact on the link between relationship banking and changes in lending rates to firms. The present study is structured as follows. In section 2, we provide an account of the literature on loan interest rate setting and on relationship banking. An empirical strategy is discussed in Section 3, along with the results obtained. Section 4 concludes.

2. Literature Review

We are studying the link between relationship banking and loan interest rate setting in a period of pronounced bank risk-taking. The account of the literature given in the present section is divided in three parts. First, we review what factors have made banks increase their risk-taking in the period under study. Second, we establish what relationship banking is, how it emerges and present both theoretical and empirical approaches as to the effects of relationship banking on loan interest rate dynamics. Third, we discuss measures of relationship banking.

2.1. Causes of Increased Bank Risk-Taking

2.1.1. Economic Expansion

There is reason to expect that during economic expansions non-relationship banking (riskier) firms benefit from more pronounced decreases in loan interest rates than relationship banking firms. This hypothesis finds support in the financial accelerator mechanism (Bernanke and Gertler (1989)) and in the notion that the cost of gathering of customer-specific soft information changes along the business cycle, as sustained by Ruckes (2004).

Bernanke and Gertler (1989) propose an analysis of the role of borrowers' net worth on business cycle fluctuations, known as the financial accelerator hypothesis. They assume that borrower net worth and agency costs of lending are inversely correlated (Sappington (1983)). A sounder financial position allows the borrower to reduce conflicts of interest with the lender, either because of increased collateral value or due to the borrower's increased self-financing capacity (Bernanke and Gertler (1995)).

According to Bernanke and Gertler (1989), borrowers' net worth increases during expansions, fuelled by improved collateral value and lower interest expenses. Agency costs of lending decrease, lowering borrowers' cost of external finance. Borrowers facing higher agency costs in credit markets, such as small firms, tend to benefit more than others from these effects (Bernanke *et al.* (1996), (Matsuyama (2007))).

In the context of the present dissertation, firms whose characteristics are relatively unknown to a bank are riskier than relationship banking firms, and thus face higher agency costs (Boot (2000)). If during an expansion the former (riskier) firms benefit more from decreasing agency costs, it follows that relationship banking may be associated with higher lending rate stickiness. This is the hypothesis under study in the present work.

Ruckes (2004) offers another explanation to how non-relationship banking firms can benefit more from an economic expansion than relationship banking firms. The author argues that banks' costs of screening unknown borrowers (Townsend (1979)) vary over the business cycle. During more expansionary and more contractive periods, screening becomes more costly because it is more likely that firms turn out to be good or bad, respectively. Therefore, rather than screening these applicants, banks price their loans based on overall macroeconomic conditions.

An important implication for our work is that, during more expansionary periods, low screening of unknown applicants may be a rational decision for banks. Therefore, banks may ignore firm-specific risks and become more lenient in pricing loans to applicants they don't know *ex-ante*. This may result in more pronounced decreases in spreads for non-relationship banking firms, *ceteris paribus*, in which case our hypothesis would be empirically validated.

2.1.2. Monetary Policy Measures

In June 2014, the European Central Bank (ECB) decided to push the rate on its deposit facility below zero, being the first major central bank to use a negative interest rate policy (NIRP). This choice came along the introduction of a wider policy package in the ensuing months, comprising the introduction of targeted longer-term refinancing operations (TLTRO) and a large-scale asset purchase programme (APP). In this subsection, we provide an account of how these non-standard monetary policy measures induced banks to take on more risk.

Monetary Policy Transmission via Bank Risk-Taking

One mechanism that links expansionary monetary policy to bank risk-taking is the upward effect of low interest rates on asset prices. As collateral value increases, agency costs are mitigated, and riskier borrowers benefit more from these effects (as explained above with respect to Bernanke and Gertler (1989)). In this context, banks are more prone to relax predictions on borrowers' default probabilities (Adrian and Shin (2010)). If, for example, banks rely on value-at-risk frameworks to manage their investment portfolios, they likely underestimate credit risk in an environment of low interest rates (Eisenschmidt and Smets (2018)).

This leniency can make banks finance riskier projects, therefore becoming riskier themselves (Borio and Zhu (2012)). Several empirical studies have found evidence on the existence of the bank risk-taking channel (Jimenez *et al.* (2014), Ioannidou *et al.* (2015), Dell'Ariccia *et al.* (2016)). In the present work, we focus on a sample period which is characterized by a zero lower bound scenario. In line with the risk-taking channel literature, our expectation is that banks provide riskier firms (in this instance, those they don't know *ex-ante*) with more pronounced decreases on lending rates.

Another mechanism through which expansionary monetary policy may induce bank risk-taking is adverse selection (Rajan (2005)). In a context of low interest rates, small returns on safer assets such as short-term lending and government bonds may pose a risk to bank profitability. As such, banks may expand their lending to higher-yield borrowers, who are usually also riskier. Recent asset purchase programmes by major central banks aim to encourage this risk-seeking behaviour. They do so by decreasing returns on safer assets like government bonds (Albertazzi *et al.* (2016)).

The most highlighted channel through which these purchases decrease returns on safer assets is portfolio rebalancing. It is effective because central bank purchases affect bond prices (Tischer (2018)). In a world of frictionless financial markets, a reduction in the supply of long-term government bonds following a central bank purchase would make investors re-allocate the extra money on short-term bonds, leaving bond prices unaffected. However, market imperfections (Tobin (1969)) such as preferred habitats limit this shift from long to short-term bonds, causing prices to adjust in both segments.

The result of these price increases is a reduction in yields on the safer assets that are included in central banks' purchase programmes. This should make banks move towards riskier lenders, such as households and firms. According to Draghi (2015), «Portfolio rebalancing [...] is one of the channels through which the asset purchase programme reaches the real economy: our purchases reduce returns on safer assets. This encourages investors to shift to riskier, higher yielding assets».

Negative Interest Rate Policy (NIRP)

In June 2014, the Governing Council introduced a negative rate on its deposit facility. This decision aimed at providing further monetary easing by means of cheaper and more abundant credit to the private sector (ECB (2015a)). Due to banks' reluctance in charging negative rates on retail deposits, these may become stickier as they approach the zero lower bound (ECB (2017a)). Banks relying more on retail deposits may transpose this stickiness to interest rates set on lending in order to protect their margins, thus refraining monetary policy transmission (Brunnermeier and Koby (2018)).

However, keeping low policy rates for an extended period of time may contribute to increases in asset prices and induce bank risk-seeking behaviour to compensate for low profitability (Gertler and Karadi (2010)). This prompts the exchange of very safe assets such as deposits in the Eurosystem by riskier assets such as loans and bonds (Jimenez *et al.* (2014), Dell'Ariccia *et al.* (2016)). Besides, NIRP may enhance the traditional bank lending channel by increasing the cost for banks of holding excess liquidity, thus making them more prone to increase credit supply (Demiralp *et al.* (2017)).

Empirical studies do find an impairment of the pass-through to rates on retail deposits, but not for rates on lending to the private sector, even for banks highly reliant on household deposit funding (see Eisenschmidt and Smets (2018) for a review). This finding is supported in bank lending surveys (BdP (2016a), BdP (2016b), ECB (2016a), ECB

(2016b)). According to Eisenschmidt and Smets (2018), the pass-through on loan rates is unchanged because the negative effects of NIRP on bank profitability are more than compensated by increased asset prices and bank risk-seeking behaviour.

Targeted Longer-Term Refinancing Operations (TLTRO)

The Governing Council announced in June 2014 the introduction of targeted longer-term refinancing operations (TLTRO). These open market operations provide banks with funding at attractive fixed costs for periods of up to four years, provided they meet certain criteria regarding the amount lent to the non-financial private sector. According to ECB (2015a), «the choice of this measure reflected the predominantly bank-based financing structure of the euro area economy and the significance of weak bank lending as a factor holding back the recovery».

Apart from cost and maturity advantages for banks, Draghi (2014) points out another crucial distinction between TLTRO and standard longer-term refinancing operations (LTRO): «the determination that this money not be spent on sovereigns». This quotation conveys the intention of monetary policymakers to induce banks to move from less risky assets, like sovereign bonds, to riskier ones, namely loans to the non-financial private sector.

A first set of eight operations was announced in June 2014 (TLTRO I), to be undertaken with fixed interest rates. In March 2016 a new set of operations was announced (TLTRO II), albeit with applicable interest rates being linked to each bidder's lending patterns. Under this framework, the higher the amounts banks had lent to the non-financial private sector prior to the operation, the more attractive the cost of their TLTRO II borrowings would become (ECB (2015a)).

To become less dependent on changes in key policy rates, banks preferred to engage more deeply in TLTRO than in any other kind of monetary policy open market operation (Renne (2014)). By the end of 2017, both in Portugal and the Euro Area, TLTRO accounted for nearly the whole outstanding amount borrowed by counterparties in monetary policy open market operations (Afonso and Sousa-Leite (2019)). This suggests that virtually all funding that banks obtained at the central bank was conditional, to some extent, on banks increasing the riskiness of their lending portfolios.

The literature addressing the link between TLTRO and interest rate setting is relatively scarce, but results are consistent. Existing studies suggest that banks which took part in

these operations decreased interest rates on loans to non-financial corporations (BdP (2017)) by more than other banks (ECB (2017b), Benetton and Fantino (2018), Afonso and Sousa-Leite (2019)).

Asset Purchase Programme (APP)

In September 2014, the Governing Council decided to launch two private sector asset purchase programmes aimed at fostering loan supply in specific markets still largely unresponsive to monetary policy actions. One is the market for high quality (“simple and transparent”) asset-backed securities (ABS). The underlying assets consist of euro area non-financial sector liabilities. The other is the market for euro-denominated covered bonds issued by euro area resident monetary and financial institutions.

The market for simple and transparent ABS has a high potential in facilitating new credit flows to the economy. Particularly important for interest rate setting, the link between ABS spreads and lending rates applied on the underlying credit is strong (ECB (2015a)). Since the European ABS market remained impaired as of the announcement of ECB purchases on this segment, there was high potential for interventions to change dynamics in that market. As ABS spreads decrease, arbitrage opportunities encourage banks to create ABS, necessarily increasing loan supply as underlying collateral.

As regards covered bonds, the link between their spread and that applied to the underlying loans is reasonably tight (ECB (2015a)). As the prices for these instruments are bid up by Eurosystem purchases, banks are expected to create more covered bonds and therefore issue more loans to the private sector as collateral. It is difficult to insulate the impact of ABSPP and CBPP3 on lending rates, since two significant asset purchase programmes were announced shortly after. These were much more substantial in terms of purchase amounts.

The public sector purchase programme (PSPP), announced in January 2015, amounted to a significant attempt to induce credit supply expansion and lending rate decreases in the euro area (ECB (2015a)). The Eurosystem had committed to purchase eligible bonds issued by euro area public institutions, which included all countries except Greece. Net purchases began in March 2015, and remained at a monthly pace of 60 billion euros until March 2016. The pace increased to 80 billion euros per month in the following 12 months, and then gradually decreased until net purchases ended in December 2018.

The corporate sector purchase programme (CSPP) was announced in March 2016 and started to be implemented in June 2016. Apart from portfolio rebalancing and signaling, this programme was transmitted to the real economy through another channel. According to ECB (2018), by reducing the cost of market-based funding for firms, CSPP allowed them to rely more on this source as compared to bank funding. The result, as suggested by the findings of Ertan *et al.* (2018), was that banks' balance sheets were freed up to lend more to smaller firms that had been previously excluded from bank funding.

Several empirical works have found the APP to account for considerable easing in the cost of credit for euro area firms (Jimenez *et al.* (2014), Altavilla *et al.* (2016), Albertazzi *et al.* (2016), Heider *et al.* (2017)). It has also been noted that there are complementarities between APP and NIRP. One of APP objectives is to make banks move from lending to sovereigns for lending to the non-financial private sector. This objective could be threatened if the Eurosystem deposit facility rate were more attractive for banks than lending to households and firms. NIRP contributes to discourage banks from hoarding excess liquidity at the central bank and lend to the real economy instead (Eisenschmidt and Smets (2018), Praet (2018)).

2.2. Relationship Banking and Loan Interest Rate Setting Heterogeneities

In financial markets, there are informational asymmetries between borrowers and lenders. This type of market failure tends to favour adverse selection and moral hazard problems, thus diminishing market efficiency in matching supply and demand for funds (Diamond (1984)). Rajan (1992) distinguishes between two types of funding sources for firms based on financial institutions' ability and interest in gathering information about the debtor. One is *transaction* or *arm's length* banking, under which lenders do not engage in acquiring soft information on the borrowers. The other is *relationship* banking, which involves the exchange of such information.

Transaction banking consists of lending funds without being aimed at an information-intensive relationship with a customer (Boot and Thakor (2000)). Even if transactions take place multiple times between two parties, this does not necessarily entail the collection of customer-specific soft information and so may still constitute transaction banking. Indeed, transaction banking is usually dependent on publicly available information, like borrowers' balance sheets (Rajan (1992)). This business model may favour larger firms, which tend to present less information asymmetries as compared to smaller firms (Boot and Thakor (2000)).

The other type of funding source is *relationship* banking. Authors like Bhattacharya and Thakor (1993) and Boot (2000) justify the existence of commercial banks in light of their capacity to mitigate costs arising from informational asymmetries. The definition of relationship banking put forward by Boot (2000) rests in two pillars. It concerns «the provision of financial services by a financial intermediary that invests in obtaining customer-specific information, often proprietary in nature, and evaluates the profitability of these investments through multiple interactions with the same customer over time and/or across products».

This definition suggests two essential elements in relationship banking: proprietary information and multiple interactions. This proprietary information may regard the borrower's business model and growth prospects (Elyasiani and Goldberg (2004)) or research and development activities (Bhattacharya and Chiesa (1995)). Banks may gather such customer-specific information when providing screening (Allen (1990)) or collateral monitoring activities (Winton (1995)), among other circumstances. This information is collected through and may be used in multiple interactions, providing the lender with the

possibility of benefiting from its inter-temporal reusability (Greenbaum and Thakor (1995)).

According to Boot and Thakor (2000), smaller firms are more prone to present lenders with information asymmetries. As such, they may tend to rely more on banks to obtain credit, as banks' business models often involve long-term information-intensive relationships, as opposed to transaction-oriented banking. At least for small and medium enterprises, this proprietary information is probably available only to the financial intermediary and to its customer.

The pros and cons of relationship banking for borrowers are analyzed by Boot (2000). On the one hand, in producing proprietary and soft information about firms as the relationship matures, banks mitigate costs arising from information asymmetries (Berger (1999)). Yet on the other hand, by having privileged access to proprietary information on the borrowers, banks may exercise market power over them, in what is usually defined as hold-up mechanism (Rajan (1992)).

Having defined relationship banking and whence it derives, the next step is to analyze its implications for interest rate setting. Both theoretical and empirical relationship banking literature provide links between relationship banking and loan contract conditions in terms of amount lent, collateral requirements and interest rates charged (Boot and Thakor (1994), Petersen and Rajan (1994)). The literature is practically consensual in concluding that relationship banking not only makes banks supply the firms involved with a larger amount of funds as it relaxes collateral requirements. Findings about the impact of relationship banking on interest rates charged on loans are however mixed, and different empirical results are consistent with diverse theoretical explanations.

Since the purpose of this dissertation is to shed light on how relationship banking impacts on interest rate setting, the single aspect of loan contract conditions that shall be henceforth taken into account is the interest rate charged on loans to non-financial corporations. Theoretical literature provides guidance on how relationship banking impacts on loan interest rate dynamics. Three *microeconomic* mechanisms that stem from relationship banking are expected to operate: mitigation of costs arising from informational asymmetries, hold-up and risk-sharing agreements between banks and firms.

The first mechanism stems from the informational advantage that a bank may have in comparison with its competitors for engaging in gathering customer-specific soft information (Boot and Thakor (1994), Petersen and Rajan (1994), Berger and Udell (1995),

Brick *et al.* (2007), Bharath *et al.* (2011), Gambacorta and Mistrulli (2014), Sette and Gobbi (2015)). This may happen when a firm is not willing to disclose information in financial markets that would benefit its competitors (Bhattacharya and Chiesa (1995)). This information, kept within one or a few banks, may provide firms with lower interest rates when dealing with those banks. Another important dimension of this mechanism is information reusability (Chan *et al.* (1986), James (1987)). This means that the mitigation of informational asymmetries costs may endure over time. Relationship banking also allows for greater flexibility in renegotiating credit conditions (Boot *et al.* (1993)).

The second mechanism regards hold-up issues. As a bank gathers more customer-specific soft information, it may acquire an information monopoly and consequently charge higher *ex-post* lending rates (Sharpe (1990), Rajan (1992), Von Thadden (1995)). If firms switch lenders or engage in multiple bank relationships, hold-up issues may be mitigated, but there are switching costs (Lowe and Rohling (1992), Ongena and Smith (2000)). For instance, multiple relationships may reduce the value of customer-specific soft information to one specific bank (Thakor (1996)). Several empirical works yield results consistent with the hold-up hypothesis, finding that interest rates on loans tend to increase as banking relationships mature (Auria *et al.* (1999), Ongena and Smith (2000), Degryse and Ongena (2005)).

The third mechanism regards the hypothesis of risk-sharing agreements arising as part of optimal contracts between banks and firms and which cause interest rate smoothness. Fried and Howitt (1980) propose that, as risk-averse borrowers, firms tend to privilege stable interest payments, which banks may concede in exchange for a higher average interest rate. Petersen and Rajan (1995) suggest banks may subsidize firms in the earlier stages of a project by setting low interest rates if they expect to partake in the returns. The risk-sharing hypothesis is empirically supported by Berger and Udell (1992), Petersen and Rajan (1995) and Berlin and Mester (1998).

2.3. Measures of Relationship Banking

We now present the measures used in our study as proxies for relationship banking. Before doing so, we assess the measures used in previous studies that suggest a link between relationship banking and interest rate setting. We start by establishing a criterion to assess whether a given proxy satisfactorily captures the characteristics of relationship banking. Then we consider if proxies for relationship banking used in previous works comply with this criterion. Finally, we present the proxies used in the present study, and justify them in light of this criterion and of the literature on relationship banking.

In order to establish a criterion aimed at assessing the quality of a candidate for relationship banking proxy, it is crucial to be clear about the elements in which this phenomenon is rooted. The two key elements are provided in the definition of Boot (2000), which emphasizes that «relationship banking involves borrower-specific [...] information available only to the intermediary and the customer». This idea is supported by Kysucky and Norden (2015) in that the dimensions of relationship banking depend «on the borrower, the bank, and bank-borrower relationship's characteristics». The necessary criterion, therefore, is that the best relationship banking proxies are found in bank-firm level data.

The first six proxies discussed are constructed using either bank or firm level data. This means they capture information that is specific to either banks or firms but not specific to bank-firm relationship characteristics. In a reference to Petersen and Rajan (1995), Berlin and Mester (1999) draw attention to this issue by noting that «[those authors] have detailed information about the borrowing firms over time, but only fragmentary information about their lenders. We have information about a changing pool of loans over time – an imperfect proxy for the borrowing firms – but very detailed information about their lenders».

Importance of Long-Term Business for Banks

At the bank level, Weth (2002) uses the sum of loans to and deposits by non-financial institutions with maturities of more than one year. In the same strand, De Graeve *et al.* (2007) and Gambacorta (2008) use the bank level ratio of loans with maturity of more than one year over total loans. According to Weth (2002), «the thinking behind this is that a bank with a relatively extensive, longer-term non-bank business maintains closer

relationships with its customers and therefore acts more as a “housebank” than one whose long-term nonbank business is only of minor importance».¹

These measures present three major drawbacks. Firstly, as Weth (2002) further states, «this indicator is imprecise insofar as it does not distinguish between credit institutions with a “housebank” status and other institutions geared to retail business with non-banks». Taking into account the author’s definition of “housebank”, this reinforces the above-mentioned idea that relationship banking proxies should reflect bank-firm specific characteristics. In other words, measures expressing the importance of long-term business for each bank do not comply with the above expounded criterion to assess the quality of a candidate for relationship banking proxy.

Secondly, by considering maturities of more than one year, this approach puts aside lines of credit, which have undefined maturities. However, as Berger and Udell (1995) and Sette and Gobbi (2015) hold, lines of credit are precisely the type of financial product that should be considered when studying relationship banking. Thirdly, the measures of relationship banking used by Weth (2002), De Graeve *et al.* (2007) and Gambacorta (2008) implicitly assume that long-term credit entails long-term relationships. This is not so, as a firm can start a new credit relationship with a bank issuing long-term debt, even if the exchange of soft information between parties is almost inexistent.

Importance of Core Deposits for Banks

Another measure of relationship banking is proposed by Berlin and Mester (1999).² «In our view, core deposits, like demand and savings deposits, which are largely rate inelastic, have historically insulated bank funding costs against economic shocks. In turn, core deposits have permitted banks to insulate borrowers against these shocks through implicit multi-period contracts that insure borrowers against adverse credit shocks. [...] Specifically we propose that banks with more core deposits smooth firms’ borrowing costs in the face of adverse aggregate credit shocks».

¹ Weth (2002) defines “housebank” as a bank which «has the best information on the customer’s creditworthiness and therefore acts as the customer’s principal lender».

² Based on this approach, the ratio of deposits over total liabilities was used by De Graeve *et al.* (2007), and Horváth and Podpiera (2012) to study heterogeneities in the interest rate pass-through across banks. Gambacorta (2008) used the ratio of deposits over deposits plus bonds.

Essentially, Berlin and Mester (1999) take the view that lending rate smoothness stems from «implicit multi-period contracts», which should in turn be associated with higher degrees of bank reliance on core deposits. We have ourselves acknowledged in the Introduction that lending rate smoothness may stem from «implicit multi-period contracts» as insurance schemes, in the spirit of Fried and Howitt (1980). However, in contrast with Berlin and Mester (1999), we view the source of these contracts as not being related to relationship banking, not core deposits.

To justify this last claim, it is worth restating the criterion adopted above to evaluate the quality of a candidate for relationship banking variable. Such variable should express banks' ability to acquire soft information on a borrower. According to Petersen and Rajan (1995) and Boot (2000), it is this knowledge that makes it viable for banks to incur in losses in some periods, provided they expect borrowers to break-even in a multi-period perspective. In other words, it is this knowledge that underpins the «implicit multi-period contracts».

A question naturally follows to assess the measure proposed by Berlin and Mester (1999) as an adequate proxy for relationship banking: whether the ratio of core deposits over total bank liabilities tells something about banks' ability to acquire soft information on a borrower. Being a bank level measure, it does not, because it carries no direct information on the borrowers. Being aware of this problem, Berlin and Mester (1999) acknowledge: «we have information about a changing pool of loans over time – an imperfect proxy for the borrowing firms».

Nonetheless, banks relying more heavily on core deposits may smooth lending rates more because deposit rates are usually stickier than lending rates, due to issues like menu costs (Driscoll and Judson (2013)). Following this premise, the more their funding structure relies on core deposits, the stickier lending rates become. The vital point here is that the degree of bank dependence on core deposits may smooth out lending rates, but through issues like menu costs associated with deposit rates, not through insurance schemes stemming from «implicit multi-period contracts», and hence not through relationship banking.

Importance of Lending to Small and Medium Enterprises

Kitamura *et al.* (2016) chose, among other proxies, the ratio of small and medium enterprises (SME) in a bank's borrower portfolio. «We expect pass-through to be lower for

banks with a high proportion of relationship lending because they typically provide an inter-temporal interest smoothing function to their customer firms». The authors further state: «it is assumed that loans to [...] [SME] typically have relationship lending characteristics because these companies have relatively limited access to market-based funding and their business models and financial conditions are more likely to be subject to the problem of asymmetric information between borrowers and lenders». To the best of our knowledge, this measure finds no precedent in the relationship banking literature.

It is possible to justify the authors' premise that information asymmetries between lenders and borrowers tend to be more acute for smaller firms (Gertler and Gilchrist (1994), Bernanke and Gertler (1995)). However, their conclusion that «loans to [...] [SME] typically have relationship lending characteristics» overlooks an important aspect. Banks know some of its SME borrowers better than others because bank-firm relationships do not share the same characteristics (Boot (2000)). For example, SME may engage in transaction-oriented relationships with banks, pledging collateral to back a loan. In other words, asymmetric information exists in varying degrees across bank-firm relationships. This discards the variable presented by Kitamura *et al.* (2016) as a good proxy for relationship banking.

Bank Regional Market Power

Kitamura *et al.* (2016) also consider as relationship banking measure the weighted average Herfindahl index by bank outstanding credit for each region. «If a bank has a large [regional] market share, its customer relationships are likely to be close and relationship lending naturally arises. A bank in this situation is expected to have lower pass-through because it provides an inter-temporal interest rate smoothing function». Again, this measure disregards borrower characteristics, which may vary substantially within a given region.

As Petersen and Rajan (1995) acknowledge, the use of this measure as a proxy for relationship banking implies assuming that firms borrow mostly from the geographic markets in which they are present. If they depend largely on other geographic markets, while also borrowing a bit from a local monopolist bank, there is no scope to expect this local monopolist to possess exclusive access to relevant soft information on the borrowers, despite their physical proximity. Hence, the regional market share, as proposed by Kitamura *et al.* (2016) may be misleading.

Even if the condition stated in the last paragraph holds, as may well be the case according to Petersen and Rajan (1995), there is another relevant objection to the measure proposed by Kitamura *et al.* (2016). It does not allow disentangling the existence of relationship banking from the exertion of bank market power. In fact, as Kitamura *et al.* (2016) put it, «market share influences loan interest rate pass-through from two perspectives. First, a bank with a large market share tends to set its loan interest rates at levels significantly higher than market interest rates by utilizing its monopolistic power. [...] Second, if a bank has a large market share, its customer relationships are likely to be close and relationship lending naturally arises».

Borrowing Firms' Leverage

Kitamura *et al.* (2016) consider the borrowing firm debt to equity ratio as another proxy for relationship banking. «One viewpoint is that the debt to equity ratio measures firms' debt burden. For example, when a borrowing firm's debt burden rises temporarily due to exogenous factors, a bank having a close relationship with the firm is expected to smooth out transaction conditions if a future benefit is expected. [...] Another viewpoint is that the debt to equity ratio represents the firm's funding structure. Because firms with a higher debt to equity ratio are more dependent on bank lending, the relationships between such firms and banks tend to be strong. In this situation, banks smooth out transaction conditions».

Two caveats are in place to assess this candidate for relationship banking proxy. Firstly, firm leverage indicators are often used as proxies for credit risk, as in Santos and Winton (2008), Santos (2011) and Banerjee *et al.* (2017). It pertains to the possibility that borrowers do not honour their debts entirely or in due time. As such, it is not the same as relationship banking, which is the determinant of interest to our study. Even if the mechanisms explained in the quotation presented in the last paragraph hold, it would not be possible to separate relationship banking from credit risk, rendering an inconclusive analysis.

The second caveat is the following. Unlike the measures previously discussed, which are constructed using bank characteristics, the present one regards borrower characteristics. In fact, the major contribution of Kitamura *et al.* (2016) is considering not only bank but also borrower characteristics in studying heterogeneities in the interest rate pass-through. However, their analysis is conducted at the bank level, not at the bank-firm level: «because it is difficult to identify individual transactions between banks and firms directly from this

data base, balance sheet data for firms with which banks conduct transactions are not available. Because of this problem, we calculate a proxy of borrowing firms' balance sheet data for each bank by averaging out firms' balance sheet data aggregated at prefecture level with the weight of each bank's loans outstanding in each prefecture».

Borrowing Firms' Interest Coverage Ratios

Another measure of relationship banking is presented by Kitamura *et al.* (2016), the interest coverage ratio (ICR).³ «The ICR influences pass-through behavior in a similar way to the debt to equity ratio. For example, if a firm's ICR temporarily declines due to deteriorating business conditions, a bank having a close relationship with the firm is expected to smooth out their transaction conditions if a future benefit is expected. Pass-through then declines. Another possibility is that firms with a lower ICR tend to be highly dependent on bank lending. If so, pass-through is likely to be low because the relationships between such firms and banks are strong. From either viewpoint, pass-through is expected to be low if the ICR is low».

The following flaws should be noted. Firstly, the interest coverage ratio was used as a proxy for credit risk in Santos and Winton (2008), Santos (2011) and Banerjee *et al.* (2017). If this variable captures both phenomena, it may be preferable to use measures which better insulate relationship banking. Secondly, Kitamura *et al.* (2016) do not provide any reference, either theoretical or empirical, in support of the interest coverage ratio as a proxy for relationship banking. Thirdly, even if it were a good measure, the way in which it is calculated (as a bank level average) masks bank-firm level heterogeneities associated with banks' collection of soft information on the borrowers.

Relationship Duration

Having discussed the relationship banking measures used in previous studies, we now turn to the ones we find best to fulfill that role. Our choices take into account the literature concerned with understanding the nature and effects of relationship banking. One of the most widely used proxies for the production of soft information is the duration of a bank-firm relationship (Diamond (1991), Petersen and Rajan (1994), Berger and Udell (1995),

³ Kitamura *et al.* (2016) define the interest coverage ratio (ICR) as the sum of operating profits, interest received, and dividends received divided by interest payments. The authors write this should reflect borrowing firms' ability to make interest payments.

Cole (1998), Degryse and Van Cayseele (2000), Ongena and Smith (2001), Beck *et al.* (2008)).

The underlying rationale is that longer relationship durations tend to be associated with a series of successful operations over time. Therefore, a bank's knowledge of soft information on a borrower tends to increase with relationship duration (Boot (2000), Kysucky and Norden (2015)). Using this measure entails satisfying an important constraint. It requires using microeconomic data at the bank-firm level. This is not always possible, as noted by Kitamura *et al.* (2016).

As regards the impact of relationship banking on interest rate changes, it has been used only by Sette and Gobbi (2015), who found it to be significant in explaining heterogeneity between bank-firm pairs. It has, nonetheless, been used as a proxy for bank acquisition of soft information on the borrowers in several studies concerned with the impact of relationship banking on interest rate spreads (Berger and Udell (1995), Angelini *et al.* (1998), Bolton *et al.* (2016)).

Some studies use measures similar to relationship duration to capture firms' credit reputation in the market. These are the age of the borrower (Petersen and Rajan (1994)) and its credit history, defined as the number of periods that have elapsed since the first time a borrower was reported to the credit register (Diamond (1989), Gambacorta and Mistrulli (2014), Bolton *et al.* (2016)). These measures, especially the latter, also capture the amount of information shared among lenders via credit registers. A crucial distinction is now required. To state that these measures proxy for firms' credit reputation in the market does not discard the possibility that banks may have better knowledge of some firms.

This distinction is drawn by Petersen and Rajan (1994): «it is possible that the lender could obtain sufficient information on the firm's ability to service debt-like claims by observing its past interactions with other fixed claim holders like employees or prior creditors. If so, the age of the firm rather than the length of the financial relationship should determine the lender's cost and the availability of funds. Alternatively, the information generated within a financial relationship may not be observable (or transferable) to outsiders. If so, the length of the relationship should exert an independent influence».

Relationship Exclusivity

The degree of lender exclusivity in a firm's credit portfolio is another aspect of bank-firm relationships that may enhance the transmission of soft information from the borrower to the lender (Harhoff and Körting (1998), Machauer and Weber (1998), Degryse and Van Cayseele (2000), Ongena and Smith (2001), Degryse and Ongena (2005), Elsas (2005), Schenone (2010)). To the best of our knowledge, the proxy that is used more often to capture this phenomenon is the number of banks lending to a given firm (Petersen and Rajan (1994), Cole (1998), Elsas and Krahnen (1998), Harhoff and Körting (1998), Machauer and Weber (1998), De Bodt *et al.* (2005)). We use this proxy in the present study.

Another measure of relationship exclusivity is bank's share of a borrower's outstanding credit amount (Degryse *et al.* (2009), Ioannidou and Ongena (2010), Gambacorta and Mistrulli (2014), Sette and Gobbi (2015)). One of the works closest to our study, Gambacorta and Mistrulli (2014), includes both this measure and the number of banks lending to a given firm as alternative proxies for relationship exclusivity. We follow the same approach.

Distance

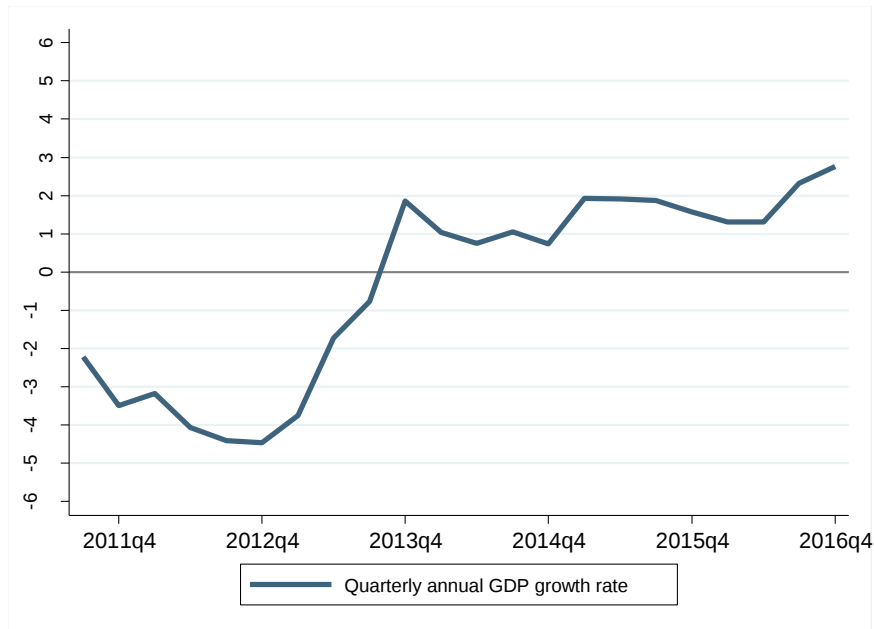
The ability of lenders to gather customer-specific soft information tends to decrease with geographical distance between lenders and borrowers (Agarwal and Hauswald (2010)). Gambacorta and Mistrulli (2014) and Sette and Gobbi (2015) use dummies that capture the distance between the bank branch and borrower's headquarters. Both studies find that shorter distances tend to translate into lower spread increases. Others have studied the impact of geographical distance on interest rates (Mistrulli and Casolaro (2008)). Due to lack of data availability, we shall not consider geographical distance as a proxy for relationship banking.

3. Methodology

3.1. Sample Period Characterization

We chose the period June 2014 to May 2016 to conduct our analysis. During this time, there were two major factors that potentially increased bank risk-taking in Portugal. These are economic expansion and non-standard expansionary measures of monetary policy. The mechanisms through which these factors might contribute to increase bank risk-taking were explored in Chapter 2. The aim of the present section is to explain the choice of the aforementioned sample period as suitable to address our research question.

Graph 1: Quarterly Annual GDP Growth Rate in Portugal

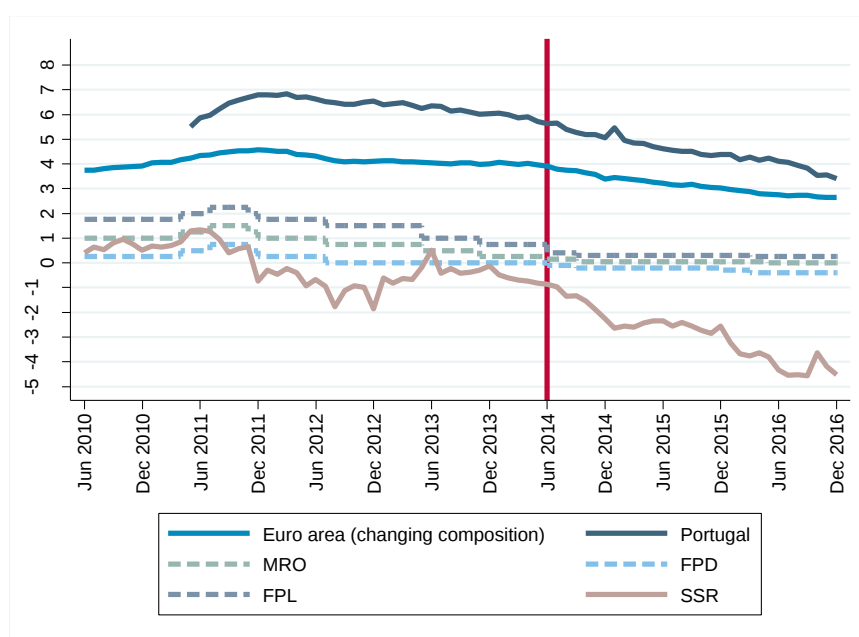


Source: Instituto Nacional de Estatística

As discussed in the literature review, economic expansions may favour increased risk-taking by banks if they provide better terms to those firms whose characteristics they don't know *ex-ante* (Bernanke *et al.* (1996), Ruckes (2004)). In the last quarter of 2013, following a severe recession, Portugal entered a period of continued GDP growth (see Graph 1). Banks' risk perception had decreased significantly throughout 2013 (ECB (2013a)). The sample period chosen to address our research question should therefore start, at the earliest, in the last quarter of 2013.

The second factor that may foster banks to take more risk is monetary policy. From mid-2011 to May 2014, lending rates in the euro area were largely unresponsive to changes in key policy rates (Graph 2) (Altavilla *et al.* (2016)). During this stage, euro area banks reported a net tightening in credit standards (ECB (2015b)).⁴ By mid-2014, because key policy rates had become so close to zero, the Governing Council decided to push the deposit facility rate to negative grounds for the first time (Graph 2).

Graph 2: Interest Rates on NFC Credit Lines and Overdrafts on Deposit Accounts, Key ECB Policy Rates (MRO, FPD, FPL) and Shadow Short Rate (SSR) (%)



Sources: ECB Statistical Data Warehouse, Wu and Xia (2016)

Against a backdrop of low inflation and limited room to decrease key policy rates, the Governing Council introduced as of June 2014 a new set of non-standard measures which comprised TLTRO and APP (ECB (2015a)). Key policy rates don't capture the introduction and implementation of these monetary policy measures. Because of this, authors such as Wu and Xia (2016) provide a short shadow rate designed to proxy for monetary policy stance in times of non-standard monetary policy actions. Graph 2 shows lending rates decreased more than key policy rates as of mid-2014, and followed

⁴ ECB (2015b) defines *credit standards* as «the internal guidelines or loan approval criteria of a bank. They are established prior to the actual loan negotiation on the terms and conditions and the actual loan approval/rejection decision».

movements in the shadow short rate. This suggests TLTRO and APP succeeded in pushing lending rates down (ECB (2017a), ECB (2017b)).

We have explained the reasons that drove us to choose June 2014 as starting date for the sample period under analysis, and now turn to justifying May 2016 as the selected end date. The choice of the end date took into account the risk that a too long sample period might cause endogeneity issues (Gambacorta and Mistrulli (2014)). For instance, more pronounced decreases in lending rates (changes in lending rates being our dependent variable) could make a firm more prone to increase the duration of its relationship (an explanatory variable of our model) with the bank.

Graph 3: Chronology of Implementation of Non-Standard Monetary Policy Measures
in the Euro Area⁵

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Source: ECB

As illustrated in Graph 3, the period June 2014 to May 2016 comprised the introduction of negative key policy rates, the nearly full implementation of TLTRO I and the beginning of PSPP purchases. These measures continued to be carried out after this period, and CSPP started to be implemented in June 2016. As mentioned in the literature review, CSPP changed, to some extent, the composition of bank borrowing firms, as larger ones moved to market-based funding.

This change in the composition of borrowing firms may affect the link between relationship banking and lending rate setting. For instance, Ertan *et al.* (2018) suggest that

⁵ Grey areas represent the months in which these measures were implemented, but do not comprise their announcements. The two vertical lines in bold mark the start and end dates of our sample period.

with CSPP banks tended to offer better terms and conditions to smaller firms. These firms often have shorter relationship durations (Ongena and Smith (2001)). As a result, a more pronounced decrease in lending rates could be due to the effect of CSPP on banks' balance sheets rather than less relationship banking. There is no reason *a priori* to expect other non-standard measures to produce changes in the type of firms that borrow from banks. In order to avoid these possible confounding effects, we chose May 2016 to end our sample period.

3.2. Data Description

We construct variables from four data sets developed at Banco de Portugal. These cover almost the whole universe of non-financial corporations and banks in Portugal. The dependent variable of our model is constructed using *Informação Individual de Taxas de Juro*, which gathers interest rates agreed between banks and non-financial corporations for new and renegotiated loans. The dependent variable measures the change in interest rate applied to credit lines and overdrafts on deposit accounts between June 2014 and May 2016.

Relationship banking variables, which are computed at the bank-firm level, are constructed using *Central de Responsabilidades de Crédito*, which contains outstanding amounts of credit granted by banks to non-financial corporations. We also control for credit supply and credit demand characteristics. Bank and firm control variables are constructed from *Base de Dados de Balanços de Bancos*, comprising banks' balance sheets and *Central de Balanços*, pertaining to non-financial corporations' balance sheets.

The terms of the agreement under which access to these data sets was made possible to us stated that we would have no direct access to them. Banco de Portugal provided us with perturbed and anonymous data, so as to ensure data confidentiality. The data analysis we undertook required us to write scripts using these pseudo data sets, which we would then send to Banco de Portugal. In turn, data providers would run these scripts on original data and send us back the output.

Dependent Variable

We use as dependent variable the change in interest rate applied to lines of credit and overdrafts on deposit accounts between June 2014 and May 2016. A line of credit is «an agreement between a lender and borrower that allows a borrower to take advances, during a defined period and up to a certain limit, and repay the advances, usually at his/her discretion, before a defined date» (ECB (2017c)). Overdrafts are «debit balances on current [deposit] accounts» (ECB (2017c)). Both are built-in contracts, framed under certain conditions that may be revised from time to time. This is why the respective maturity is undefined in the interest rates data set.

Table 1: Variables Description

Variable	Description
Delta IR	Change in interest rate on lines of credit and overdrafts on deposit accounts between June 2014 and May 2016 (winsorized at 5%)
Duration	Duration of the relationship between a bank and a firm (in years) on December 2013
Bank Share	Share of outstanding credit held by each one of a firm's creditors from January 2013 to December 2013
Number Banks	Number of banks holding outstanding credit of a given firm from January 2013 to December 2013
PSPP	Dummy variable (0 if the observation is between June 2014 and February 2015 and 1 between March 2015 to May 2016)
Log(Firm Assets)	Natural Logarithm of a firm's asset value on December 2013(asset value winsorized at 5%)
Firm Liquidity Ratio	A firm's working capital (current assets minus current liabilities) over total asset value on December 2013 (winsorized at 5%)
Firm Return on Assets	A firm's net earnings over total asset value on December 2013 (winsorized at 5%)
Firm Equity-Debt Ratio	A firm's equity over total liability value on December 2013 (winsorized at 5%)
Firm Asset Turnover Ratio	A firm's sales income over total asset value on December 2013 (winsorized at 5%)
Log(Bank Assets)	Natural Logarithm of a bank's asset value on December 2013
Bank Liquidity Ratio	A bank's current assets over total asset value on December 2013
Bank Non-Performing Loans Ratio	A bank's outstanding amount of non-performing loans to non-financial corporations over total outstanding amount of credit to non-financial corporations on December 2013
Bank Market Share	A bank's share of the sum of banks' assets on December 2013
Bank Capital Ratio	A bank's volume of capital and reserves over total liability value on December 2013

Bank Deposit Ratio	A bank's volume of deposits over total liability value on December 2013
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Source: Banco de Portugal (Informação Individual de Taxas de Juro, Central de Responsabilidades de Crédito, Central de Balanços, Base de Dados de Balanços de Bancos)

According to Berger and Udell (1995), credit lines are particularly well suited to study relationship banking. They exist mainly to satisfy recurring credit needs, making its issuance more frequent than that of a term loan and less likely to involve collateral (Sette and Gobbi (2015)). This recurrent access to credit allows banks to gather more soft information on the borrowers, when compared to term, transaction-driven loans, which tend to satisfy nonrecurring credit needs. In the literature more closely related to our study, authors have used credit lines (Gambacorta and Mistrulli (2014), Sette and Gobbi (2015)).

BdP (2014) and BdP (2016c) place credit lines and overdrafts in the same statistical category in terms of maturity, because this is indeterminate for both products. Indeed, as shown in Table 2, credit lines and authorized overdrafts tend to be priced similarly. The type of interest rate present in the data set is the annualized agreed rate, which does not take in fees and commissions. Loans with indeterminate maturity include not only credit lines and overdrafts on deposit accounts but also credit cards and unauthorized overdrafts (ECB (2009), ECB (2013b)).

Table 2: Pricing of Products with Undefined Maturity in Portugal⁶

Bank	Date	Credit Lines	Overdrafts on Deposit Accounts (Authorized)	Unauthorized Overdrafts	Credit Cards
Santander Totta	01-10-2018	12 Month Euribor + Spread (3.750 p.p. to 6.500 p.p.)	6 Month Euribor + Spread (3.750 p.p. to 6.500 p.p.)	26.750%	20.000%*
Caixa Geral de Depósitos	05-10-2018	12 Month Euribor + Spread (1.910 p.p. to 9.680 p.p.)	12 Month Euribor + Spread (1.910 p.p. to 9.680 p.p.)	Up to 22.500%	12.500%*

⁶ The values marked with an asterisk are simple averages of the annualized agreed rates applied on several products a bank supplies within each product category. E.g. for Santander Totta, it is the simple average of the annualized agreed rates on the credit card products “Business Advance”, “Sata Blue Empresas” and “Sata Gold Empresas”.

Novo Banco	01-10-2018	1, 3, 6 or 12 Month Euribor + Spread (5.000 p.p. to 14.800 p.p.)	27.000%	27.000%	27.200%
Banco Português de Investimento	01-10-2018	6 or 12 Month Euribor + Spread (4.750 p.p. to 10.250 p.p.)	6 or 12 Month Euribor + Spread (4.750 p.p. to 10.250 p.p.)	20.500%	15.617%*
Banco Comercial Português	03-10-2018	Eonia or 1, 3, 6 or 12 Month Euribor + Spread (5.500 p.p. to 15.750 p.p.)	Eonia or 1, 3, 6 or 12 Month Euribor + Spread (6.250 p.p. to 16.750 p.p.)	24.667%*	16.000%

Sources: BCP (2018), BPI (2018), CGD (2018), Novo Banco (2018), Santander Totta (2018).

It was not possible for us to identify the specific product category to which a loan belongs in the interest rate data set. To be more precise, we can know if a loan has indeterminate maturity, but not whether it is a credit line, overdraft or credit card. Because we are focusing on credit lines and authorized overdrafts, we only consider in the main regressions loans with interest rates up to a threshold of 15%. Although this procedure is not entirely accurate to determine whether a loan is a credit line or an authorized overdraft, it is likely to capture mostly these products (see Table 2). Besides, as robustness checks, we use alternative thresholds of 10% and 20%.

We took six steps to calculate the dependent variable. In a first step, we excluded loan renegotiations, thus keeping only new loans. A renegotiation may be due to issues like debt restructuring, and can interfere with our results. Secondly, we kept only loans with zero maturity, since lines of credit and authorized overdrafts both fall in this category. The third step was to exclude products which also have indeterminate maturity but are not of interest for our study, *e.g.* credit cards. We did so by keeping only loans with an interest rate up to 15%, as described in the last paragraph.

The fourth step was to compute, for every bank-firm pair, a weighted average interest rate per month, using loan amounts as weights. This was necessary because a given bank-firm pair may engage in more than one new credit operation in the same month, meaning that in a given month the same bank-firm pair may have more than one observation in the raw data. The fifth step was to fill out missing observations for June 2014, February 2015 and May 2016 with the last available observation for each bank-firm pair, for the contracts that still applied in these four months (Gambacorta and Mistrulli (2014)). The last step was

to take the differences of the weighted average interest rates between June 2014 and February 2015 and then February 2015 to May 2016. The use of these two sub-periods has two important advantages, which are explained in section 3.3.

Table 3: Descriptive Statistics

Variable	N	Mean	1 st Percentile	50 th Percentile	99 th Percentile
Delta IR	9,182	-0.919	-3.077	-0.339	-.008
Duration	9,182	7.088	0	6	32.583
Bank Share	9,182	0.316	0.001	0.172	1
Number Banks	9,182	6.122	1	5	18
Log(Firm Assets)	9,182	13.584	10.340	13.865	14.785
Firm Liquidity Ratio	9,182	0.160	-0.911	0.181	0.834
Firm Return on Assets	9,182	-0.005	-0.506	0.008	0.217
Firm Equity-Debt Ratio	9,182	0.615	-0.524	0.377	4.549
Firm Asset Turnover Ratio	9,182	1.268	0.011	1.038	4.404
Log(Bank Assets)	9,182	8.972	8.667	8.667	11.201
Bank Liquidity Ratio	9,182	0.472	0.160	0.548	0.548
Bank Non-Performing Loans Ratio	9,182	0.095	0.069	0.069	0.218

Bank Market Share	9,182	0.022	0.013	0.013	0.144
Bank Capital Ratio	9,182	0.101	0.098	0.098	0.119
Bank Deposit Ratio	9,182	0.815	0.628	0.841	0.841

Sources: Banco de Portugal (Informação Individual de Taxas de Juro, Central de Responsabilidades de Crédito, Central de Balanços, Base de Dados de Balanços de Bancos)

Relationship Banking Variables

Following our discussion of relationship banking measures in the literature review, we chose to use three proxies in the present study. Our choice was underpinned by the idea that relationship banking is a bank-firm level phenomenon, which is best captured by proxies built at this level of aggregation, and not at the bank or firm levels (Berlin and Mester (1999), Kysucky and Norden (2015)). The first proxy is the duration of the relationship between a bank and a firm, which is positively associated with relationship banking; the longer it is, the more soft information banks may gather on firms (Berger and Udell (1995), Ongena and Smith (2001)).

The second is a bank's share of a firm's outstanding credit amount (Degryse *et al.* (2009), Ioannidou and Ongena (2010)). The higher this share, the more exclusive a relationship is, and the more likely it becomes that only a few banks possess relevant soft information on the firm. The same reasoning goes for the third proxy, the number of banks lending to a given firm (Petersen and Rajan (1994), De Bodt *et al.* (2005)). This is expected to be inversely related with relationship banking. We do not use geographical proxies such as the distance between a bank and a firm (Mistrulli and Casolaro (2008)), due to lack of data availability.

Control Variables

As regards controls for bank and firm-specific characteristics, we consider measures commonly used in the literature. To capture the effect of the bank lending channel on monetary policy transmission, we use bank size, capitalization and liquidity (De Graeve *et*

et al. (2007), Gambacorta (2008), Horváth and Podpiera (2012), Holton and Rodriguez d'Acri (2015), Albertazzi *et al.* (2016) Kitamura *et al.* (2016)). As regards banks' risk, we use banks' ratios of non-performing credit over total assets (Horváth and Podpiera (2012), Ioannidou *et al.* (2015)). The bank-level share of new loans is used in our study as proxy for bank market power (De Graeve *et al.* (2007), Antão (2009)).

As regards non-financial corporations' characteristics, we take firm size to capture the effects of the balance sheet channel (Gertler and Gilchrist (1994), Ehrmann (2000), Ashcraft and Campello (2007)). A widespread measure of firms' credit risk is Altman's Z-score (Altman *et al.* (1994), Santos and Winton (2008), Gambacorta and Mistrulli (2014), Sette and Gobbi (2015), Bolton *et al.* (2016), Banerjee *et al.* (2017)). Although this measure sums up several determinants of firms' credit risk and is widely used, it is not available in the data sets used in this dissertation.

It is however possible to measure several dimensions of firms' credit risk. To measure profitability, we shall use retained earnings over total assets (Altman *et al.* (1994), Santos (2011)). The proxy we use for leverage is the ratio of equity to total debt (Altman *et al.* (1994), Banerjee *et al.* (2017)). We capture liquidity through the working capital ratio (Altman *et al.* (1994)). The level of business activity is measured using the ratio of sales to total assets (Altman *et al.* (1994), Santos and Winton (2008)). We use two-digit Classificação de Actividade Económica (CAE) as industry dummy (Dedola and Lippi (2005), Gambacorta and Mistrulli (2014)).

3.3. Econometric Modeling and Results

In the present work, we aim at measuring and testing the impact of relationship banking on loan interest rate setting. Our main regressions are based on the estimation of the model presented below. This model includes a relationship banking variable (RB), bank and firm fixed effects. We use bank and firm fixed effects to better disentangle relationship banking characteristics from factors related to the supply and demand for credit. $PSPP_t$ is a dummy variable that equals 1 for the observations of ΔIR pertaining to February 2015 – May 2016, and zero otherwise.

$$(1) \Delta IR_{b,f,t} = \alpha_b + \gamma_f + \beta RB_{b,f,t} + \delta RB_{b,f,t} * PSPP_t + \lambda PSPP_t + \varepsilon_{b,f,t}$$

The use of bank-firm level data allows us to improve parameter identification by including bank and firm fixed effects in the same model. These fixed effects capture both observable and unobservable characteristics of the supply and demand for credit that may be correlated with relationship banking variables. For instance, firm size and relationship duration tend to be correlated (Ongena and Smith (2001)). Some studies close to ours also follow this approach (Gambacorta and Mistrulli (2014), Sette and Gobbi (2015), Bolton *et al.* (2016)).

The inclusion of an interaction term follows Sette and Gobbi (2015). The dummy variable $PSPP_t$ is 0 if the subscript t refers to June 2014 – February 2015 and 1 if it refers to February 2015 – May 2016. Because PSPP net purchases started in March 2015, the latter sub-period is probably more associated with bank risk-taking than the former. The interaction term is intended to test how relationship banking affects interest rate setting in a sub-period of more pronounced risk-taking. The inclusion of this interaction term in the model contributes to make sure our empirical findings are not driven by confounding effects such as the hold-up issues mentioned in the literature review. $PSPP_t$ controls for effects associated with PSPP which might otherwise be captured by the interaction term, making parameter identification less clear.

In their main analyses, Gambacorta and Mistrulli (2014) and Sette and Gobbi (2015) consider only multiple relationship firms, *i.e.* those firms which maintain a relationship with more than one bank at the same time. They do so because, when adding firm fixed effects to the model, single relationship firms are excluded from the sample. Both recognize the exclusion of these firms may result in sample selection bias, and present solutions to

address this problem. The use of two sub-sample periods in the present work allows us to introduce firm fixed effects without excluding firms. This is because in our sample single relationship firms have two observations, one for each sub-period.

In order to mitigate endogeneity issues, explanatory variables were calculated *ex-ante*, as described in Table 1. This limits the possibility that interest rate changes (the dependent variable) have an impact on regressors. For instance, more significant interest rate decreases can make firms willing to increase the duration of a relationship. We use the OLS method for estimation, and standard errors are robust to heteroskedasticity and autocorrelation.

Table 4: Baseline Regressions

	Delta IR	Delta IR
Duration	0.002 (0.25)	
Duration*PSPP	-0.005 (-1.58)	
Bank Share		-0.414 (-1.00)
Bank Share*PSPP		0.077 (1.36)
PSPP	-0.236*** (-8.21)	-0.295*** (-11.15)
Firm Fixed Effects	Yes	Yes
Bank Fixed Effects	Yes	Yes
N	9,182	9,182
Adjusted R^2	0.057	0.057

Notes: Values in parentheses correspond to t-statistics. * denotes statistical significance at 10%, ** at 5% and *** at 1%

Sources: Banco de Portugal (Informação Individual de Taxas de Juro, Central de Responsabilidades de Crédito, Central de Balanços, Base de Dados de Balanços de Bancos)

Estimates for baseline results are presented in Table 4. Estimates for the interaction terms are not statistically significant, suggesting that the link between relationship banking and changes in lending rates does not depend on bank risk-taking. This means that our hypothesis is not confirmed by the data, but is also not rejected. These results are robust to the use of different thresholds in determining what new operations constitute credit lines and overdrafts (Tables 5 and 6).

In Table 9, we use the number of banks lending to a given firm as proxy for relationship banking. As this is a firm-specific proxy and relationship banking is a bank-firm level phenomenon, we decided to exclude it from the main analysis. While including it in the model, we had to exclude firm fixed effects. The result, presented in Table 9, is consistent with those presented in the baseline regression and robustness checks. Overall, both firm and bank control variables yield expected signs (Tables 7 to 11).

4. Conclusion

The present dissertation concerns the study of the link between relationship banking and the setting of interest rates on bank loans to non-financial corporations. The research question we presented is whether, in a period of increased bank risk-taking, banks decrease lending rates by more to those firms that are less reliant on relationship banking and, *ceteris paribus*, riskier. The rationale underpinning such question is that increased bank risk-taking may stem from the reduction of agency costs, and that agency costs decrease by more to more opaque borrowers (Bernanke *et al.* (1996), (Matsuyama (2007))).

We chose a sample period characterized by increased bank risk-taking, due to two major factors: economic expansion and unconventional monetary policy. Contrary to our expectations, the test of the hypothesis proposed in the present work made us conclude that, even in a period of increased bank risk-taking, relationship banking has no statistically significant impact on changes in lending rates to firms. A likely explanation for this result is that, whilst pricing loans to firms, banks did not significantly distinguish between firms more or less reliant on relationship banking.

5. Annex

Table 5: Robustness Checks ($IR \leq 10\%$)

	Delta IR	Delta IR
Duration	0.004 (0.55)	
Duration*PSPP	-0.005 (-1.52)	
Bank Share		-0.425 (-1.03)
Bank Share*PSPP		0.153** (2.37)
PSPP	-0.218*** (-7.22)	-0.295*** (-10.75)
Firm Fixed Effects	Yes	Yes
Bank Fixed Effects	Yes	Yes
N	7,386	7,386
Adjusted R^2	0.051	0.052

Notes: Values in parentheses correspond to t-statistics. * denotes statistical significance at 10%, ** at 5% and *** at 1%

Sources: Banco de Portugal (Informação Individual de Taxas de Juro, Central de Responsabilidades de Crédito, Central de Balanços, Base de Dados de Balanços de Bancos)

Table 6: Robustness Checks ($IR \leq 20\%$)

	Delta IR	Delta IR
Duration	0.003 (0.38)	
Duration*PSPP	-0.005 (-1.61)	
Bank Share		-0.415 (-1.00)
Bank Share*PSPP		0.084 (1.51)
PSPP	-0.212*** (-7.43)	-0.274*** (-10.46)
Firm Fixed Effects	Yes	Yes
Bank Fixed Effects	Yes	Yes
N	9,332	9,332
Adjusted R^2	0.066	0.066

Notes: Values in parentheses correspond to t-statistics. * denotes statistical significance at 10%, ** at 5% and *** at 1%

Sources: Banco de Portugal (Informação Individual de Taxas de Juro, Central de Responsabilidades de Crédito, Central de Balanços, Base de Dados de Balanços de Bancos)

Table 7: Inclusion of Control Variables (I)

	Delta IR	Delta IR	Delta IR	Delta IR	Delta IR
Duration	-0.003 (-1.30)	-0.004** (-2.05)	-0.005** (-2.15)	-0.005** (-2.19)	-0.006*** (-2.84)
Duration*PS PP	-0.005 (-1.64)	-0.005 (-1.63)	-0.005 (-1.64)	-0.005 (-1.63)	-0.005 (-1.63)
PSPP	-0.236*** (-8.31)	-0.236*** (-8.27)	-0.236*** (-8.30)	-0.236*** (-8.27)	-0.236*** (-8.28)
Log(Firm Assets)	-0.090*** (-10.26)				
Firm Liquidity Ratio		-0.078*** (-2.65)			
Firm Return on Assets			-0.695*** (-8.20)		
Firm Equity- Debt Ratio				0.006 (0.69)	
Firm Asset Turnover Ratio					-0.075*** (-6.77)
Firm Fixed Effects	No	No	No	No	No
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes
N	9,182	9,182	9,182	9,182	9,182
Adjusted R^2	0.059	0.049	0.055	0.048	0.053

Notes: Values in parentheses correspond to t-statistics. * denotes statistical significance at 10%, ** at 5% and *** at 1%

Sources: Banco de Portugal (Informação Individual de Taxas de Juro, Central de Responsabilidades de Crédito, Central de Balanços, Base de Dados de Balanços de Bancos)

Table 8: Inclusion of Control Variables (II)

	Delta IR	Delta IR	Delta IR	Delta IR	Delta IR
Bank Share	-0.062 (-1.47)	0.112*** (2.96)	0.088** (2.31)	0.113*** (2.99)	0.125*** (3.30)
Bank Share*PSPP	0.077 (1.34)	0.077 (1.34)	0.077 (1.34)	0.077 (1.34)	0.077 (1.34)
PSPP	-0.295*** (-11.27)	-0.295*** (-11.22)	-0.295*** (-11.25)	-0.295*** (-11.21)	-0.295*** (-11.23)
Log(Firm Assets)	-0.096*** (-9.30)				
Firm Liquidity Ratio		-0.081*** (-2.78)			
Firm Return on Assets			-0.657*** (-7.72)		
Firm Equity-Debt Ratio				0.000 (0.03)	
Firm Asset Turnover Ratio					-0.073*** (-6.56)
Firm Fixed Effects	No	No	No	No	No
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes
N	9,182	9,182	9,182	9,182	9,182
Adjusted R^2	0.058	0.050	0.055	0.049	0.054

Notes: Values in parentheses correspond to t-statistics. * denotes statistical significance at 10%, ** at 5% and *** at 1%

Sources: Banco de Portugal (Informação Individual de Taxas de Juro, Central de Responsabilidades de Crédito, Central de Balanços, Base de Dados de Balanços de Bancos)

Table 9: Inclusion of Control Variables (III)

	Delta IR	Delta IR	Delta IR	Delta IR	Delta IR
Number of Banks	-0.007** (-2.14)	-0.021*** (-7.08)	-0.020*** (-6.49)	-0.021*** (-6.93)	-0.022*** (-7.24)
Number of Banks*PSPP	0.003 (0.63)	0.003 (0.63)	0.003 (0.63)	0.003 (0.63)	0.003 (0.63)
PSPP	-0.288*** (-8.57)	-0.288*** (-8.54)	-0.288*** (-8.56)	-0.288*** (-8.53)	-0.288*** (-8.55)
Log(Firm Assets)	-0.080*** (-7.49)				
Firm Liquidity Ratio		-0.097*** (-3.30)			
Firm Return on Assets			-0.654*** (-7.73)		
Firm Equity-Debt Ratio				-0.004 (-0.46)	
Firm Asset Turnover Ratio					-0.074*** (-6.71)
Firm Fixed Effects	No	No	No	No	No
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes
N	9,182	9,182	9,182	9,182	9,182
Adjusted R^2	0.058	0.054	0.058	0.052	0.057

Notes: Values in parentheses correspond to t-statistics. * denotes statistical significance at 10%, ** at 5% and *** at 1%

Sources: Banco de Portugal (Informação Individual de Taxas de Juro, Central de Responsabilidades de Crédito, Central de Balanços, Base de Dados de Balanços de Bancos)

Table 10: Inclusion of Control Variables (IV)

	Delta IR	Delta IR	Delta IR	Delta IR	Delta IR	Delta IR
Duration	0.001 (0.14)	0.008 (1.25)	0.011* (1.72)	0.006 (0.76)	0.002 (0.24)	0.001 (0.14)
Duration*P SPP	-0.005 (-1.58)	-0.005 (-1.58)	-0.005 (-1.58)	-0.005 (-1.58)	-0.005 (-1.58)	-0.005 (-1.58)
PSPP	-0.236*** (-8.21)	-0.236*** (-8.21)	-0.236*** (-8.21)	-0.236*** (-8.21)	-0.236*** (-8.21)	-0.236*** (-8.21)
Log(Bank Assets)	0.158*** (2.68)					
Bank Liquidity Ratio		-0.517** (-2.44)				
Bank NPL Ratio			1.123** (2.09)			
Bank Market Share				2.272* (1.74)		
Bank Capital Ratio					16.570*** (2.81)	
Bank Deposit Ratio						-1.852*** (-2.71)
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	No	No	No	No	No	No
N	9,182	9,182	9,182	9,182	9,182	9,182
Adjusted R^2	0.057	0.057	0.057	0.056	0.057	0.057

Notes: Values in parentheses correspond to t-statistics. * denotes statistical significance at 10%, ** at 5% and *** at 1%

Sources: Banco de Portugal (Informação Individual de Taxas de Juro, Central de Responsabilidades de Crédito, Central de Balanços, Base de Dados de Balanços de Bancos)

Table 11: Inclusion of Control Variables (V)

	Delta IR	Delta IR	Delta IR	Delta IR	Delta IR	Delta IR
Bank Share	-0.475 (-1.19)	0.043 (0.12)	0.191 (0.55)	-0.416 (-1.00)	-0.365 (-0.95)	-0.461 (-1.16)
Bank Share*PSPP	0.077 (1.36)	0.077 (1.36)	0.077 (1.36)	0.077 (1.36)	0.077 (1.36)	0.077 (1.36)
PSPP	-0.295*** (-11.15)	-0.295*** (-11.15)	-0.295*** (-11.15)	-0.295*** (-11.14)	-0.295*** (-11.15)	-0.295*** (-11.15)
Log(Bank Assets)	0.181*** (3.19)					
Bank Liquidity Ratio		-0.579*** (-2.81)				
Bank NPL Ratio			1.284** (2.43)			
Bank Market Share				3.236** (2.46)		
Bank Capital Ratio					18.317*** (3.25)	
Bank Deposit Ratio						-2.109*** (-3.20)
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	No	No	No	No	No	No
N	9,182	9,182	9,182	9,182	9,182	9,182
Adjusted R^2	0.057	0.057	0.056	0.056	0.057	0.057

Notes: Values in parentheses correspond to t-statistics. * denotes statistical significance at 10%, ** at 5% and *** at 1%

Sources: Banco de Portugal (Informação Individual de Taxas de Juro, Central de Responsabilidades de Crédito, Central de Balanços, Base de Dados de Balanços de Bancos)

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