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Bank lending technologies and credit availability in Europe: What can we learn from the crisis?

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Abstract

Using a unique sample of European manufacturing firms, we empirically investigate how bank lending technologies and soft information adoption affected firms' credit availability during the 2007-2009 financial crisis. Estimation results indicate that transactional lending technologies increased firms' credit rationing, whereas soft information mitigated asymmetric information problems and improved firms' access to credit. By looking at the combined effect of bank lending technologies and soft information, we also provide evidence about the complementarity between transactional lending techniques and soft information adoption. When soft information was incorporated in transactional lending technologies firms' credit rationing significantly reduced. This result is especially strong for small borrowing firms and for companies matching with large financial institutions.

Keywords: Lending technologies, Soft information, Credit rationing, Financial crisis
JEL codes: G21, D82, G30, O16

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Abstract

Using a unique sample of European manufacturing firms, we empirically investigate how bank lending technologies and soft information adoption affected firms' credit availability during the 2007-2009 financial crisis. Estimation results indicate that transactional lending technologies increased firms' credit rationing, whereas soft information mitigated asymmetric information problems and improved firms' access to credit. By looking at the combined effect of bank lending technologies and soft information, we also provide evidence about the complementarity between transactional lending techniques and soft information adoption. When soft information was incorporated in transactional lending technologies firms' credit rationing significantly reduced. This result is especially strong for small borrowing firms and for companies matching with large financial institutions.

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1 Introduction

Firms' access to credit is a topic of significant research interest among academics and a crucial issue for policy makers (Berger and Udell, 2006). During the last years, the global financial crisis has significantly affected firms' credit availability and consistently depressed economic growth. This phenomenon was particularly relevant in Continental Europe, where immature capital markets and negligible corporate bond finance have made banks the main providers of external funds for European firms (Campello et al., 2010). The uniqueness of the recent financial collapse has led many economists to analyze different features of the crisis: the international transmission of the financial shock (De Haas and Van Horen, 2012; De Haas et al., 2015), the effects on the real economy (Amiti and Weinstein, 2011; Aiyar, 2012; Cingano et al., 2016), the behavior of financing constrained firms (Campello et al., 2010; Campello et al., 2011), and bank lending decisions (Sette and Gobbi, 2015; Bolton et al., 2016; Beck et al., 2018; Li et al., 2018).

The aim of this paper is to contribute to this last strand of literature by investigating whether the probability of firms experiencing credit restrictions during the crisis was affected by bank lending technologies and the adoption of soft information. Several studies indicate that information asymmetries magnify during deep recessions, such as that of 2007-2009 (De Haas and Van Horen, 2013). However, the extent to which banks are able to overcome this problem may depend on their lending technologies. The current literature has thus far focused on two main classes of lending techniques: transactions-based lending and relationship lending. According to the prevailing paradigm, transactional lending is based on the use of hard quantitative data, such as information derived from the borrowers' balance sheet or the collateral they offer; conversely, relationship lending assigns a key role to the production of soft qualitative information obtained via personal interactions with the borrowing firms (Stein, 2002). This differentiation makes large banks more apt to lend through transactional lending technologies, and local financial institutions to rely more on relationship lending techniques (Berger and Black, 2011). Moreover, while transactions-based lending is argued to be more appropriate to screen and monitor transparent firms, relationship lending and soft information production are particularly useful in dealing with opaque borrowers suffering from more intense information asymmetries (Berger and Udell, 2006).

In order to provide additional evidence about this topic, in this paper we first estimate the impact of transactional and relationship lending technologies on the probability of firms experiencing credit restrictions during the crisis. Then, to shed light on the role played by soft information adoption, we study the combined effect of bank lending technologies and soft information on firms' credit availability. Finally, as the current paradigm emphasizes the advantages of large banks and firms in transactional lending and the edge of local financial

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institutions and small businesses in relationship lending, we analyze whether bank type and firm size shape the lending technologies-credit rationing link, by also splitting our aggregate indicators of lending techniques in all their individual components.

To perform our empirical investigation, we draw information on firms' access to credit, bank lending technologies and soft information from the EU-EFIGE Bruegel-UniCredit survey, which covers 14,759 manufacturing firms from seven European countries: Austria, France, Germany, Hungary, Italy, Spain and UK. To all the surveyed companies we also attach balance sheet data provided by Bvd-Amadeus, the most comprehensive and widely used source of financial information for public and private enterprises in Europe.

By way of preview, estimation results indicate that during the crisis firms matching with banks employing transactional lending technologies had a larger probability of experiencing credit restrictions, while relationship lending techniques did not significantly affect firms' credit availability. Consistently with previous studies (see, e.g., Bartoli et al., 2013), we also find that soft information adoption mitigated asymmetric information problems and improved firms' access to credit. Regarding the complementarity between soft information and bank lending technologies, estimation results indicate that the probability of firms experiencing credit rationing was somewhat reduced when soft information was used in combination with transactions-based lending techniques. While firms coupling with transactional banks not relying on soft information were more likely to be credit restricted during the crisis, the probability of rationing marginally reduced when firms matched with a transactional bank employing soft qualitative data.

By investigating whether these findings change with firm size and bank type, we provide some other interesting insights. First, estimation results indicate that the adoption of transactional lending technologies was positively associated with the probability of firms experiencing credit restrictions, both for firms matching with local banks and for firms coupling with national financial intermediaries. Conversely, relationship lending technologies did not significantly affect the probability of firms experiencing credit restrictions during the crisis, neither for the subsample of companies matching with local banks, nor for the firms coupling with large, national financial institutions. From a theoretical point of view it is interesting to find no differences in the effect of transactional and relationship lending technologies across bank types. Whereas the current literature has strongly emphasized the advantages of large banks in transactional lending, and the edge of local financial institutions in relationship lending, our results suggest that it is not the nature of banks, but the technology used that matters for credit availability. Second, regarding the combined effect of bank lending technologies and soft information, we show that the adoption of soft information improved firms' access to credit when the firm dealt with large banks employing transactional lending technologies. As larger banks are the most concerned with the problems associated to the production and

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transmission of soft information and the most able to manage complex rating models, during a financial crisis they have the greatest incentive to efficiently combine transactional lending techniques and soft qualitative data in order to assess borrowers' creditworthiness. On the contrary, small local banks, usually relying on relational lending technologies, are not able to efficiently exploit the benefits associated with the complementary use of transactional lending techniques and soft information. Moving on to the role of firm size, estimation results indicate that transactional lending technologies did not affect the probability of large firms to experience credit restrictions in 2009, whereas significantly impacted on the credit rationing status of small businesses. Contrary to the current paradigm (Berger and Udell, 2006; Berger and Black, 2011), we also find that relationship lending technologies did not mitigate the financing problems of small and medium firms. Finally, when we try to unbundle the multidimensional nature of lending technologies, we find that banks' emphasis on collateral and historical records are negative for firms' credit availability. Conversely, when the main bank has access to interviews with the firm's management, the borrowing firm is less likely to be credit restricted.

In providing these findings, this study contributes to different fields of the banking literature. First, by analyzing whether transactional and relationship lending technologies affected the probability of firms experiencing credit restrictions in 2009, we contribute to the literature on lending technologies during the crisis (Sette and Gobbi, 2015; Bolton et al., 2016; Beck et al., 2018). In particular, to the best of our knowledge, this is the first study showing a negative effect of transactions-based lending techniques on firms' access to credit for both firms dealing with local banks and national financial institutions. Second, we contribute to the literature on soft information. By analyzing the impact of soft information adoption on European firms' credit availability during the crisis, we corroborate the results of D'Aurizio et al. (2015) for the Italian context and the ones of Bartoli et al. (2013) related to the pre-crisis period. Third, by studying the combined effect of soft information and bank lending technologies on credit rationing, we add to the current literature on the complementarity between lending techniques and soft information adoption (Berger and Black, 2011; Uchida, 2011).

The remainder of the paper is organized as follows. Section 2 reviews the current literature on bank lending technologies, soft information production, and their impact on credit dynamics. In Section 3, we describe the dataset, the variables employed in the regression analysis and the econometric model used to perform our investigation. In Section 4 we discuss the empirical results. Section 5 provides some concluding remarks.

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2 Related Literature

2.1 Lending technologies and information production

Although banks lend through a variety of lending technologies, the current literature has thus far focused on two main classes of lending techniques: transactions-based lending and relationship lending (see, e.g., Berger and Udell, 2002; 2006). Although transactions lending has been used for any type of loan based on easily verifiable information, Berger and Udell (2002; 2006) argue that transactions-based lending cannot be considered a single homogeneous technique but a set of distinct transactions technologies used by financial institutions. The literature has identified four main types of transactions-based lending technologies: financial statement lending, asset-based lending, fixed-asset lending, and credit scoring.[1] Financial statement lending is a transactions technology based on the strength of a borrower's financial records. The decision to lend and the loan contract terms are based on the borrower's financial conditions, as reflected in the financial and economic ratios calculated from the balance sheets and income statements. In order to provide reliable hard information, the borrower must have informative financial statements prepared by a reputable accounting firm according to widely accepted accounting standards. Asset-based lending is a transactions lending technology in which lenders address the opacity problem by focusing on a subset of the firm's assets, such as accounts receivable and inventory, which are pledged as collateral and represent the main source of repayment. The pledging of these assets is often associated with other transactions lending technologies, such as financial statement lending and credit scoring, where collateral is used as secondary source of repayment. Under asset-based lending, however, the extension of credit is primarily based on the value of the collateral, rather than the overall creditworthiness of the firm. In fact, the amount of credit granted is linked to a dynamic model estimating the liquidation value of the assets used as collateral. Fixed-asset lending technologies involve lending against long-lasting assets, such as real estates, that are not sold in the normal course of business. Like asset-based lending, the underlying assets are pledged to the lender as collateral. However, unlike accounts receivable and inventory, in fixed-asset lending the pledged assets are virtually always uniquely identified by a deed. The contract structure typically specifies an initial loan-to-value ratio less than one and usually involves setting a loan amortization schedule with a final maturity less than the lifespan of the asset. Credit scoring is a transactions technology based primarily on hard information about the firm and its owner collected by the financial institution from commercial and consumer credit bureaus. The data are entered into a loan performance prediction model, which yields a score or a summary statistic for the loan.

Relationship lending is at the opposite of transactions-based lending. Under this lending

[1] Berger and Udell (2006) include among transactions lending technologies also factoring and leasing.

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technology, the assessment of borrowers' creditworthiness is based on soft information about the firms and their managers gathered through a variety of contacts over time. This information is obtained through the provision of loans, deposits, other financial products, and through the analysis of the future prospects of the business. Additional information may also be gathered through contacts with other members of the local community, such as suppliers and customers, who may give specific information about the firm or general information about the business environment in which it operates. Of course, the information gathered over time has a significant value beyond the firm's financial statements, collateral, and credit score, helping the relationship lender to mitigate firm opacity better than transactions lenders (Berger and Udell, 2002; 2006).[2]

The distinction between relationship and transactions-based lending technologies has also been analyzed in connection with banks' organizational structure. According to the prevailing view, large banks hold a comparative advantage in transactions lending and hard information processing, while small-sized and local banks have an edge in relationship lending and soft-information production (Stein, 2002; Berger and Udell, 2006). This result is due to the existence of organizational diseconomies that restrict the scope of large banks in their lending activities (Williamson, 1998; Berger and Udell, 2002). First, as soft information is difficult to transmit through the communication channels of complex organizations, the provision of relationship lending technologies by large banks requires internal organizational adjustments, whose cost increases with bank size. Second, the key role that a loan officer plays as a repository of soft information within a bank gives rise to agency problem. This creates an efficiency trade-off. On the one hand, banks have to delegate more authority to their loan officers, since they are in a unique position to personally contact the firm and the local community. On the other hand, delegation may aggravate agency problems if the incentives of the loan officers are not aligned with those of the bank (Cerqueiro et al., 2009). The magnitude of this contracting problem depends on the complexity and size of the bank. In small banking institutions, the problem is resolved with the president of the bank making or reviewing most of the business loans. Larger and more complex bank may require more intervening layers of management that increase organizational and monitoring costs. Large banks may also choose to avoid relationship lending because these banks are more often headquartered at substantial distance from potential relationship customers, aggravating the problems associated with transmitting soft information to senior bank managers.

Consistently with these theories, Scott (2004) shows that soft information production is

[2]These characteristics have led the literature to consider transactional and relationship lending as substitute technologies. However, some recent papers have not neglected the hypothesis of complementarity between the two lending techniques. As all lending technologies require screening and monitoring processes that are similar in nature and intensity, it can be reasonably argued that they may be used simultaneously instead of being strictly distinct from each other (Berger and Udell, 2006).

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significantly higher for firms borrowing from small community financial institutions and when loan officers do not rotate over time. Similarly, Berger et al. (2005) indicate that small banks are better able to collect and act on soft information than large financial intermediaries. After controlling for the endogeneity of bank-firm matching, the authors find that U.S. large banks lend at a greater distance, interact more impersonally with their borrowers, and have shorter and less exclusive relationships. Comparable results are provided by Uchida et al. (2008) for the Japanese context. Larger firms are found to borrow from larger banks, and smaller banks are shown to have stronger relationships with their borrowers.

2.2 Measures and benefits of lending technologies

Traditionally, empirical studies on lending technologies have adopted indirect measures of relationship lending: the length of the bank-borrower relationship (Petersen and Rajan, 1994; 1995; Berger and Udell, 1995; Angelini et al., 1998; Ongena and Smith, 2000), the exclusivity of the relationship in terms of the bank being the sole provider of loans to the firm (Harhoff and Korting, 1998; Ongena and Smith, 2000), the share of credit granted by the firm's main bank (Sette and Gobbi, 2015), and the geographical distance between the firm's headquarter and the bank branch (Bofondi and Gobbi, 2006; Hauswald and Marquez, 2006; Alessandrini et al., 2009; Sette and Gobbi, 2015). All these measures proxy for the ability of lenders to accumulate soft information about borrowers. Longer lending relationships allow banks to accumulate information over time. Banks holding a larger share of credit have better access to proprietary information about the borrower. Finally, firms located closer to a bank branch may be easier and cheaper to monitor (Sette and Gobbi, 2015). Instead of using measures of relationship strength to separate relationship lending from transactions technologies, the literature has recently started to identify one or more specific lending techniques. Frame et al. (2001) and DeYoung et al. (2008) rely on survey data about US banks in order to identify small business credit scoring. Berger and Black (2011) employ the Survey of Small Business Finance (SSBF) to identify different classes of fixed-asset lending techniques (leasing contracts, real estate lending, motor vehicle loans, and equipment lending) and analyze the comparative advantages of large and small banks in lending through them. Uchida (2011) relies on a survey on Japanese SMEs to distinguish financial statement lending, fixed-asset lending and relationship lending. Bartoli et al. (2013), by drawing information from the Survey on Italian Manufacturing Firms (SIMF), define transactions-based lending technologies as composed by financial-statement lending, real estate lending, and other fixed-assets lending techniques.

Several studies have analyzed the effect of relationship lending measures on credit availability and cost. Degryse and Ongena (2005) and Agarwal and Hauswald (2010) in models of spatial pricing find that borrowers' transportation costs induce a negative relationship be-

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tween distance and the level of interest rates. Petersen and Rajan (1994) and Angelini et al. (1998) show that longer lending relationships improve firms' access to credit, while other studies provide mixed findings about the effect on the cost of credit. Berger and Udell (1995) and Brick and Palia (2007) find that borrowers with longer relationships pay lower interest rates or face lower collateral requirements. Conversely, Degryse and Van Cayseele (2000) and Degryse and Ongena (2005) show that interest rates increase with the length of the lending relationship. Additional findings have been provided in relation to multiple banking relationships: banks holding the largest share of credit granted to the firm provide more credit (Elsas and Krahnen, 1998), while the number of banking relationships the firm maintains is positively linked to the probability of experiencing credit restrictions (Cenni et al., 2015).[3] A number of studies have also analyzed the specific effect of soft information production. For Italy, Bartoli et al. (2013) provide evidence that the use of soft information decreases the probability of firms experiencing credit restrictions. Similarly, D'Aurizio et al. (2015) indicate that during the last financial crisis those banks increasing the adoption of soft information in the screening process cut credit supply less than other financial institutions. For Europe, Cosci et al. (2016) and Cucculelli et al. (2019) find that firms providing soft information in their lending relationships are less likely to be credit rationed and more likely to innovate. Finally, Jiangli et al. (2008) and De Mitri et al. (2010) show that soft information production mitigates the repercussions of aggregate credit contractions. While hard information is less reliable in predicting firm risk profile during a crisis, soft information, which is continuously updated and better targeted to the characteristics of the borrower, can reduce such uncertainty.

2.3 Relationship and transactions-based lending during the crisis

While a large literature has shown the effects of lending technologies during "normal" times, there is less evidence about the effects of relationship and transactions lending during a crisis.

From a theoretical point of view, there are three main reasons why relationship lenders may support borrowers more than transactional lenders during a financial crisis. First, relationship lenders may decide to keep financing their borrowers in order to maintain the informational capital acquired through the years. Second, relationship lenders may want to provide liquidity insurance to borrowers to honor the long-term implicit contract on which the relationship is based. Third, relationship lenders may be forced to keep lending to borrowers because of the higher potential losses associated with holding a large share of the overall credit granted to these borrowers (Sette and Gobbi, 2015). However, when liquidity and capital constraints

[3] Kysucky and Norden (2016) conduct a meta-analysis to summarize and explain the heterogeneity in the results in the literature using information from 101 studies in the United States, Europe, Asia and Latin America from 1970 to 2010.

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make banks unable to provide any extra support to borrowers, relationship lenders may behave the same as transactional lenders.

Empirically, only few papers have tested these predictions with a main focus on relationship lending technologies. Sette and Gobbi (2015), for a sample of Italian firms, find that relationship lenders offer more support than transactional lenders during a crisis. Banks located closer to their borrowers, involved in longer relationships, and holding a larger share of credit, granted more loans than other banks. Bolton et al. (2016) confirm the beneficial role of relationship lenders during the last financial crisis: firms operating with relationship banks were less likely to default on their loans and were better able to withstand the crisis thanks to the more favorable continuation lending terms in comparison with firms dealing with transactional lenders. Similar findings are shown by Beck et al. (2018), who conduct face-to-face interviews with bank chief executive officers to classify banks as relationship or transaction lenders. By analyzing how the lending techniques of banks near firms are related to credit constraints, the authors find that while relationship lending is not associated with credit constraints during a credit boom, it alleviates such constraints during a downturn. This positive role of relationship lending results to be stronger for small and opaque firms and in regions with a more severe economic downturn. Opposite results are reported by Carvalho et al. (2015). By studying the transmission of bank distress to non-financial firms from 34 countries during the 2007-2009 financial crisis, the authors find that borrower firms with the strongest lending relationships cut more their investments than other firms. Similar findings are provided by Li et al. (2018), which show that borrowers in distress do not derive benefits from relationship banks.

This paper contributes to the current literature in several ways. First, we contribute to the literature on lending technologies during the crisis by analyzing whether transactions and relationship lending technologies affected European firms' credit availability in 2009. However, while previous studies mainly focus on relationship lending technologies, in this paper we provide new insights about the effect of transactions-based lending techniques. Second, we contribute to the literature on soft information by studying the impact of soft information adoption on the probability of firms experiencing credit restrictions during the crisis. Third, through the analysis of the combined effect of soft information and bank lending technologies on credit rationing, we add to the current literature on the complementarity of lending techniques. To the best of our knowledge, we are the first providing evidence about a beneficial effect of the complementary use of transactional lending and soft information on firms' credit availability. Finally, by investigating the role played by banks' organizational structure and firm size on the relationship between lending technologies adoption and credit rationing, we contribute to the literature on the comparative advantage of small (large) banks in relationship (transactional) lending.

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3 Data and method

3.1 Datasets

In order to perform our empirical investigation, we draw information from two main sources: the EU-EFIGE Bruegel-UniCredit survey on "European Firms in a Global Economy" and the BvD-Amadeus database.

The EFIGE survey, coordinated by the Bruegel Institute and supported by the Directorate General Research of the European Commission, collects information for a representative sample of 14,759 firms (with a lower threshold of 10 employees) across seven European countries: Austria, France, Germany, Hungary, Italy, Spain and UK. The survey has been run in early 2010 and information is mostly collected as a cross-section for the year 2008. Moreover, some questions cover the period 2007-2009 and/or the behavior of firms during the crisis (Altomonte and Aquilante, 2012). In order to ensure statistical representativeness, the dataset has been built to fulfill two main criteria. First, the availability of an adequately large target sample of firms: 3,000 firms for each large country (France, Germany, Italy, Spain and UK) and some 500 firms for each small country (Austria and Hungary). Second, the sample was stratified to ensure representativeness of the collected data for each country, especially focusing on its composition by sectors, regions and size classes. The questionnaire submitted to the surveyed firms covers different broad areas: firm ownership structure and governance systems; workforce characteristics; exports, imports, and internationalization activities; investments, technological innovation and R&D expenditures; financial conditions and bank-firm relationships; market structure and competition.[4] To all the surveyed firms, we attach balance-sheet information for the years 2007-2009 provided by BvD-Amadeus, the most comprehensive and widely used source of financial information for public and private firms in Europe.

Table 1 reports the summary statistics for all the variables employed in the econometric specifications.[5] At the average, the surveyed firms have been in business for 26 years; beyond 60 percent of them have fewer than 50 employees (below 5 percent of the firms have more than 500 workers); 10 percent of them are foreign owned, and 22 percent belong to a group. The majority of firms are located in Germany, Italy and Spain (80 percent of the total), while 14 percent of firms operate in UK, 3.3 percent in Hungary and 3 percent in Austria. Alternatively, 82.7 percent of firms belong to the Eurozone.

[4] The data collection has been performed through a survey carried out by a professional Contractor (GFK, the fourth largest market research company in the world).

[5] All of the variables are defined in Table A1.

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3.2 Variable definitions

3.2.1 Lending technologies

Although the traditional literature on lending technologies has employed indirect measures of relationship and transactions lending (see Section 2.2), recently some empirical studies have started to identify specific lending techniques by relying on survey data. Uchida (2011) relies on a survey of Japanese SMEs (Management Survey of Corporate Finance Issues in the Kansai Area) that asked sample firms to grade the extent to which their main bank focuses on specific borrower characteristics when underwriting their loans. Starting from a set of listed criteria (financial ratios calculated from financial statements, the reliance of banks on collateral or guarantees, and borrower information that is not publicly available), the authors distinguish financial statement, fixed-asset and relationship lending technologies. Bartoli et al. (2013) identify the same lending techniques by referring to the following question of the Survey on Italian Manufacturing Firms: "In your view, which criteria does your bank follow in granting loans to you?". In answering this question, the firm was required to give a weight to fifteen factors indirectly associated to one of the lending technologies described in Berger and Udell (2006).

Following the literature, in this paper we distinguish transactions and relationship lending technologies by relying on question F16 of the EFIGE survey. In this question, firms are required to indicate the type of information they normally provide to their main bank in the screening and monitoring processes. In particular, the questionnaire reads out as follows:

> F16. *Which type of information does the bank normally use/ask to assess your firm's creditworthiness? (a) collateral (0/1); (b) balance sheet information (0/1); (c) interviews with management on firm's policy and prospects (0/1); (d) business plan and firms' targets (0/1); (e) historical records of payments and debt service (0/1); (f) brand recognition (0/1); (g) other (0/1).* (Multiple answers are allowed).[6]

By looking at firms' answers, we build two indicators of lending technologies: (i) Transactions - based lending (Transactional Lending), computed as the average of collateral, balance-sheet information and historical records dummies (alternatives a, b, and e); and (ii) Relationship - based lending (Relationship Lending), computed as the average of interviews with management, business plan, and brand recognition dummies (alternatives c, d, and f). A

[6]The survey does not refer to a specific year when posing this question. However, lending technologies are highly persistent over time, as they depend on structural aspects such as the bank-firm distance (Minetti et al., 2018). Nonetheless, since one cannot entirely rule out that the financial crisis have induced some modification in the perception of the lending technologies, some caution should be used when interpreting the empirical results.

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drawback of these variables is that they are based on the perceptions of borrowers about what their bankers evaluate in the lending decisions. To have better proxies of lending technologies we would use evaluations of banks with respect to each borrower. However, although firms' perceptions of bank screening standards may be imperfect, they should reflect well the lending standards, processes, and procedures effectively used by their main bank.

To test the robustness of our results, we then exclude collateral from the definition of transactions-based lending (Transactional Lending 2) and study the stand-alone impact of this variable (Collateral) on the credit rationing phenomenon. In addition, we remove brand recognition from the definition of relationship lending (Relationship Lending 2).[7]

As shown in Table 1, transactional lending is the most employed lending technology: while the average value of the relationship lending indicator is 0.40, the average of the transactional lending index is 0.60. Regarding the specific factors included in the definition of lending technologies, 55.2 percent of firms state to pledge collateral, 84.4 percent use to provide balance-sheet information, 56 percent are subject to managers' interviews, 47.6 percent are requested for business plans, 40.3 percent are screened through historical records of payments and debt services, and 15.4 percent are evaluated through brand recognition (see Table A2).[8]

3.2.2 Soft information

As described in Section 2.1, soft information is subjective knowledge acquired by lenders in the course of frequent face-to-face interactions with borrowers (Petersen, 2004); it is qualitative, often communicated in words, and not easy to store and transmit. The empirical literature has traditionally employed survey questions to measure soft information. Scott (2004) relies on survey data provided by the membership of the National Federation of Independent Business to create a proxy for soft information production. The survey included a set of characteristics that were central to the owners' relationship with their primary financial institution. Among them, four characteristics were employed to define soft information: "(the bank) Knows you and your business"; "(the bank) Knows your industry"; "(the bank) Knows the local market and/or community"; "(the firm has) Social contact with loan officer". A similar classification has been employed by Uchida et al. (2012), who exploit a question of the RIETI survey

[7] As a further robustness check, we create two dummy variables for transactional and relationship lending equal to one if at least one of the alternatives included in the definition of the related lending technology was used, and zero otherwise. The estimation results obtained by employing these variables are consistent with our baseline findings and are available upon request.

[8] These values indicate that financial-statement lending, i.e. the transactional lending technology based on balance-sheet analysis, is the most widespread lending technique. However, the presence of a ranking in the use of lending technologies does not rule out the possibility for banks to use together transactional and relationship lending. As all lending techniques require screening and monitoring processes that are similar in nature and intensity, it can be reasonably argued that they may be used simultaneously instead of being strictly distinct from each other. The existence of complementarity between transactions and relationship-based lending is somewhat confirmed by the positive correlation coefficient reported in Table 2 (0.320).

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(Management Survey of Corporate Finance Issues in the Kansai Area) that asks the respondent firms to rate their main bank on different characteristics of the bank's knowledge of the firm. The authors focused on five specific items: "How well the bank knows the firm and its business"; "How well the bank knows the firm's managers and owners"; "How well the bank knows the firm's industry"; "How well the bank knows the local community where the firm is located"; "How well the bank knows the firm's market". Bartoli et al. (2013) build a similar indicator of soft information production by employing the Survey on Italian Manufacturing Firms (SIMF). The authors chose two characteristics describing the bank-firm relationship: "The bank knows you and your business"; "Frequent contacts with the credit officer at the bank".[9]

In this paper, we employ different proxies of soft information. First, we identify soft information by employing the following question of the EFIGE survey:

> F12. *Which factors are key in the choice of a main bank? (a) the bank offers competitive services and funding (0/1); (b) the bank offers efficient internet services (0/1); (c) the bank's lending criteria is clear and transparent (0/1); (d) the bank is conveniently located (0/1); (e) the bank has an extensive international network (0/1); (f) the bank offers also a consultancy on strategic financial decisions (0/1); (g) the bank has a long-lasting relationship with the firm (0/1); (h) the bank has flexible procedures/not constrained by red tape (0/1); (i) it was the Group's main bank (0/1).*

By looking at firms' answers, we measure soft information as the average of the following items: "The bank offers a consultancy on strategic financial decision" (alternative f); "The bank has a long-lasting relationship with the firm" (alternative g). Although partially different from the alternatives employed in previous studies, these items should reflect a deep knowledge of the bank about the firm and its business. Summary statistics indicate that 43 percent of the surveyed firms claim to have a long-lasting relationship with their lenders, while 15 percent state to take advantage from the consultancy services offered by their banks. As a result, the average value of our soft information indicator is 0.29 (Table 1).

Following Petersen and Rajan (1994), we then consider an additional set of variables measuring soft information production. As the exclusivity and the length of the credit relationships may measure the experience garnered by the main bank about the borrowing firm, we employ the following alternative proxies of soft information: (i) the financing share of the firm's main bank (Financing Share); (ii) the inverse of the number of banking relationships enjoyed by the surveyed firms (Inverse of Num. Banks, computed as one over the number of

[9] The question asked to the respondent firms was: "Which characteristics are key in selecting your main bank?"

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banks with which the firm does business); (iii) the length of the firm's main credit relationship (Duration). It is important to note that, while the Relationship Lending variable measures if lending banks make credit decisions based on soft information, our proxies for soft information measure whether banks actually accumulate them.

Table 1 reports the summary statistics for these variables. The average financing share of the firm' main bank is 58.95 percent, the average number of banking relationships enjoyed by the sample firms is 3.10, and the length of their main lending relationship is 15.85 years.

3.2.3 Credit rationing

Firms are defined as credit constrained if, at the prevailing market interest rate, they would like to obtain a larger amount of loans but cannot (Angelini et al., 1998; Guiso, 1998). This theoretical definition has made it difficult to practically identify rationed firms, and has led some authors to resort to indirect indicators of financing constraints. Petersen and Rajan (1994) rely on the fact that credit constrained firms are willing to pay a higher rate to raise additional funds, and define as credit rationed those firms that borrow from non-institutional lenders at abnormally high rates. Gertler and Gilchrist (1994) argue that larger firms have easier access to credit and use firm size as identification criterion to separate rationed and non-rationed companies. Fazzari et al. (1988) claim that firms that retain more of their earnings are more likely to be liquidity constrained and classify them as credit rationed. While these indirect proxies have been particularly useful in the seminal literature on financing constraints, in recent years the usage of survey data is becoming more established due to concerns about the correctness of identification using other methods (Casey and O'Toole, 2014). Although liquidity constraint indicators might be correlated with the firm's access to credit, they could also pick-up other effects that have little or nothing to do with credit constraints (Guiso, 1998).

In this study, the information provided by the EFIGE survey allows us to directly measure the credit rationing status of the surveyed firms. In particular, to create our main dependent variables, we rely on the following questions of the EFIGE survey:

> *F13. During the last year (2009), was the firm willing to increase its borrowing at the same interest rate of its current credit line? (i) yes; (ii) no.*
>
> *F14. During the last year (2009), did the firm apply for more credit? (i) yes, applied for it and it was successful; (ii) yes, applied for it and was not successful; (iii) no, did not apply for it.*
>
> *F15. To increase its borrowing, would the firm have been prepared to pay a higher rate of interest? (i) yes; (ii) no.*

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Following Minetti and Zhu (2011) and Ferri and Murro (2015), we classify firms as being credit rationed (Rationing=1) if they respond (ii) to question F14, and non-rationed (Rationing=0) if they respond (i) or (iii) to question F14, or (ii) to question F13. We also use a broader definition of credit restrictions, which includes potentially discouraged borrowers from among the rationed ones. More precisely, we build the dummy variable Rationing - Wide that takes the value one if the firm responds (ii) or (iii) to question F14, and zero if it responds (ii) to question F13 or (i) to question F14. Finally, by relying on question F15 of the EFIGE survey, which provides information about borrowers' willingness to pay a higher interest rate, we alternatively classify as rationed (Rationing - Willingness to Pay More) those firms answering (ii) to question F14 and (i) to question (F15). All these measures, although reflecting a different intensity of credit rationing, should capture the existence of credit constraints.

Similar definitions of financially constrained firms have been also adopted by Angelini and Generale (2008) and Murro and Peruzzi (2019), who employed the Survey on Italian Manufacturing Firms (SIMF), by Minetti et al. (2018), who relied on the Unicredit Survey on small and medium-sized enterprises, by Guiso (1998), who used the Bank of Italy Survey on Investment in Industry (SIM), and by Jappelli (1990) and Duca and Rosenthal (1993), who employed the Survey on Consumer Finances in the context of studies of credit constraints among US consumers.

Summary statistics reported in Table 1 indicate that 9 percent of firms were rationed in the bank lending market during the crisis (Rationing), 19 percent were wide rationed (Rationing - Wide), and 5 percent were rationed although they were willing to pay a higher interest rate (Rationing - WtPM). The majority of rationed firms results to be located in Spain and Italy (respectively, 41 and 39 percent), while 8 percent operate in Germany, 7 percent in France, 2 percent in Hungary and UK, and 1 percent in Austria. The univariate tests presented in Table 3 indicate that rationed firms are on average younger, more indebted, less profitable and productive. From a financial point of view, the transactional lending indicator is significantly higher for the subsamples of rationed borrowers, while the production of soft information is larger for non-rationed firms. Moreover, rationed companies borrow from a larger number of banks and enjoy shorter relationships with their main banks.

3.2.4 Control variables

In order to correctly identify the impact of bank lending technologies and soft information production on firms' access to credit and to mitigate the omitted variable concern associated with the cross sectional structure of our dataset, we control for a large set of possible confounding effects. First of all, we consider the following standard firm-specific characteristics and balance-sheet indicators: (i) firm's age, measured by the number of years from the firm's inception (Age); (ii) the number of employees as proxy for firm's size (Size, expressed in loga-

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rithm); (iii) the firm's level of indebtedness, proxied by the debt ratio, computed as total debt over total assets (Debt Ratio); (iv) the firm's liquidity indicator, measured as current assets over current liabilities (Liquidity Ratio); (v) the differential profitability of the firm (Differential ROS), measured by the difference between the firm's return on sales and the median return on sales of its industry (Villalonga, 2004); (vi) the firm's capital intensity (Capital Intensity), computed as the ratio between the firm's fixed assets and number of employees; (vii) the firm's level of labour productivity (Labour Productivity), measured by value added per worker;[10] (viii) a dummy variable indicating whether the firm belongs to a business group (Group); (ix) the foreign ownership of the firm (Foreign).[11] Then, in order to fully account for industry- and country-specific effects, we include country and industry dummies (at the NACE 2-digit level of aggregation).

3.3 Econometric specification

To study the impact of lending technologies and soft information production on firms' access to credit during the crisis, we start building an empirical model that estimates the firm's probability of being rationed in the bank lending market. Denote y_i^d as firm i's desired amount of credit and y_i^a as the actual amount of credit given to firm i, the firm is rationed any time $y_i^* = (y_i^d - y_i^a) > 0$.

Thus, we can model the probability of rationing as:

$$y_i = \begin{cases} 1 & if\ y_i^* > 0 \\ 0 & otherwise \end{cases} \tag{1}$$

$$y_i^* = \alpha X_i + \beta Z_i + u_i \tag{2}$$

where y_i denotes, alternatively, one of the credit rationing variables described in section 3.2.3 (Rationing, Rationing - Wide or Rationing - WtPM); X_i is the set of lending technologies and soft information production measures presented in sections 3.2.1 and 3.2.2; Z_i is a vector of exogenous covariates; u_i is the residual. As the credit rationing variables are dummy variables taking values zero and one, we estimate Equation (2) by maximum likelihood probit regressions. In all the regressions, standard errors are heteroskedasticity robust, clustered at the regional level (NUTS-2).

One might be concerned that the credit crunch during the crisis can trigger changes in

[10] Value added is computed as EBITDA (earnings before interests, taxes, depreciations and amortization) plus labour costs.

[11] As the main dependent variables refer to 2009, all the balance-sheet indicators are computed as average values for the years 2007-2009. Estimation results are robust to the inclusion of balance-sheet information taken in 2007.

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banks' lending technologies, that is, the causality may be reversed. However, we have mild concerns about reverse causality in our setting. In fact, the financial crisis hit in a sudden way at the end of 2008, while bank lending technologies are a slow-moving feature of the firm-bank relationship, as they are strongly driven by structural aspects such as the physical distance between bank and the borrower, the size of the firm, or the bank's organizational structure (Berger and Udell, 2002; Agarwal and Hauswald, 2010). In addition to this, our econometric specification controls for a rich set of factors that could affect credit rationing, including firm-level characteristics, industry and country fixed effects. This should reduce the risk of omitting factors correlated with both lending technologies and credit decisions.

The aim of our empirical investigation is to analyze the impact of lending technologies and soft information production on the probability of firms being credit rationed during the crisis. Hence, we first estimate whether firms coupling with transactional and relationship main banks have different likelihood of experiencing credit restrictions. Then, in order to assess the role played by the production of soft information, we estimate the interaction effects between the lending technologies and the soft information variables.

4 Results

4.1 Baseline estimates: Lending technologies and credit rationing

The estimation results about the impact of transactional and relationship lending on credit rationing are displayed in Table 4. Columns (1)-(3) report the marginal effects for the estimations with our main explanatory variables, i.e. Transactional Lending and Relationship Lending; columns (4)-(6) present the estimation results obtained by employing the alternative measures of lending technologies, i.e. Transactional Lending 2 and Relationship Lending 2; columns (7)-(9) show the stand-alone impact of collateral (Collateral) on the probability of firms experiencing credit restrictions; columns (10)-(12) report the estimation results obtained with the adoption of balance sheet data in 2007.

Starting with our main transactional lending indicator, the marginal effects reported in columns (1)-(3) indicate that firms matching with banks employing transactional lending technologies are significantly more likely to end up rationed during a crisis. More specifically, a one-unit increase in the transactional lending variable increases by 11.6 percentage points the probability of Rationing, by 12.6 percentage points the probability of Rationing-Wide, and by 6.7 percentage points the probability of Rationing - Willingness to Pay More (all statistically significant at 99 percent). This result confirms the adverse effect of transactions-based lending technologies on credit rationing during recession periods: consistently with Sette and Gobbi (2015) and Bolton et al. (2016), banks employing more impersonal and standardized lending

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techniques are more likely to reduce credit availability during a financial crisis. When we turn to the relationship lending indicator, however, estimation results show that the probability of experiencing credit restrictions is not reduced when the firm couples with a bank using relationship lending. The marginal effects of the Relationship Lending variable are always not statistically significant (columns 1-3). This result is in line with Carvalho et al. (2015) and Li et al. (2018), but it is in contrast with Sette and Gobbi (2015) and Bolton et al. (2016). A plausible explanation for this different finding is that we estimate simultaneously the impact of both transactions and relationship lending techniques, instead of using them alternatively as done by some previous studies.[12]

Looking at the other firm-specific characteristics, consistently with the current literature (Petersen and Rajan, 1994; Ferri and Murro, 2015), we find that firms holding a higher share of liquid assets (Liquidity Ratio) and displaying a lower indebted financial structure (Debt Ratio) are significantly less likely to be credit rationed. Similarly, more profitable (Diff. ROS) and productive firms (Labour Productivity) are associated with a reduced probability of experiencing credit restrictions.

In order to test the robustness of these findings, in columns (4)-(6) of Table 4 we employ two alternative measures of transactional and relationship lending technologies: Transactional Lending 2, computed as the average of balance sheet information and historical records dummies (alternatives b and e of question F16), and Relationship Lending 2, computed as the average of interviews and business plan (alternatives c and d of question F16). Estimation results broadly reproduce our main findings. The marginal effects of the transactional lending indicator are positive and statistically significant, although with lower magnitudes. More specifically, a one-unit increase in the transactional lending variable increases by 4.5 percentage points the probability of Rationing, and by 2.6 percentage points the probability of Rationing - Willingness to Pay More (statistically significant at 99 and 95 percent, respectively). Conversely, the relationship lending indicator does not significantly affect the probability of firms experiencing credit restrictions, independently of the definition of credit rationing employed. Overall, these results confirm our main findings: while transactional lending technologies are positively associated with the probability of firms experiencing credit restrictions, relationship lending techniques do not significantly impact on firms' access to credit.

Berger and Udell (2002) suggest that fixed-assets lending technique, i.e. the ones based on the provision of collateral, have very different underwriting processes, contract structures, and monitoring mechanisms with respect to the other transactional lending technologies.

[12] As a robustness check, we estimate the probability of rationing when the bank mainly uses relationship or transactional lending technologies alternatively. The results, available upon request, confirm the findings of previous studies.

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Hence, in columns (7)-(9) of Table 4, we estimate the stand-alone impact of the collateral dummy on the credit rationing status of the surveyed firms. The estimated marginal effects are all positive and statistically significant. Firms providing collateral are 7.4 more likely to experience Rationing, 9.4 percent more likely to experience Rationing-Wide, and 4.4 percent more likely to experience Rationing - Willingness to Pay More (all statistically significant at 99 percent).[13]

Finally, as the balance sheet indicators computed as three-years averages across the 2007-2009 periods may rise endogeneity concerns, in columns (10)-(12) of Table 4, we report the estimation results obtained by employing balance sheet data from 2007 to construct the Debt Ratio, Liquidity Ratio, Diff. ROS, Capital Intensity and Labour Productivity variables. As indicated by the estimated marginal effects, the impact of transactional and relationship lending technologies on firms' credit rationing remains substantially unchanged.

4.2 The adoption of soft information

In the previous section, we have analyzed whether bank lending technologies affect firms' access to credit during a financial crisis; here, we investigate how soft information enters in this picture. In particular, we first estimate whether the adoption of soft information by banks reduces the probability of firms experiencing credit restrictions, as demonstrated by the current literature (see, e.g., Cosci et al., 2016, and Cucculelli et al., 2019). Then, we study the combined effect of bank lending technologies and the adoption of soft information on firms' rationing status. Estimation results are presented in Table 5. Panel A reports the results with our survey-based measure of soft information (Soft Information); Panels B-D present the findings with the alternative proxies of soft information production (Financing Share; Inverse of Num. Banks; Duration).

Starting with the stand-alone impact of soft information on credit rationing, the marginal effects reported in columns (1)-(3) of Table 5 (Panels A-D) indicate that firms producing soft information are significantly less likely to experience credit restrictions. This result is robust to our multiple definitions of credit rationing and soft information adoption.[14] The beneficial effect of soft information adoption on credit rationing remains statistically significant also when the lending technologies indicators are included in the regressions (columns 4-6 of Table Table 5, Panels A-D). In this case, consistently with our previous findings, transactions-based lending technologies result to be positively associated with the credit rationing status, whereas

[13]This result is consistent with the large literature showing that aggregate shocks that erode collateral asset values depress total investment by hindering firms' access to external finance (Kiyotaki and Moore, 1997; Buera and Moll, 2015; Araujo et al., 2019).

[14]For example, a one-unit increase in the Soft Information and Inverse of Num. Banks variables reduce by 2.1 and 6.1 percentage points the probability of Rationing, respectively (statistically significant at 95 and 99 percent).

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relationship lending techniques do not significantly explain firms' access to credit.

Moving on to the combined effect of bank lending technologies and soft information production, in columns (7)-(9) of Table 5 (Panels A-D) we estimate the interaction effects among our main independent variables. Estimation results indicate that firms coupling with banks employing transactional lending technologies alone are more likely to be credit restricted, whereas the probability of rationing is somewhat reduced when transactional lending technologies incorporate soft qualitative data. As reported in Panel A, when the Soft Information indicator is equal to 0, transactions lending technologies increase the probability of experiencing credit restrictions by 19.1 percentage points. However, when the Soft Information variable increases to 0.5 and 1, the impact of transactional lending techniques on credit rationing reduces to 13.9 and 8.6 percentage points, respectively (both statistically significant at 99 percent).[15] These findings remain statistically significant and economically sizeable for all the other credit rationing and soft information proxies. For example, as shown in Panel B, when the financing share of the firm's main bank raises from 30 to 70 percent (the 25th and 75th percentile of the distribution), the impact of transaction lending technologies on the probability of experiencing credit restrictions reduces from 17.1 to 13.1 percentage point (both statistically significant at 99 percent). Looking at the Relationship Lending variable, estimation results indicate that soft information production does not significantly affect the impact of this lending technique on credit rationing. The interaction effects of the Relationship Lending indicator and the soft information variables are never statistically significant in explaining the probability of firms experiencing credit restrictions (Panels A-D).

These findings provide several intuitions. First, consistently with the current literature, soft information is found to mitigate asymmetric information problems and credit rationing during a crisis (Petersen, 1994; Liberti and Petersen, 2018). In fact, hard information is less reliable in predicting firm risk profile under uncertainty, whereas continuously updated soft information is better targeted to borrowers' characteristics during a financial turmoil. Second, although soft information is usually incorporated in relationship lending techniques, we show that it may also be used in combination with transactional lending technologies. This result contributes to the literature on the complementarity between lending technologies and soft information adoption (see, e.g., Berger and Black, 2011; Uchida, 2011; Bartoli et al., 2013). However, in addition to previous studies, we show that the complementary use of transactional lending techniques and soft information improves firms' credit availability.

[15] We tested the statistical significance of the sum of the coefficients through a Wald test.

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4.3 The role of bank type and firm size

According to the prevailing view, large banks hold a comparative advantage in transactions lending and hard information processing, while small-sized and local banks have an edge in relationship lending and soft information production (Berger et al., 2005; Liberti and Mian, 2009; Berger and Black, 2011). Moreover, while transactional lending technologies are more apt to screen large, transparent firms, relationship lending techniques are more desirable for opaque borrowers with asymmetric information problems. In order to provide some insights about these issues, in this section we investigate whether the impact of transactional and relationship lending technologies on firms' access to credit is affected by the nature of the firm's main bank and by the firm's size.[16]

4.3.1 The nature of banks

Starting with the nature of banks, in Table 6 we split the sample of firms by distinguishing firms dealing with local (columns 1-3) and national banks (columns 4-6).[17] The estimation results provide several intuitions. First, the adoption of transactional lending technologies is positively associated with the probability of firms experiencing credit restrictions, both for firms matching with local banks and for firms coupling with national financial intermediaries. This result is statistically significant for all the credit rationing proxies and the soft information measures reported in the table (Panels A and B). Second, consistently with our previous findings (Sections 4.1 and 4.2), relationship lending technologies do not significantly affect the probability of firms experiencing credit restrictions, neither for the subsample of companies matching with local banks (columns 1-3, Panels A and B) nor for the firms coupling with large, national financial institutions (columns 4-6, Panels A and B). From a theoretical point of view, it is particularly interesting to find no differences in the effects of transactional and relationship lending technologies across bank types. Whereas the current literature has strongly emphasized the advantages of large banks in transactional lending, and the edge of local financial institutions in relationship lending (Berger et al., 2005; Agarwal and Hauswald, 2010), our results suggest that it is not the nature of banks, but the technology used that matters.

Finally, regarding the combined effect of bank lending technologies and soft information adoption, the estimation results reported in Table 6 indicate that soft information improves

[16]For reasons of space, in this section we report the estimation results obtained by employing only two measures of soft information, i.e. Soft Information and Financing Share. The results obtained with the other proxies of soft information are qualitatively similar and available upon request.

[17]The distinction between local and national banks is based on the survey question "What type of bank/credit institution does the firm use for domestic activities? (a) Domestic local banks; (b) Domestic national banks; (c) Foreign banks." We classify the firm's main bank as local when the firm answers (a), and as national when it answers either (b) or (c).

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firms' access to credit when the firm deals with a national banks employing transactional lending technologies. As shown in columns (4)-(6) of Panel A, when the Soft Information indicator increases from 0 to 1, the impact of transactional lending techniques on credit rationing reduces from 22.5 to 1.7 percent (statistically significant at 99 percent). Similarly, when the financing share of the firm's main bank raises from 30 to 70 percent (columns 4-6, Panel B), the impact of transactions lending technologies on credit restrictions reduces from 16.4 to 8.4 percent (statistically significant at 95 percent). The beneficial effect of soft information on credit rationing is instead not statistically significant for those firms coupling with local banks.[18] These findings are almost consistent with the emerging literature on the hardening of soft information (Agarwal and Hauswald, 2010; Liberti and Petersen, 2018): as larger banks are the most concerned with the problems associated to the production and transmission of information and the most able to manage complex screening and rating models, during a financial crisis they have the greatest incentive to efficiently combine transactional lending techniques and soft qualitative data in order to assess borrowers' creditworthiness. On the contrary, small local banks, usually relying on relational lending technologies, are not able to efficiently exploit the benefits associated with the combined adoption of transactional lending techniques and soft information. These results are also consistent with the anecdotal evidence that during the crisis large banks partially changed their business model by relying more on soft information and increasing the degree of autonomy of local loan officers (see, e.g., Rotondi, 2013).

4.3.2 The role of firm size

Moving on to the role of firm size, in Table 7 we split the sample of firms in small (columns 1-3), medium (columns 4-6), and large companies (columns 7-9). As regression coefficients indicate, transactional lending technologies affect the probability of small frms experiencing credit restrictions, whereas they are not always statistically significant in explaining the rationing status of large companies. Contrary to the current literature (see, e.g., Berger and Black, 2011), we also find that relationship lending technologies do not significantly reduce the probability of small enterprises to experience credit restrictions. The coefficients of the Relationship Lending variable are not statistically significant for the subsample of small firms.

With regard to the combined effect of bank lending technologies and soft information adoption, estimation results indicate that only small firms benefit from the combination of transactional lending techniques and soft information use. As shown in columns (1)-(3) of

[18] Although the coefficients of the interaction terms Soft Information * Transactional Lending and Financing Share * Transactional Lending are in some cases statistically significant (column 2, Panel A and column 3, Panel B), the Wald test indicates that they are not significantly different from the coefficients of Transactional Lending alone.

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Panel A, when the Soft Information indicator increases from 0 to 1, the impact of transactional lending technologies on credit rationing reduces from 19.5 to 7.2 percent (statistically significant at 99 and 95 percent, respectively). Similarly, when the financing share of the firm's main bank raises from 30 to 70 percent (columns 1-3, Panel B), the impact of transactions lending techniques on credit restrictions reduces from 17.1 to 13.1 percent (statistically significant at 99 and 90 percent, respectively). The beneficial effect of soft information on credit rationing is instead not statistically significant for large and medium-sized enterprises (columns 4-9, Panels A and B). Consistently with Berger and Udell (2006), these results support the idea that soft information production is more useful with small and more opaque borrowers, than with large and more transparent firms. Hence, during the last financial crisis, the exacerbation of SMEs' information asymmetries have led transactional banks to adopt soft qualitative information to better assess small borrowers' creditworthiness and try to ease their access to bank lending.

4.4 Exploring the nature of lending technologies

Following Berger and Udell (2002), in this section we exploit the richness of our database to unbundle the multidimensional nature of transactional and relationship lending technologies. In particular, by relying on question F16 of the EFIGE survey (see Section 3.2.1), we split our aggregate indicators of lending technologies (i.e. Transactional Lending and Relationship Lending) in six different lending techniques: (i) Collateral; (ii) Historical Records; (iii) Balance Sheet Info; (iv) Interviews with Management; (v) Business Plan; (vi) Brand Recognition. Then, in order to investigate whether the adoption of these specific lending technologies affected differently credit availability during the last financial crisis, we estimate the impact of these variables on the credit rationing status of the surveyed firms. The estimation results are reported in Table 8. Column (1) presents the results for the full sample of companies; columns (2)-(3) show the marginal effects for the subsamples of firms dealing with local and national banks; columns (4)-(6) report the estimation results for the subsamples of small, medium, and large businesses.

Starting with the transactional lending components, the results presented in Table 8 provide several intuitions. First, consistently with our previous findings, the provision of collateral positively affects the probability of firms experiencing credit restrictions. This is true for the full sample of firms, for companies dealing with local and national banks, and for small and medium-sized enterprises (columns 1-5).[19] Conversely, the marginal effect of the Collateral

[19]The probability of credit rationing increases by 6.8 percent for the full sample of firms, by 6.6 percent for the subsample of companies dealing with local banks, by 7 percent for the subsample of firms operating with national financial institutions, by 6.8 percent for the subsample of small businesses, and by 5.6 percent for the subsample of medium-sized enterprises.

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dummy is not statistically significant for the subsample of large companies (column 6). Second, in line with the literature on lending technologies and banks' organizational structures (Liberti and Mian, 2009; Agarwal and Hauswald, 2010; Berger and Black, 2011), we find that the use of historical records to screen and monitor borrowers increases the probability of firms experiencing credit restrictions for the full sample of firms, and for companies dealing with local banks (columns 1-2). On the contrary, companies operating with large, national financial institutions do not suffer from more credit constraints because of this lending technology (column 3). Finally, although transactional lending should be more appropriate for large and transparent firms, we find that the use of historical records reduces firms' credit availability both for small businesses and large corporations (columns 4 and 6).

Regarding relationship lending technologies, we find opposite results among the different components of this lending technique. The adoption of direct interviews with the firm's management (Interviews with Managers) as lending technology significantly reduces the probability of firms experiencing credit restrictions, both for the full sample of companies, for small enterprises, and for firms dealing with local banks (columns 1-2 and 4).[20] This result confirms the findings of Sette and Gobbi (2015), Bolton et al. (2016), and Beck et al. (2018) about the beneficial effect of relationship lending on small businesses' credit availability during the last financial crisis. Moreover, we support the paradigm according to which local banks have an edge in relationship lending in comparison to large financial institutions (Berger and Black, 2011). The findings for the Brand Recognition dummy further confirm this result. Although not statistically significant in the full sample estimation, the use of brand recognition as lending technology reduces by 2.3 percent the probability of small firms to be financially constrained (column 5). Contrary results are found with respect to business plan adoption. As indicated by the estimated marginal effects, the use of this lending technology increases the probability of firms experiencing credit restrictions for the full sample of firms, for companies coupling with local banks, and for small and medium-sized enterprises (columns 1-2 and 4-5).

Overall, these findings suggest that banks and firms may not have equal advantages in all the individual lending techniques. Regarding transactional lending technologies, the bank focus on historical records has a negative impact on firms' credit availability only when the main bank is local. Conversely, the reliance on balance sheet information seems not to be statistically significant in explaining the probability of firms experiencing credit restrictions. This result is partially consistent with Berger and Udell (2006), who suggest that financial statement lending is relevant only when borrowers have informative balance-sheets prepared by a reputable accounting firm. As our sample is mainly composed by unlisted small and medium-sized enterprises, the consistency and reliability of their financial statements may

[20] The probability of credit rationing reduces by 2 percent for the full sample of firms, by 3.2 percent for the subsample of companies dealing with local banks, and by 1.8 percent for the subsample of small businesses.

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not be ensured.[21] Finally, the emphasis on collateral exacerbate credit rationing during a crisis, regardless of the bank's nature. This finding is consistent with the large literature showing that aggregate shocks eroding collateral asset values hinder firms' access to external finance (Kiyotaki and Moore, 1997; Buera and Moll, 2015). As for relationship lending, interviews with the firm's management and the evaluation of brand recognition help small businesses to access the bank lending market, while business plans work in the opposite way. These mixed effects translate in a non-significant coefficient of our aggregate indicator of relationship lending in the previous sections.

4.5 Controlling for differential effects of the global financial crisis

The reader might wonder whether differences in the effects of the global financial crisis across countries could affect our main results. For example, banks located in countries that were more exposed to the financial crisis could have been less inclined to adopt relationship lending technologies. For this reason, in columns (1)-(6) of Table 9, we run our baseline regressions by classifying sample firms on the basis of their geographical location distinguishing between Core countries (Austria, France, Germany and United Kingdom) and Periphery countries (Italy, Spain and Hungary). The estimation results confirm our baseline findings, although transactional lending technologies seem to have a larger impact on credit rationing for the subsample of firms located in the Periphery countries. In order to control for the different intensity of the crisis at the regional level, in columns (7)-(9) of Table 9, we also perform our regressions by adding a control variable (Differential Growth) defined as the difference between the growth rate of the region where the firm operates (at the NUTS-1 level) and the average growth rate of the country where the company is located. The estimation results remain virtually unchanged.

5 Conclusions

This paper examined the impact of lending technologies and soft information on firms' credit availability during the global financial crisis. By using a detailed questionnaire on European manufacturing firms, we found that the use of transactional lending technologies increased the probability of credit rationing. On the contrary, we uncovered no significant evidence of a supposed positive role of relationship lending on credit availability. Estimation results also revealed that the adoption of soft information reduced the probability of firms experiencing credit restrictions. By studying the combined effect of soft information and bank lending

[21] This result is also in line with Uchida (2011) and Uchida et al. (2008) who suggest that financial statements provide basic information that banks always check. Hence, they are not significant in determining the probability of firms experiencing credit restrictions.

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technologies, we also found that the probability of firms being credit rationed was somewhat reduced when soft information was used in combination with transactions-based lending techniques. While firms coupling with transactional banks not relying on soft information were more likely to be credit restricted during the crisis, the probability of rationing marginally reduced when firms matched with a transactional bank employing soft qualitative data. In the last part of the paper, we also examined whether firm and bank characteristics played a role in the interaction between soft information and lending technologies. SMEs are found to benefit more when their transactional main banks use soft information. Correspondingly, by bank type, large banks were more effective at incorporating soft information in transactional technologies, partially healing the credit crunch.

Overall, our findings support prior literature indicating that, also during a deep recession such as that of 2007-2009, lending technologies play an important role in determining firms' access to credit (Berger and Udell, 2006). In a policy perspective, these results suggest that during a financial crisis, regulations enabling banks to increase the discretionary power of loan officers could favor firms' access to liquidity. This might be achieved by either relying more on relationship lending technologies or incorporating soft information in transactional lending techniques.

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Tables

Table 1: Summary statistics

	Mean	Median	Std. Dev	Obs.
Lending technologies and soft information:				
Transactional Lending	0.60	0.67	0.30	6,875
Relationship Lending	0.40	0.33	0.34	6,870
Transactional Lending 2	0.62	0.50	0.33	6,875
Relationship Lending 2	0.52	0.50	0.43	6,868
Collateral	0.55	1	0.50	6,855
Soft Information	0.29	0.00	0.35	8,910
Financing Share	58.95	60	33.08	6,873
Number of Banks	3.10	2.00	2.65	14,655
Inverse of Num. Banks	0.49	0.50	0.30	14,655
Duration	15.85	12.00	13.81	6,757
Credit rationing:				
Rationing	0.09	0.00	0.28	6,837
Rationing - Wide	0.19	0.00	0.39	6,837
Rationing - WtPM	0.05	0.00	0.23	6,605
Firm characteristics:				
Age	26.50	21.00	22.58	14,759
Size (Number of Employees)	71.63	26.00	142.92	11,442
Debt Ratio	66.16	66.45	27.69	13,844
Liquidity Ratio	1.54	1.04	1.73	13,322
Differential ROS	0.00	0.00	0.08	9,827
Capital Intensity	38.37	18.88	53.72	10,884
Labour Productivity	51.31	45.75	27.67	9,645
Group	0.22	0.00	0.41	14,759
Foreign	0.10	0.00	0.29	14,302
Countries:				
Austria	0.03	0.00	0.17	14,759
Germany	0.20	0.00	0.40	14,759
France	0.20	0.00	0.40	14,759
Hungary	0.03	0.00	0.18	14,759
Italy	0.20	0.00	0.40	14,759
Spain	0.20	0.00	0.39	14,759
United Kingdom	0.14	0.00	0.35	14,759

Notes: Balance-sheet indicators refer to the period 2007-2009. Extreme values are recoded at the 1st and 99th percentiles because of outliers.

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Table 2: Correlation matrix

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1)	Rationing	1.000										
(2)	Rationing-Wide	0.633	1.000									
(3)	Rationing-WtPM	1.000	0.544	1.000								
(4)	Transactional Lending	0.128	0.109	0.107	1.000							
(5)	Relationship Lending	-0.012	0.015	0.000	0.320	1.000						
(6)	Transactional Lending 2	0.066	0.060	0.056	0.839	0.286	1.000					
(7)	Relationship Lending 2	-0.008	0.016	0.001	0.286	0.939	0.246	1.000				
(8)	Collateral	0.144	0.117	0.120	0.697	0.197	0.193	0.190	1.000			
(9)	Soft Information	-0.027	-0.054	-0.028	-0.041	0.074	-0.027	0.072	-0.038	1.000		
(10)	Inverse of Num. Banks	-0.124	0.043	-0.113	0.069	0.074	0.027	0.070	0.086	-0.170	1.000	
(11)	Financing Share	-0.072	0.016	-0.071	0.120	0.105	0.076	0.105	0.114	-0.057	0.439	1.000
(12)	Duration	-0.054	-0.028	-0.051	-0.037	0.018	-0.037	-0.002	-0.020	0.119	0.013	0.033
(13)	Age	-0.044	-0.028	-0.039	-0.032	0.068	-0.028	0.060	-0.023	-0.067	-0.052	-0.003
(14)	Size	-0.016	0.016	0.019	-0.028	0.216	0.003	0.211	-0.053	-0.121	-0.093	-0.107
(15)	Debt Ratio	0.142	0.105	0.126	0.124	0.036	0.069	0.041	0.136	-0.044	-0.044	-0.036
(16)	Liquidity Ratio	-0.107	-0.079	-0.095	-0.062	-0.016	-0.036	-0.022	-0.070	-0.162	0.086	0.064
(17)	Diff. ROS	-0.083	-0.076	-0.073	-0.034	-0.024	-0.015	-0.030	-0.040	0.002	-0.024	0.019
(18)	Capital Intensity	0.019	0.013	0.000	0.019	-0.022	0.051	-0.017	-0.033	-0.024	-0.167	-0.105
(19)	Labour Productivity	-0.091	-0.065	-0.085	-0.103	0.051	-0.035	0.049	-0.138	-0.050	-0.072	-0.124
(20)	Group	-0.004	0.000	0.001	-0.074	0.108	-0.069	0.101	-0.045	0.019	0.000	-0.081
(21)	Foreign	-0.018	0.012	-0.008	-0.016	0.074	-0.011	0.064	-0.018	-0.046	0.075	-0.020

		(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)
(12)	Duration	1.000									
(13)	Age	0.371	1.000								
(14)	Size	0.005	0.170	1.000							
(15)	Debt Ratio	-0.110	-0.112	-0.012	1.000						
(16)	Liquidity Ratio	0.096	0.103	-0.025	-0.458	1.000					
(17)	Diff. ROS	-0.001	0.010	-0.001	-0.260	0.150	1.000				
(18)	Capital Intensity	-0.001	0.056	0.065	-0.017	-0.100	0.116	1.000			
(19)	Labour Productivity	0.059	0.119	0.112	-0.210	0.212	0.353	0.367	1.000		
(20)	Group	-0.081	-0.014	0.399	-0.016	-0.018	-0.003	0.080	0.198	1.000	
(21)	Foreign	-0.072	-0.009	0.282	-0.021	0.023	-0.009	0.033	0.156	0.469	1.000

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Table 3: Univariate tests

	Rationing			Rationing - Wide			Rationing - WtPM		
	Yes	No	*t-statistics*	Yes	No	*t-statistics*	Yes	No	*t-statistics*
Lending technologies and soft information:									
Transactional Lending	0.72	0.59	*-11.78*	0.67	0.59	*-9.22*	0.73	0.59	*-9.55*
Relationship Lending	0.38	0.40	*0.97*	0.41	0.40	*-1.24*	0.40	0.40	*0.03*
Transactional Lending 2	0.69	0.62	*-5.76*	0.67	0.62	*-5.03*	0.70	0.62	*-4.72*
Relationship Lending 2	0.51	0.52	*0.67*	0.53	0.52	*-1.29*	0.52	0.52	*-0.09*
Collateral	0.78	0.53	*-14.03*	0.67	0.52	*-10.12*	0.79	0.53	*-11.73*
Soft Information	0.36	0.39	*2.30*	0.35	0.40	*4.56*	0.35	0.39	*2.30*
Financing Share	51.34	59.73	*6.55*	60.11	58.75	*-1.32*	49.34	59.73	*6.51*
Number of Banks	4.69	3.63	*-7.96*	3.67	3.74	*0.75*	5.11	3.63	*-7.89*
Inverse of Num. Banks	0.30	0.43	*13.71*	0.44	0.41	*-3.32*	0.29	0.43	*12.68*
Duration	13.43	16.07	*5.27*	15.11	16.01	*2.06*	13.06	16.07	*4.76*
Firm characteristics:									
Age	22.49	25.47	*4.00*	24.12	25.47	*2.34*	22.13	25.47	*3.66*
Size (Number of Employees)	59.38	64.91	*1.01*	68.24	63.60	*-0.99*	71.35	64.91	*-0.83*
Debt Ratio	81.49	69.23	*-12.86*	75.60	69.06	*-8.40*	82.68	69.23	*-11.23*
Liquidity Ratio	0.77	1.18	*12.51*	0.96	1.18	*7.61*	0.73	1.18	*15.67*
Differential ROS	-0.02	0.00	*5.22*	-0.01	0.00	*5.24*	-0.02	0.00	*4.31*
Capital Intensity	47.79	44.01	*-1.37*	46.04	44.02	*-0.96*	44.06	44.01	*-0.02*
Labour Productivity	41.79	49.44	*7.85*	45.16	49.44	*4.83*	40.70	49.44	*7.96*
Group	0.19	0.19	*0.31*	0.19	0.19	*0.03*	0.20	0.19	*-0.10*
Foreign	0.05	0.07	*1.60*	0.07	0.06	*-0.92*	0.06	0.07	*0.65*

Notes: The table reports univariate statistics. All of the variables are defined in Table A1. Accounting figures are expressed in thousands of Euros. Balance-sheet indicators refer to the period 2007-2009. Extreme values are recoded at the 1st and 99th percentiles because of outliers.

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Table 4: Baseline estimates

	Main results			Robustness checks: Alternative measures of lending technologies						Robustness checks: Balance sheet data in 2007		
	Rationing	Rationing Wide	Rationing WtPM	Rationing	Rationing Wide	Rationing WtPM	Rationing	Rationing Wide	Rationing WtPM	Rationing	Rationing Wide	Rationing WtPM
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Transactional Lending	0.116***	0.126***	0.067***							0.147***	0.150***	0.093***
	(0.016)	(0.025)	(0.012)							(0.020)	(0.027)	(0.014)
Relationship Lending	-0.005	-0.012	-0.002							0.002	0.010	0.002
	(0.012)	(0.017)	(0.007)							(0.013)	(0.020)	(0.008)
Transactional Lending 2				0.045***	0.030	0.026**						
				(0.017)	(0.022)	(0.012)						
Relationship Lending 2				0.012	0.008	0.006						
				(0.010)	(0.014)	(0.006)						
Collateral							0.074***	0.094***	0.044***			
							(0.008)	(0.012)	(0.007)			
Age	0.000	-0.000	-0.000	0.000	-0.000	-0.000	-0.000	-0.000	-0.000	0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)
Size	0.003	-0.000	0.008***	-0.000	-0.004	0.007**	0.005	0.002	0.009***	0.005	-0.000	0.011***
	(0.004)	(0.006)	(0.003)	(0.005)	(0.006)	(0.003)	(0.004)	(0.006)	(0.003)	(0.005)	(0.006)	(0.003)
Debt Ratio	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.002***	0.002***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Liquidity Ratio	-0.057***	-0.042***	-0.038***	-0.062***	-0.044***	-0.042***	-0.053***	-0.039***	-0.035***	-0.044***	-0.041***	-0.027***
	(0.008)	(0.011)	(0.006)	(0.009)	(0.012)	(0.006)	(0.008)	(0.011)	(0.006)	(0.013)	(0.014)	(0.008)
Diff. ROS	-0.136***	-0.189**	-0.059*	-0.140***	-0.190**	-0.065*	-0.142***	-0.196**	-0.066**	0.002	0.016	-0.010
	(0.049)	(0.084)	(0.032)	(0.051)	(0.085)	(0.034)	(0.049)	(0.084)	(0.032)	(0.059)	(0.092)	(0.046)
Capital Intensity	0.012*	0.022**	0.003	0.014**	0.024***	0.005	0.012*	0.020**	0.004	0.000	0.000*	0.000
	(0.007)	(0.008)	(0.004)	(0.007)	(0.008)	(0.005)	(0.006)	(0.008)	(0.004)	(0.000)	(0.000)	(0.000)
Labour Productivity	-0.061***	-0.094***	-0.041***	-0.074***	-0.106***	-0.050***	-0.053***	-0.082***	-0.035**	-0.000**	-0.001***	-0.000
	(0.023)	(0.032)	(0.015)	(0.024)	(0.032)	(0.016)	(0.023)	(0.031)	(0.015)	(0.000)	(0.000)	(0.000)
Group	0.016	0.017	0.007	0.016	0.017	0.008	0.013	0.014	0.005	0.027*	0.022	0.009
	(0.012)	(0.017)	(0.008)	(0.012)	(0.016)	(0.009)	(0.012)	(0.017)	(0.008)	(0.014)	(0.018)	(0.011)
Foreign	0.011	0.025	0.003	0.010	0.026	0.003	0.013	0.027	0.003	0.008	0.030	0.006
	(0.016)	(0.022)	(0.011)	(0.016)	(0.023)	(0.011)	(0.016)	(0.022)	(0.011)	(0.019)	(0.026)	(0.014)
Country Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4,630	4,657	4,454	4,630	4,657	4,454	4,630	4,657	4,454	3,985	3,990	3,826
R-squared	0.139	0.071	0.153	0.119	0.061	0.133	0.146	0.079	0.160	0.124	0.069	0.139

Notes: The table reports Probit marginal effects. Three, two and one star (*) mean, respectively, a 99, 95 and 90 percent level of significance. Standard errors clustered at the regional level (NUTS-2) are in parentheses. All regressions include industry and country dummies not reported for reasons of space. All of the variables are defined in Table A1. The variable Size is expressed in logarithm. In columns (1)-(9), balance-sheet indicators refer to the period 2007-2009. In columns (10)-(12), balance-sheet indicators refer to the year 2007.

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Table 5: The role of soft information production

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	Rationing	Rationing Wide	Rationing WtPM	Rationing	Rationing Wide	Rationing WtPM	Rationing	Rationing Wide	Rationing WtPM
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A: Soft information									
Soft Information	-0.021**	-0.007	-0.016**	-0.031***	-0.019	-0.022***	0.026	0.062**	0.018
	(0.010)	(0.013)	(0.008)	(0.010)	(0.013)	(0.007)	(0.019)	(0.027)	(0.018)
Transactonal Lending				0.118***	0.129***	0.068***	0.191***	0.195***	0.139***
				(0.016)	(0.025)	(0.012)	(0.032)	(0.037)	(0.029)
Relationship Lending				0.001	-0.008	0.001	0.010	0.002	0.014
				(0.012)	(0.018)	(0.007)	(0.023)	(0.026)	(0.020)
Soft Information * Trans. Lending							-0.105***	-0.131***	-0.084**
							(0.038)	(0.046)	(0.035)
Soft Information * Relat. Lending							-0.013	-0.022	-0.012
							(0.028)	(0.040)	(0.025)
Observations	4,630	4,657	4,454	4,630	4,656	4,454	4,661	4,661	4,485
R-squared	0.114	0.060	0.130	0.142	0.071	0.157	0.080	0.061	0.066
Panel B: Main bank financing share									
Financing Share	-0.020	-0.009	-0.021**	-0.020*	-0.010	-0.019**	0.000	0.000	0.000**
	(0.013)	(0.019)	(0.010)	(0.012)	(0.019)	(0.009)	(0.000)	(0.000)	(0.000)
Transactional Lending				0.116***	0.125***	0.065***	0.201***	0.194***	0.170***
				(0.016)	(0.025)	(0.012)	(0.043)	(0.040)	(0.039)
Relationship Lending				-0.006	-0.014	-0.004	-0.007	-0.039	-0.004
				(0.012)	(0.017)	(0.007)	(0.029)	(0.034)	(0.023)
Financing Share * Trans. Lending							-0.001**	-0.001**	-0.001***
							(0.001)	(0.001)	(0.000)
Financing Share * Relat. Lending							0.000	0.000	0.000
							(0.000)	(0.001)	(0.000)
Observations	4,610	4,638	4,434	4,610	4,636	4,434	4,641	4,641	4,465
R-squared	0.114	0.061	0.133	0.141	0.071	0.158	0.079	0.061	0.066
Panel C: Inverse of number of banks									
Inverse of Num. Banks	-0.061***	-0.087**	-0.059***	-0.050**	-0.078**	-0.049***	0.064*	0.084	0.058*
	(0.023)	(0.034)	(0.016)	(0.022)	(0.035)	(0.014)	(0.037)	(0.054)	(0.030)
Transactional Lending				0.115***	0.125***	0.064***	0.224***	0.212***	0.172***
				(0.015)	(0.025)	(0.012)	(0.040)	(0.042)	(0.034)
Relationship Lending				-0.007	-0.016	-0.004	-0.019	0.014	-0.002
				(0.012)	(0.017)	(0.007)	(0.024)	(0.027)	(0.020)
Inverse of Num. Banks * Trans. Lending							-0.251***	-0.230***	-0.217***
							(0.069)	(0.076)	(0.056)
Inverse of Num. Banks * Relat. Lending							0.050	-0.082	0.012
							(0.045)	(0.060)	(0.040)
Observations	4,627	4,656	4,451	4,627	4,654	4,451	4,659	4,659	4,483
R-squared	0.115	0.062	0.134	0.141	0.072	0.158	0.080	0.063	0.067
Panel D: Length of the lending relationship									
Duration	-0.001***	-0.001***	-0.001***	-0.001***	-0.001**	-0.000***	0.001	0.001	0.001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)
Transactional Lending				0.116***	0.125***	0.067***	0.173***	0.175***	0.132***
				(0.016)	(0.025)	(0.012)	(0.028)	(0.033)	(0.024)
Relationship Lending				-0.007	-0.016	-0.003	0.001	-0.009	0.009
				(0.012)	(0.018)	(0.007)	(0.022)	(0.029)	(0.020)
Duration * Trans. Lending							-0.002**	-0.003**	-0.002***
							(0.001)	(0.002)	(0.001)
Duration * Relat. Lending							-0.000	-0.000	-0.000
							(0.001)	(0.001)	(0.001)
Observations	4,570	4,596	4,396	4,570	4,595	4,396	4,600	4,600	4,426
R-squared	0.114	0.063	0.130	0.140	0.072	0.156	0.078	0.062	0.065

Notes: The table reports Probit marginal effects in columns (1)-(6) and OLS regression coefficients in columns (7)-(9). Three, two and one star (*) mean, respectively, a 99, 95 and 90 percent level of significance. Standard errors clustered at the regional level (NUTS-2) are in parentheses. All regressions include control variables, industry and country dummies not reported for reasons of space. All of the variables are defined in Table A1.

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Table 6: The nature of banks

	Local banks			National banks		
	Rationing	Rationing Wide	Rationing WtPM	Rationing	Rationing Wide	Rationing WtPM
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Soft information						
Soft Information	(0.022)	(0.035)	(0.022)	(0.039)	(0.050)	(0.034)
	(0.020)	(0.035)	(0.014)	(0.034)	(0.054)	(0.021)
Transactional Lending	0.174***	0.190***	0.128***	0.225***	0.194***	0.160***
	(0.022)	(0.039)	(0.016)	(0.021)	(0.034)	(0.018)
Relationship Lending	(0.037)	(0.048)	(0.035)	(0.044)	(0.046)	(0.043)
	(0.033)	(0.040)	(0.024)	(0.038)	(0.041)	(0.043)
Soft Information	-0.064	-0.107*	-0.067	-0.208***	-0.181**	-0.126*
* Transactional Lending	(0.045)	(0.059)	(0.041)	(0.070)	(0.083)	(0.064)
Soft Information	-0.014	0.009	-0.004	0.003	-0.084	-0.016
* Relationship Lending	(0.036)	(0.049)	(0.028)	(0.058)	(0.079)	(0.059)
Observations	3,126	3,126	3,009	1,527	1,527	1,468
R-squared	0.078	0.058	0.064	0.105	0.093	0.097
Panel B: Main bank financing share						
Financing Share	0.000	0.001	0.000	0.001	0.000	0.001*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)
Transactional Lending	0.182***	0.192***	0.149***	0.224***	0.175***	0.208***
	(0.053)	(0.050)	(0.041)	(0.052)	(0.066)	(0.053)
Relationship Lending	-0.007	-0.041	-0.016	-0.003	-0.012	0.020
	(0.034)	(0.045)	(0.028)	(0.061)	(0.066)	(0.051)
Financing Share	-0.001	-0.001	-0.001**	-0.002**	-0.001	-0.002**
* Transactional Lending	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Financing Share	0.000	0.000	0.000	0.000	0.000	0.000
* Relationship Lending	(0.000)	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)
Observations	3,120	3,120	3,003	1,513	1,513	1,454
R-squared	0.078	0.059	0.065	0.102	0.092	0.096

Notes: The table reports OLS regression coefficients. Firms are classified as dealing with Local (National) banks if their main bank is a local (national) bank. Three, two and one star (*) mean, respectively, a 99, 95 and 90 percent level of significance. Standard errors clustered at the regional level (NUTS-2) are in parentheses. All regressions include control variables, industry and country dummies not reported for reasons of space. All of the variables are defined in Table A1.

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Table 7: The role of firm size

Panel A: Soft information									
	Small firms			Medium firms			Large firms		
	Rationing	Rationing Wide	Rationing WtPM	Rationing	Rationing Wide	Rationing WtPM	Rationing	Rationing Wide	Rationing WtPM
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Soft Information	0.036	0.081**	0.027	-0.031	-0.018	-0.043	0.094	0.131	0.090
	(0.023)	(0.034)	(0.020)	(0.059)	(0.064)	(0.055)	(0.080)	(0.133)	(0.069)
Trasactional Lending	0.195***	0.196***	0.139***	0.177***	0.170**	0.109*	0.181	0.240	0.226*
	(0.039)	(0.046)	(0.032)	(0.063)	(0.073)	(0.059)	(0.126)	(0.149)	(0.121)
Relationship Lending	-0.006	-0.014	-0.003	0.035	0.047	0.059	0.121	0.094	0.067
	(0.029)	(0.033)	(0.022)	(0.049)	(0.059)	(0.047)	(0.084)	(0.113)	(0.070)
Soft Information	-0.123**	-0.162***	-0.104***	-0.096	-0.029	-0.016	0.033	-0.068	-0.037
* Trans. Lending	(0.048)	(0.061)	(0.040)	(0.098)	(0.118)	(0.094)	(0.207)	(0.198)	(0.198)
Soft Information	-0.008	-0.025	-0.010	0.027	-0.000	-0.000	-0.190	-0.096	-0.095
* Relat. Lending	(0.035)	(0.052)	(0.031)	(0.085)	(0.122)	(0.076)	(0.129)	(0.187)	(0.107)
Observations	3,658	3,658	3,501	748	748	733	255	255	251
R-squared	0.080	0.062	0.063	0.098	0.076	0.081	0.194	0.182	0.197
Panel B: Main bank financing share									
Financing Share	0.000	0.000	0.000	0.001	0.001	0.001**	0.001	0.000	0.001
	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Trasactional Lending	0.201***	0.198***	0.153***	0.124**	0.100	0.135**	0.292**	0.190	0.327***
	(0.054)	(0.050)	(0.048)	(0.060)	(0.063)	(0.057)	(0.129)	(0.165)	(0.120)
Relationship Lending	-0.029	-0.068	-0.031	0.085*	0.095	0.109**	0.059	0.063	0.009
	(0.038)	(0.044)	(0.025)	(0.049)	(0.068)	(0.051)	(0.107)	(0.123)	(0.099)
Financing Share	-0.001*	-0.001**	-0.001**	0.000	0.001	-0.001	-0.002	-0.000	-0.003
* Trans. Lending	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.003)	(0.002)
Financing Share	0.000	0.001	0.000	-0.001	-0.001	-0.001	-0.000	0.000	0.001
* Relat. Lending	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)
Observations	3,644	3,644	3,487	741	741	726	256	256	252
R-squared	0.079	0.061	0.063	0.092	0.077	0.081	0.192	0.175	0.199

Notes: The table reports OLS regression coefficients. Firms are classified as: (i) Small, if they have less than 50 employees; (ii) Medium, if they have more than 50 and less than 250 employees; (iii) Large, if they have more than 250 employees. Three, two and one star (*) mean, respectively, a 99, 95 and 90 percent level of significance. Standard errors clustered at the regional level (NUTS-2) are in parentheses. All regressions include control variables, industry and country dummies not reported for reasons of space. All of the variables are defined in Table A1.

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Table 8: The nature of lending technologies

	Dependent variable: Rationing					
	Full sample	Bank type		Firm size		
		Local banks	National banks	Small	Medium	Large
	(1)	(2)	(3)	(4)	(5)	(6)
Collateral	0.068***	0.066***	0.070***	0.068***	0.056***	0.015
	(0.007)	(0.009)	(0.011)	(0.008)	(0.018)	(0.016)
Historical Records	0.025***	0.029**	0.014	0.021**	0.021	0.049**
	(0.009)	(0.013)	(0.012)	(0.011)	(0.017)	(0.025)
Balance Sheet Info	0.002	0.005	-0.010	0.002	0.018	-0.122
	(0.011)	(0.010)	(0.026)	(0.011)	(0.026)	(0.080)
Interview with Managers	-0.020**	-0.032***	0.006	-0.018**	-0.022	-0.028
	(0.008)	(0.010)	(0.018)	(0.009)	(0.018)	(0.023)
Business Plan	0.027***	0.033***	0.015	0.023**	0.039***	0.017
	(0.010)	(0.011)	(0.017)	(0.009)	(0.017)	(0.014)
Brand Recognition	-0.010	-0.009	-0.011	-0.023**	0.007	0.028
	(0.009)	(0.013)	(0.015)	(0.010)	(0.022)	(0.021)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Country Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4,630	3,114	1,508	3,649	734	225
R-squared	0.154	0.158	0.178	0.154	0.178	0.412

Notes: The table reports Probit marginal effects. Firms are classified as dealing with Local (National) banks if their main bank is a local (national) bank. Firms are classified as: (i) Small, if they have less than 50 employees; (ii) Medium, if they have more than 50 and less than 250 employees; (iii) Large, if they have more than 250 employees. Three, two and one star (*) mean, respectively, a 99, 95 and 90 percent level of significance. Standard errors clustered at the regional level (NUTS-2) are in parentheses. All regressions include control variables, industry and country dummies not reported for reasons of space.

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Table 9: Controlling for differential effects of the global financial crisis

	Periphery: Italy - Spain - Hungary			Core: Austria - France - Germany - UK			Additional control: Differential Growth (NUTS-1)		
	Rationing	Rationing Wide	Rationing WtPM	Rationing	Rationing Wide	Rationing WtPM	Rationing	Rationing Wide	Rationing WtPM
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Transactional Lending	0.165***	0.185***	0.099***	0.031***	0.023	0.020***	0.107***	0.113***	0.066***
	(0.026)	(0.034)	(0.019)	(0.010)	(0.029)	(0.008)	(0.014)	(0.022)	(0.011)
Relationship Lending	-0.011	-0.019	-0.003	-0.000	-0.004	-0.006	0.002	0.005	0.002
	(0.015)	(0.020)	(0.009)	(0.016)	(0.030)	(0.010)	(0.013)	(0.023)	(0.009)
Age	-0.000	-0.000	-0.000	0.000	0.000	0.000	-0.000	-0.000	-0.000
	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Size	0.006	0.002	0.013***	-0.001	-0.001	0.000	-0.000	-0.002	0.005
	(0.006)	(0.007)	(0.004)	(0.004)	(0.009)	(0.002)	(0.005)	(0.008)	(0.003)
Debt Ratio	0.001***	0.002***	0.001***	0.000	0.000	0.000	0.000	0.000	0.000**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Liquidity Ratio	-0.067***	-0.058***	-0.051***	-0.029***	-0.020*	-0.015***	-0.046***	-0.041***	-0.026***
	(0.011)	(0.015)	(0.009)	(0.007)	(0.012)	(0.005)	(0.009)	(0.012)	(0.007)
Diff. ROS	-0.180**	-0.251**	-0.082*	-0.029	0.026	-0.017	-0.120**	-0.155	-0.045
	(0.071)	(0.104)	(0.048)	(0.051)	(0.145)	(0.035)	(0.060)	(0.101)	(0.043)
Capital Intensity	0.014	0.023**	0.006	0.015*	0.039*	0.002	0.017*	0.019	0.005
	(0.009)	(0.011)	(0.006)	(0.008)	(0.021)	(0.008)	(0.009)	(0.015)	(0.007)
Labour Productivity	-0.072**	-0.125***	-0.053**	-0.051**	-0.058	-0.027	-0.065***	-0.045	-0.050***
	(0.033)	(0.040)	(0.022)	(0.023)	(0.043)	(0.018)	(0.025)	(0.036)	(0.018)
Group	0.023	0.025	0.007	0.002	-0.002	0.006	0.004	0.007	0.002
	(0.018)	(0.022)	(0.013)	(0.007)	(0.022)	(0.006)	(0.012)	(0.019)	(0.009)
Foreign	0.035	0.051	0.019	-0.006	0.011	-0.005	0.003	0.003	-0.007
	(0.029)	(0.032)	(0.021)	(0.009)	(0.025)	(0.005)	(0.021)	(0.029)	(0.012)
Differential Growth							1.030**	1.263*	0.663**
							(0.413)	(0.681)	(0.294)
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3,438	3,438	3,282	1,192	1,219	1,172	2,708	2,733	2,626
R-squared	0.123	0.086	0.138	0.153	0.054	0.153	0.166	0.062	0.180

Notes: The table reports Probit marginal effects. Three, two and one star (*) mean, respectively, a 99, 95 and 90 percent level of significance. Standard errors clustered at the regional level (NUTS-2) are in parentheses. All regressions include industry and country dummies not reported for reasons of space. All of the variables are defined in Table A1. The variable Size is expressed in logarithm. The variable Differential Growth is computed as the difference between the growth rate of the region where the firm operates (at the NUTS-1 level) and the average growth rate of the country where the company is located.

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Appendix

Table A1: Variable definitions

Variable	Definition
Rationing	Dummy variable equal to one if the firm unsuccessfully applied for credit, and zero otherwise. (Source: EU-EFIGE survey)
Rationing - Wide	Dummy variable equal to one if the firm was willing to increase its borrowing, and zero otherwise. (Source: EU-EFIGE survey)
Rationing - WtPM Willingness to Pay More	Dummy variable equal to one if the firm unsuccessfully applied for credit and was willing to pay a higher rate of interest, and zero otherwise. (Source: EU-EFIGE survey)
Transactional Lending	Average of collateral, balance sheet information and historical records dummies. (Source: EU-EFIGE survey)
Relationship Lending	Average of interviews with management, business plan and brand recognition dummies. (Source: EU-EFIGE survey)
Transactional Lending 2	Average of balance sheet information and historical records dummies. (Source: EU-EFIGE survey)
Relationship Lending 2	Average of interviews with management and business plan dummies (Source: EU-EFIGE survey)
Soft Information	Average of consultancy service and long-lasting relationship dummies. (Source: EU-EFIGE survey)
Financing Share	Financing share of the firm's main bank. (Source: EU-EFIGE survey)
Number of Banks	Total number of firm's banking relationships. (Source: EU-EFIGE survey)
Inverse of Num. Banks	One over the number of banking relationships enjoyed by the firm. (Source: EU-EFIGE survey)
Duration	Length (in number of years) of the bank-firm relationship. (Source: EU-EFIGE survey)
Age	Number of years from firm's inception. (Source: EU-EFIGE survey)
Size	Logarithm of the number of workers employed in the firm. (Source: Bvd-Amadeus)
Debt Ratio	Ratio of total debt to total assets. (Source: Bvd-Amadeus)
Liquidity Ratio	Ratio of current assets to current liabilities. (Source: Bvd-Amadeus)
Differential ROS	Difference between firm i return on sales and the median return on sales of its industry (at the size class and regional level). (Source: Bvd-Amadeus)
Capital Intensity	Ratio of tangible fixed assets to number of employees. (Source: Bvd-Amadeus)
Labour Productivity	Ratio of value added (EBITDA plus labour costs) to number of employees. (Source: Bvd-Amadeus)
Group	Dummy variable equal to one if firm i is part of a group, and zero otherwise. (Source: EU-EFIGE survey)
Foreign	Dummy variable equal to one if the main shareholder of the firm i is foreign. (Source: EU-EFIGE survey)

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Table A2: Lending technologies - Summary statistics

	Mean	Std. Dev.	Obs.
Transactional lending technologies:			
Collateral	0.55	0.50	6,855
Balance Sheet Info	0.84	0.36	6,874
Historical Records	0.40	0.49	6,865
Relationship lending technologies:			
Interview with Managers	0.56	0.50	6,863
Business Plan	0.48	0.50	6,864
Brand Recognition	0.15	0.36	6,855

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Highlights

- We empirically investigate how lending technologies and use of soft information affected firms' credit availability during the 2007-2009 crisis.
- We find that transactional lending technologies increased firms' credit rationing, whereas soft information improved firms' access to credit.
- When soft information was incorporated in transactional lending technologies firms' credit rationing significantly reduced.

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