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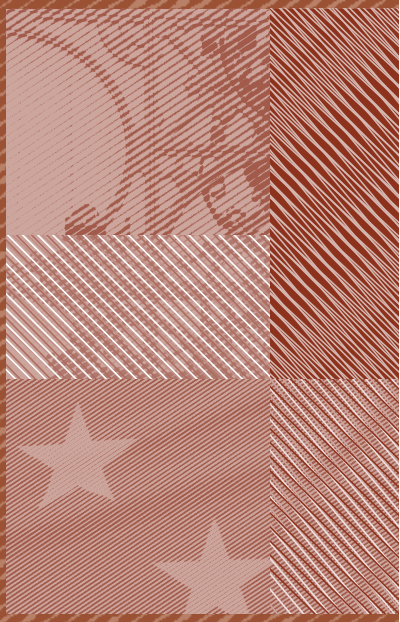

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Abstract

We show that bank lending standards are influenced by macroeconomic conditions. We use monthly data from the Banco de España Central Credit Register, which allow us to monitor all loan applications made by non-financial firms to non-current banks from 2002 to 2015. To test the pro-cyclicality of banks' appetite for risk, we investigate how two firm characteristics (ex-ante credit risk and productivity) interacting with two macroeconomic indicators (business cycle and the monetary policy stance) affect the probability of granting a loan. In order to enhance identification we account for unobserved heterogeneity by means of firm and bank-time fixed effects. Our findings indicate that banks soften their credit standards during booms or when monetary policy is loose to harden them during busts or when short-term interest rates increase. This pattern is especially relevant in the case of firms' productivity, which might partly explain the dismal evolution of aggregate productivity in Spain during the pre-crisis period. Finally, we also find that these results are more pronounced among less capitalized, less liquid and more profitable banks.

Keywords: productivity, credit risk, bank supply, lending standards.

JEL Classification: G21, E51, D24, O47.

Resumen

En este trabajo mostramos que los estándares de concesión de préstamos por parte de los bancos se ven afectados por las condiciones macroeconómicas. Utilizamos datos mensuales entre 2002 y 2015 de la Central de Información de Riesgos del Banco de España (CIRBE), que nos permiten monitorear todas las solicitudes de préstamos realizadas por empresas no financieras a bancos con los que no tienen relación crediticia previa. Con el objetivo de analizar la prociclicalidad del apetito por el riesgo de los bancos, investigamos cómo la probabilidad de otorgar un préstamo cambia en función de dos características de las empresas (riesgo de crédito *ex ante* y productividad) y cómo esta relación varía a lo largo del ciclo económico, que medimos mediante el crecimiento del PIB y los cambios en tipos de interés. Nuestra estrategia de identificación se basa en la inclusión de efectos fijos de empresa y banco-mes en nuestras regresiones, de modo que explotamos diferencias en la concesión de préstamos del mismo banco en el mismo mes a empresas que son diferentes en términos de productividad y riesgo de crédito. Nuestros resultados indican que los bancos relajan sus estándares de crédito en momentos de expansión económica y/o de caídas de tipos de interés, y los endurecen durante la fase recesiva y/o cuando aumentan los tipos de interés. Este patrón es especialmente relevante en el caso de la productividad de las empresas, lo que podría explicar en parte la caída de la productividad agregada en España durante el período expansivo previo a la crisis. Finalmente, también encontramos que estos patrones cíclicos son más pronunciados entre los bancos menos capitalizados, menos líquidos y más rentables.

Palabras clave: productividad, riesgo de crédito, oferta de crédito, estándares crediticios.

Códigos JEL: G21, E51, D24, O47.

1 Introduction

The recent financial crisis lived by the Western economies in general and by Spain in particular has once again revived the interest on the behaviour of banks during lending booms. It is well rooted that banks soften their lending standards during times of strong economic growth or expansionary monetary policy periods, to tighten them during busts. While the importance of short-term interest rates on banks risk-taking has been widely studied in the empirical literature in recent years (Jiménez, Ongena, Peydró & Saurina, 2014; (Dell'Ariccia, Laeven & Suarez, 2013; (Becker & Ivashina, 2015; (Chodorow-Reich, 2014; (Di Maggio & Kacperczyk, 2017) the literature on the link between economic cycle and the appetite for risk of banks is scarce (Rodano, Serrano Velarde, & Tarantino, 2017).

Our study investigates how bank lending standards are affected by firms' ex-ante creditworthiness, proxied by ex-ante credit risk and productivity, and how this pattern depends not only on the monetary policy stance and the economic cycle, but also on the balance-sheet strength of banks. In this sense, the importance of the firm balance-sheet channel in terms of ex-ante credit risk is well documented in the literature (see, for instance, Rodano, Serrano-Velarde, & Tarantino, 2017; and Jiménez, et al., 2014), but we know little about the role of productivity differences across firms in the allocation of credit depending on the banks' balance-sheet strength. Indeed, although there is a strong correlation between bank credit and aggregate productivity growth in Spain (see Figure 1), the link between bank lending standards and productivity, however, is not well understood yet. Our findings indicate that banks soften their lending standards during expansionary times, in terms of firms' productivity and ex-ante credit risk, and especially among lowly capitalized, less liquid and more profitable banks. This pattern might partly explain the misallocation of resources towards low-productivity and risky firms which is at the root of the dismal evolution of aggregate productivity during the Spanish boom as documentd in García-Santana, Moral-Benito, Pijoan-Mas and Ramos (2016).

There is a vast strand of literature that highlights the importance of lending standards to understand the economic fluctuations and the dynamics of credit over the business cycle (Greenwood & Hanson, 2013; Lopez-Salido & Zakrajsek, 2015; Covas & Den Haan, 2011; Jermann & Quadrini, 2012; Becker & Ivashina, 2014; Gilchrist, Yankov, & Zakrajsek, 2009), and there are different theories that provide a rationale for the mechanisms that make creditors vary their lending standards and their perception of credit risk over the cycle: agency problems (Williamson, 1963), herd behavior (Rajan, 1994), institutional memory hypothesis (Berger & Udell, 2004) and disaster myopia (Guttentag & Herring, 1986). Furthermore on the empirical front, there is evidence in the literature that contractive monetary policies and bad economic conditions affect lending standards and reduce banks' credit supply Jiménez et al. 2012; Dell'Ariccia, Laeven, & Suarez, 2017; Dell'Ariccia & Marquez, 2006; Saurina & Jimenez, 2006; Ozlem, García Montalvo, García Villar, Peydró, & Maria Raya, 2014). Moreover, banks that are less capitalized, less liquid, and small are also those adjusting more pro cyclically their credit risk portfolio levels Rodano et al, 2017; Kashyap & Jeremy, 2000; Jiménez et al, 2014; (Bedayo, Estrada, & Saurina, 2017).

Turning to the demand side (balance-sheet strength of firms), a credit contraction affects firms heterogeneously on the basis of their characteristics implying changes in the allocation of funds across firms and the composition of banks' loans portfolios (Jiménez, Ongena, & Peydró, 2017). Indeed, the ability of banks to discriminate in terms of firms'

productivity when granting new loans might wave in the end the allocation of resources and shape productivity, real activity and economic growth; (Borio, Kharroubi, Upper, & Zampolli, (2015) show that lax credit conditions lead to misallocation of resources and productivity losses; while Rodano, et al. (2017) show that substandard firms excluded from access to credit during busts (because banks' cyclical adjustment of lending standards) report lower values of production and capital investment than their peers slightly over the threshold cutoff that classified them into performing firms. More broadly, one can also connect these mechanisms with the recent literature about the productivity effects of financial frictions and misallocation of resources across firms (Hsieh & Klenow, 2009; Gopinath, Kalemli, Karabarbounis, & Villegas-Sánchez, 2017; García-Santana, Moral-Benito, Pijoan-Mas, & Ramos, 2016; Dörr, Raissi, & Weber, 2017).

Our work is related to a number of previous studies. The relationship between monetary policy and bank risk-taking has been explored in Jiménez et al., 2014; Dell'Arriccia, Laeven and Suarez, 2017; and Ioannidou, Ongena, and Peydro, 2015). However these studies do not analyze either the impact of the economic cycle in terms of GDP growth or the effect of bank lending standards on other firm quality measures different from firm credit risk such as productivity. We capture the effect of bank risk taking in the decision of granting a loan request over the business cycle, through the analysis of two firm characteristics: credit risk and productivity. In this sense, our paper is related to the work by Dell'Arriccia et al. (2017), who use an ex-ante measure of borrower's risk instead of credit history or ex-post defaults rates. The bank-balance sheet channel using loan applications is also employed in Jiménez et al. (2012) but their focus is to analyze the impact on monetary policy on bank credit supply.

Our paper complements the literature about the effects of monetary policy and the business cycle on banks' credit supply. While previous papers cast their conclusions about banks' lending standards focusing on different measures of firms' credit risk, to the best of our knowledge, there is no paper that studies how banks consider firms' productivity during a complete business cycle when they choose their loan portfolio. Therefore, we consider how productivity and ex-ante firms' credit risk affect banks' loan granting, and to what extent banks' lending policies vary over the business cycle depending on the balance-sheet strength of the banks.[1] We thus estimate how the ability of banks to discriminate in terms of firms' productivity depends on macroeconomic conditions, which allows us to relate our findings to the literature about misallocation of resources across firms.

We use more than one million loan applications matched at the bank-firm level[2] from the Credit Register of Spain (CIR). Banco de España collects this information in a monthly basis for those firms that are not working with the bank at the time of the loan request. Additionally, we match the CIR with banks' monthly balance sheet information (collected by Banco de España in its role as bank supervisor) and with firms' balance sheet data from the Spanish Mercantile Register collected by the Central Balance Sheet Office in the Bank of Spain. Using this information, we compute firms' total factor productivity (TFP) following Levinsohn and Petrin, 2003) and firms' ex ante credit risk following a Z-score procedure. Both variables summarize the information that banks evaluate for granting a loan to a company. Other firm controls included are the number of banking relationships and a set of firm fixed effects which

1 In the spirit of Markowitz' theory (Markowitz, 1952) our specifications rely on the idea that banks choose their loan portfolio composition considering firms' ex- ante credit risk and productivity (that in the end are presumably correlated with banks' loan portfolio credit- risk and returns). That is, banks would grant a loan to those firms with a specific mix of ex ante credit risk and productivity that would lead them to a loan portfolio composition with a targeted credit risk and returns mix.

2 1,027,436 loan applications and 201,741 firms.

controls for unobserved firm heterogeneity (including demand factors). Finally, our data allow us, in some specifications, to use bank-time fixed effects to exhaustively control for time varying observable and unobservable supply factors (including the bank balance-sheet channel).

Our main findings are as follows: higher firms' productivity or lower credit risk increase the probability that a loan application is granted. This finding suggests that banks discriminate in terms of both productivity and ex-ante credit risk so that bank lending policies might play a role in the allocation of resources towards more/less productive firms. Moreover firm's credit risk and productivity are substitutes in terms of their effects on bank's screening process. Regarding macroeconomic fluctuations, we find that banks soften their lending standards during expansions: the economic cycle and the monetary policy affects lending standards both in terms of firms' credit risk and productivity, i.e., when the economy is growing or it is in a loosen monetary policy environment, banks respond taking on more risk. In other words, banks screening process reduces the relative importance of productivity or ex-ante credit risk to the point of not taking them into accountin good times. Finally, our estimates indicate that these patterns are stronger in the case of less capitalized, less liquid and more profitable (higher risk profile) banks.

The remainder of the paper is organized as follows. The databases and registries relevant to the paper are described in Section 2A. Section 2B describes in detail the variables we use in the regressions. Section 2C presents the empirical specifications considered in the paper. Section 3 discusses the estimates and how bank lending standards depend on macroeconomic conditions as well as bank balance-sheet strength with special emphasis on the role of firms' productivity. Section 4 presents some robustness checks illustrating that our results are not affected by the behavior of current banks. Finally, Section 5 concludes.

2 Data and Empirical Strategy

In this section we first discuss the data employed in our analysis. Second, we provide the definition of the dependent and the independent variables. Finally, we describe the empirical strategy.

2.1 Database

We use confidential loan level data for Spanish non-financial companies at monthly frequency over the period 2002 to 2015 from the Spanish Credit Register (CIR), which is collected by the Banco de España acting as the national banker supervisor and regulatory authority.[3] We work with commercial and industrial (C&I) loans granted by commercial banks, savings banks and credit cooperatives (what embodies almost the entire Spanish banking system) to non-financial publicly limited and limited liability companies (almost the 95% of all non-financial firms).

The CIR contains very detailed loan level data since 1984 on all loan commitments above € 6,000 granted by any bank operating in Spain. It means that more than 600,000 firms and 200 banks are active in the database at any moment in time. The CIR provides some information about borrower, lender and detailed information about loan characteristics, such as the type of instrument, currency, maturity, degree of collateralization, default status, as well as the amount drawn by the firm.

The information about the total current credit exposures, loan characteristics, and (possible) defaults is updated at a monthly frequency basis. All banks receive this information automatically, but only regarding their current borrowers. Therefore, they only file information requests following loan applications from firms that are currently not borrowing from them. Banks are legitimated to demand this data with the consent of their potential borrowers (Jiménez et al. 2012; Jiménez et al. 2014), what is considered a signal that they are seriously approaching to the bank to get a credit. We observe all loan applications from 2002:02 to 2015:12 (before 2002 this information was not stored). Requests can be made at any time but they are collected monthly. Each request links uniquely a bank with (a potential) borrower, what permits us to infer which loans are granted by matching the loan application database with the CIR database. We match logged requests by firm i to bank b with new loans coded in the CIR database. For all requests lodged we observe whether the bank accepted and granted the loan if the new loan is coded in the CIR within three months after the information request was submitted by the bank (and we infer the bank rejected the loan if it is not coded).

Although the CIR and loan application databases provide comprehensive data on loans, they don't provide any additional information on borrowers but its identity, the amount drawn by the firm, province and sector of activity and its credits records (if any). We can also obtain from the CIR information about legal status, total credit amount and the number of banking relationships of the firm as well as the non-performing loan ratio. However, additional data on firms' and banks' balance sheets is crucial to build some key variables for our analysis, such as firms' total factor productivity (TFP) and firms' ex-ante credit risk (scoring). This information allows us to disentangle supply from demand factors: loan demand for each bank is given and observed, so each bank has in light of their potential borrowers' balance sheet strength. Therefore, we match CIR and the loan requests dataset with additional information about firms and banks balance sheets.

3 The CIR was first employed by Jiménez and Saurina (2004) and Jiménez, Salas and Saurina (2006).

We have information about firm characteristics at a yearly frequency from Central Balance Sheet Data (CBI, *Central de Balances Integrada* in Spanish).[4] This dataset is only available for researchers undertaking projects for the Banco de España and comprises data from the Spanish Mercantile Register (an administrative database that contains available information from firms financial statements required to be submitted by law to the commercial registry and also on their income corporate tax returns) collected by Central Balance Sheet Office, that is the unit in charge of collecting and cleaning these datasets within Bank of Spain.

Additionally, we get banks' information at a monthly frequency from banks' balance-sheet data owned by Banco de España in its role as banking supervisor. To capture macroeconomic conditions, we include the overnight interest rate and the GDP growth rate. All firm variables are set at the last December before the loan request is made to reduce reverse causality. In the same vein, banks' and macroeconomic variables refers to the month previous to the loan application.

2.2 Variables

We use data about loan applications together with information about bank characteristics (to measure banks' balance sheet strength) as well as firm characteristics. Therefore, we can disentangle supply from demand factors by exploiting within bank variation in credit availability as a function of firm characteristics during upturns and downturns.

Table 1 shows the descriptive statistics of the variables used in the paper for the whole period 2002:02-2015:12.

2.2.1 DEPENDENT VARIABLE: LOAN APPLICATION IS ACCEPTED AND THE LOAN IS GRANTED

The dependent variable is an indicator dummy, LOAN APPLICATION IS GRANTED, which equals one if the bank b grants a loan requested by firm i at time t within the period t to t+3 and equals zero otherwise. The average value of loan requests granted inthe period considered is around 35 percent. We focus on loans granted by commercial banks, savings banks and credit cooperatives to nonfinancial limited liability companies.

2.2.2 INDEPENDENT VARIABLES

As independent variables, we include two macroeconomic indicators, namely, annual change of *OVERNIGHT INTEREST RATE* (ΔIR_{t-1}) as a measure of the monetary policy stance, and annual growth RATE of *GDP* (ΔGDP_{t-1}) as a proxy for the business cycle. In some specifications we substitute these macroeconomic variables by a set of time dummies.

In order to disentangle the role of demand and supply factors, we include a set of firm and bank observable characteristics described below. Crucially, we also include a set of firm- and bank-specific fixed effects to control for demand and supply time invariant heterogeneity. Later, to fully account for time-varying heterogeneity in the supply side we saturate the specifications including a set of bank-time fixed effects.

Regarding firm characteristics, the regressors of interest are the two variables that summarize the information on the firm's quality as borrower: firm's total factor productivity and

4 Central Balance Sheet Database has been filed with Mercantile Registries since 1995. Its size has grown progressively since then. Over 100,000 annual account of non-financial corporation were processed in the first years, while more than 400,000 annual accounts of non-financial corporations are processed each year since 2004 and more than 600,000 since 2011). In the last update, in 2015 9,086 corporations were processed from CBA and 667,585 corporations from CBB.

ex-ante credit risk. These variables are calculated using information from CIR and CBI data as we next describe.

Firms' total factor productivity (TFP) is computed as the residual in a logged production function with three inputs (labor, capital and intermediate materials) and industry-specific technology parameters. The industry-specific parameters of the firms' production function are estimated based on Wooldridge, (2009) GMM approach to implement Olley and Pakes, (1996) and Levinsohn and Petrin, (2003) identification strategy.[5] For that purpose we use information on firm's revenue, total wage bill, employment, book value of capital stock (both physical and intangible), expenses in intermediate goods, and sector of activity at the NACE 4-digit level. A cut-off of a minimum of 25 observations per sector and year is required to compute the input variables to estimate sector-specific parameters of the production function. Sectors that do not meet the minimum cut-off criterion are flagged (agriculture and mining, petroleum industry companies) and firm specific TFP figures are computed using the estimated production function parameters at the corresponding macro-sector level. A full set of year dummies is included to control for sector specific trends. ECB (2016) contains a detailed description of the methodology used here to estimate TFP at the firm level.

Regarding the measure of ex-ante credit risk for each firm, we consider a numerical score (*SCORING*) that proxies for the firm's probability to not fulfill its commitments with any bank based on lagged balance sheet information. To compute this variable we estimate a probability model for the whole sample where the dependent variable is an indicator equal to one when the firm defaulted in any of the 36 following months after a loan was granted and zero otherwise.[6] Specifically, each firm's score is the total summation of the product between the regressors values and their respective coefficients in the default probability model. We use fifteen variables as controls based on firms' balance sheet characteristics — financial ratios, financial indebtedness, solvency, liquidity, profitability, and expertise, structure, credit history and provincial and sectorial dummies — plus their quadratic, cubic and fourth power to assign a score to each company. The higher the scoring the riskier the company and therefore the likelihood to default.

Additionally, we include the logarithm of the number of banks with which a company is indebted each period plus one, ln (NUMBER OF BANKS RELATIONSHIPS + 1) $_{bit-1}$, as another control. It provides relevant information about the solidity of the firm-bank relationship and also, ceteris paribus, about the firm's creditworthiness. Notice we are focusing on new loans, so our estimations are not affected by loan evergreening. Finally, to control for unobserved firm heterogeneity constant over time, firm fixed effects are also included in all the estimations. This implies that we are only working with firms that have more than one loan application during the period considered (96% of total observations in our data).

Turning to banks' characteristics, we include a set of six bank's balance sheet variables to capture supply side developments. They are included in the regression lagged one period (one month) to avoid endogeneity concerns, as we presuppose that banks optimally take decisions about loan granting and capital and liquidity holdings in response to macroeconomic

5 For robustness, we computed 5 alternative TFP measures: nominal TFP GMM estimation, TFP OLS estimation (we get two measures using alternatively real variables and nominal variables in an OLS regression), and real and nominal TFP estimation using industry-specific US labor shares in total production (constant returns to scale assumed in this case). Main results keep qualitatively the same using all the 5 alternative measures of TFP.

6 Using alternative time horizons for firm's underperformance (one and two years ahead) to construct our scoring variable, results remain qualitatively the same. Specifically we compute credit risk for a firm i at period t using three alternative sets of information: i) all firms' credit history until T, (where T is the last period of observation in our data); ii) all firms' credit history until t-1; and ii) firm's credit history from the previous three years (t-19 to period t-1). Results are available upon request.

and monetary policy conditions. We include, the log of the total assets of the bank, ROA_{bt-1}, the bank's return on assets; LIQUIDITY $RATIO_{bt-1}$, liquid assets (cash and balance with central banks, and loans and advances to governments and credit institutions) held by the bank over the total assets of the bank; BANK CAPITAL $RATIO_{bt-1}$, the logged ratio of bank equity over total assets of the bank, as a measure of bank's net worth; and the DOUBTFUL LOAN $RATIO_{bt-1.}$ Additionally we include a measure of bank supply constructed following a methodology similar to the one proposed by (Amiti & Weinstein, (2017).[7] Finally, it is worth mentioning that a set of bank-time fixed effects is included in our most stringent specifications to fully account for supply side factors beyond the ones control for that might affect banks' ability to discriminate in terms of firms' productivity and credit risk.

Table 1 presents the summary statistics of the variables used in the regressions. The average probability of granting a loan during the period considered is around 36%, with a standard deviation of 0.48. It varies between 50% and 40% between 2002 and 2007, and it decreases afterwards reaching 33.6% in 2015. Average total factor productivity is around –0.091 with a standard deviation of 0.55. Its value remains stable between 2002 and 2008 around –0.1 and then it increases. The average scoring is –1.32 with a standard deviation of 0.75, what implies an average predicted default probability of 0.09 for the whole period. It provides a likelihood to default in the future for each borrower, thus the higher its value the higher the credit risk of the firm. As can be seen in Figure 2 yearly average predicted default probability reached its local maximum in 2008 and from then onwards it monotonically decreased.

2.3 Empirical Strategy

The aim of the paper can be summarized by the following three questions: (1) Does higher firms' productivity or lower firm's ex-ante credit risk increase the likelihood of a loan being granted? Are lending standards cyclical? (2) Does banks' assessment about firms' quality as a debtor (measured in terms of productivity and ex-ante credit risk) vary over the business cycle? That is to say, is there a risk-taking effect? (3) Does the bank-balance sheet channel matters for lending policies? That is to say, does the strength of bank balance-sheet affect the way firms' productivity and ex-ante credit risk vary over the cycle?

We thus consider three alternative specifications to explore the answers to the three questions above. In all cases we estimate linear probability models[8] at the bank-firm-month (loan-month) level by matching data on the loan application outcome with the relevant macroeconomic, bank and firm balance-sheet characteristics.

The baseline specification tries to answer the first question and it includes firm controls — ex ante credit risk and productivity —[9] together with the business cycle and interest rate. To be more concrete, we consider the following equation:

---

7 We performed a weighted linear regression where the dependent variable is bank credit growth between period t to period t-1, over total credit granted by each bank in both periods. Bank and Firm Fixed Effects are included to identify the supply and demand.

8 We estimate a linear model instead of non-linear one because it allow multi-clustering the standard errors, to avoid selection problems that arise in such cases and to improve the interpretability of coefficients (Chunrong & Norton, 2003; Norton an, Wang, & Ai 2004).

9 Firm controls -TFP and SCORING- are variables that we estimate in a first step. We afterwards include them in Equation (1) as regressors. Given that in this two-step procedure we estimate both regressors by linear methods, the adjustment factor for the resulting sampling error resembles the traditional sandwich formula that depends on the variance of the estimated parameters in the first step (Murphy & Topel, 1985). Since we are using hundreds of thousands of observations in our first step, we expect the correction factor for the second step to have a negligible effect on our second-step inferences because the first-step variance is close to zero (see Bai & Ng, 2006) for a formal proof of this argument in a similar context).

$$Loan\ application\ is\ granted_{bit} = \beta_1 TFP_{it-1} + \beta_2 SCORING_{it-1} +$$

$$\beta_3 TFP_{it-1} \times SCORING_{it-1} + \beta_F OTHER\ FIRM\ CHARACTERISTICS_{\ bit-1} +$$
$$\beta_B BANK\ CHARACTERISTICS_{bt-1} + \beta_5 \Delta GDP_{t-1} + \beta_6 \Delta IR_{t-1} + \vartheta_b + f_i + \varepsilon_{bit} \quad (1)$$

where b refers to banks, i refers to firms, and t refers to months. Moreover, firm fixed effects, f_i, and bank fixed effects, ϑ_b, are included to capture time-invariant demand and supply factors. Our main interest relies on the coefficients for productivity (TFP) and credit risk (SCORING) to understand whether banks' lending standards and credit allocation depend on these two factors. Finally, the interaction between credit risk and productivity informs about the degree of substitutability in banks' assessments between these two firm characteristics. The coefficients on TFP and SCORING provide an answer to the first set of questions. The expected signs are $\beta_1 > 0$ and $\beta_2 < 0$ if banks take into account firm creditworthiness during the granting process of a loan request. The complementarity or substitutability between both variables is captured with the multiplicative term coefficient between them. If the estimated coefficient is positive it will be concluded that productivity and credit risk are substitutive when banks choose the firms' in their loan portfolio, and complementaries in the other situation. On the other hand, it is expected $\beta_5 > 0$ and $\beta_6 < 0$ (see Jiménez et al. 2012), which would highlight the cyclical behavior in the credit standards of banks.

To answer question 2 we enhance the baseline specification with interaction terms between firm controls (credit risk scoring and productivity) and macroeconomic characteristics (ΔGDP and ΔIR) to show how the cycle drives banks' lending policies and its compositional effects on banks' loan portfolio through the demand side. In particular, we consider the following model:

$$Loan\ application\ is\ granted_{bit} =$$

$$= \beta_1 TFP_{it-1} + \beta_2 SCORING_{it-1} + \beta_3 TFP_{it-1} \times SCORING_{it-12}$$
$$+ \beta_F OTHER\ FIRM\ CHARACTERISTICS_{it-12}$$
$$+ \beta_B BANK\ CHARACTERISTICS_{bt-1} + \beta_c MACRO\ CHARACTERISTICS_{\ t-1}$$

$$+ \vartheta_b + f_i$$
$$+ \beta_7 \begin{pmatrix} TFP_{it-1} \\ SCORING_{it-1} \end{pmatrix} \times MACRO\ CHARACTERISTICS_{\ t-1}$$

$$+ \beta_8 TFP_{it-1} \times SCORING_{it-1} \times MACRO\ CHARACTERISTICS_{\ t-1} + \varepsilon_{bit} \quad (2)$$

The coefficients on the cross-effects give answer to the second question about the compositional effects of the cyclicality of bank lending standards. On the one hand, we expect to have $\beta_7 > 0$ for the interactions TFP*ΔIR and SCORING*ΔGDP and $\beta_7 < 0$ for the interactions TFP*ΔGDP and SCORING*ΔIR. This would imply that banks increase their appetite for risk, softening their lending standards, when the economy is growing or during times of loose monetary policy.

Turning to the third specification, we add triple interaction terms between firms' variables, macroeconomic variables and banks characteristics, to test whether the cyclicality of the lending policy of the banks depends on the strength of their balance sheets. More specifically, in order to analyze how bank lending standards variation is related with bank characteristics, we enlarge specification (2) and estimate the following specification:

$$
\begin{aligned}
&Loan\ application\ is\ granted_{bit} = \\
&= \beta_1 TFP_{it-12} + \beta_2 SCORING_{it-1} + \beta_3 TFP_{it-1} \\
&\quad \times SCORING_{it-12} + \beta_4 OTHE\ R\ FIRM\ CHARACTERISTICS_{\ it-1} \\
&+ \beta_B BANK\ CHARACTERISTICS_{\ b,t-1} + \beta_C MACRO\ CHARACTERISTICS_{\ t-1} \\
&+ \vartheta_b + f_i + \beta_7 \begin{pmatrix} TFP_{it-1} \\ SCORING_{it-1} \end{pmatrix} \times MACRO\ CHARACTERISTICS_{\ t-1} \\
&+ \beta_8 TFP_{it-1} \times SCORING_{it-1} \times MACRO\ CHARACTERISTICS_{\ t-1} \\
&+ \beta_{Bcg} BANK\ CHARACTERISTICS_{\ b,t-1} \times MACRO\ CHARACTERISTICS_{\ t-1} \\
&+ \beta_{Bc1} BANK\ CHARACTERISTICS_{\ b,t-1} \times \begin{pmatrix} TFP_{it-1} \\ SCORING_{it-1} \end{pmatrix} \\
&+ \beta_{Bcs} BANK\ CHARACTERISTICS_{\ b,t-1} \times \begin{pmatrix} TFP_{it-1} \\ SCORING_{it-1} \end{pmatrix} \times \\
&MACRO\ CHARACTERISTICS_{\ t-1} + \varepsilon_{bit}
\end{aligned}
\tag{3}
$$

The coefficients $\beta_{Bc1}$and β_{Bc2} provide information about the variation in lending standards associated with banks' balance sheet characteristics to investigate whether the pro-cyclicality in bank lending policies is more marked in certain type of banks.

Finally, it is worth highlighting that in all the three specifications we consider a final version of the models in which we substitute bank variables and bank fixed effects by a set of bank-time fixed effects (ϑ_{bt}) to better identify supply factors beyond banks' lending standards in terms of firms productivity and credit risk.

3 Results

Table 2 reports the estimates of the baseline specification, which aims to answer the question: Does higher firms' productivity or lower firms' ex-ante credit risk increase the likelihood of a loan being granted? Does the loan granting probability depend on the economic cycle? We answer these two questions looking at column (1) of Table 1, where our variables of interest (TFP and SCORING) are included. Macroeconomic conditions are controlled using the GDP growth and the change in interest rate. In addition, a set of bank controls is also included to account for differences in time-varying fluctuations in the supply side. Unobserved time-invariant firm and bank heterogeneity are controlled through the inclusion of firm and bank fixed effects in the demand and supply side. The estimated model in column (2) includes the interaction term $\mathrm{TFP}_{\mathrm{it}-1} * \mathrm{SCORING}_{\mathrm{it}-1}$, which captures the potential complementarities between productivity and credit risk in the loan granting decision process.[10] Finally, in column (3) we substitute the bank fixed effects, the bank balance-sheet variables and the macroeconomic indicators by a set of bank-time dummies. This saturated specification allows us to identify the coefficients by exploiting variation across firms within the same month and bank in order to isolate the role of firms' productivity and ex-ante credit risk while controlling for time-varying supply factors.

According to the estimates in Table 2, an increase from 25th to 75th percentile in firm's total factor productivity rises the probability of loan granting in around 1.302 pp.,[11] while an increase from 25th to 75th percentile in firm's credit risk scoring reduces the probability of loan granting by 0.986 pp.[12] These effects are significant not only statistically but also economically. In particular, the TFP effect increases in 3.7% of the average loan granting probability (see Table 1) and the corresponding credit risk effect is –2.8%. Both effects are fairly stable across all the three specifications considered in Table 2. We therefore conclude that both dimensions are relevant in the banks' decision of loan granting.

The interaction coefficient in columns (2) and (3) can be interpreted in terms of substitutability or complementarity between the two firms' characteristics considered. Given the estimated coefficients, we conclude that firm's ex-ante credit risk and productivity are substitutes in terms of their effects on the banks' credit granting process. In particular, this result implies, for instance, that the importance of the ex-ante credit risk of the firm in the granting decision is lower among highly productive firms.

Columns (1) to (3) also show that higher interest rates or lower GDP growth contract credit availability, which reflects the cyclicality of lending standards of banks.

Turning to the next question (Does banks' assessment about firms' quality as a debtor vary over the business cycle?), we gradually saturate the baseline specification by adding interaction terms to see how banks frame their lending policies over the cycle in response to loans applicants' productivity and ex-ante credit risk. Table 3 reports the estimated coefficients for the specification in Model 2. In column (1) we only add an interaction term between firms' productivity and macroeconomic variables. In column (2) we only consider an interaction between firms' ex-ante credit risk and the macroeconomic variables. In column (3) we include

10 All variables are demeaned to keep the economic sense of all the variables in levels.
11 2.1*(0.219 – (–0.401)).
12 1.4*(–0.871 – (1.575)).

both firms' TFP and SCORING interacted with macroeconomic variables. The specification in column (4) also includes two triple interactions between TFP, SCORING and the two macroeconomic indicators to test whether the substitutability pattern identified above varies with aggregate macroeconomic conditions. All specifications from columns (1) to (4) include firm and bank fixed effects. As a robustness check, in column (5) we include a set of time fixed effects while in column (6) a set of bank-time fixed effects is included instead of the macro and bank variables. In both columns (5) and (6), the results remain virtually unaltered with respect to those of column (4) where macroeconomic and bank variables are included as controls instead of time and bank-time fixed effects.

The main conclusion from the estimates reported in Table 3 is that bank lending standards vary with macroeconomic conditions. This is so because the interaction terms of firm characteristics with macroeconomic variables are statistically significant in most cases. In particular, we estimate a negative (positive) coefficient for the interaction of TFP with GDP growth rate (ΔIR), and a positive (negative) coefficient for the interaction of *SCORING* with GDP growth (ΔIR). These findings indicate that during the expansionary phases of the cycle banks soften their lending standards implicitly increasing the risk in their loan portfolios, while they tighten lending standards during downturns so that the implicit credit risk assumed by banks is reduced. When TFP is interacted with the annual change in the overnight interest rate its coefficient is statistically significant, which can be interpreted as evidence of the impact of monetary policy in the loan portfolio composition in terms of productivity.[13] Summing up, both economic cycle and monetary policy appear to have a compositional effect on banks' loan portfolios. The former would affect loan portfolios both in terms of credit risk and productivity of the borrowers, while the latter would only change the loan portfolio composition in terms of firms' credit risk.

Turning to the economic significance of the estimated effects in column (4) of Table 3, a one percentage point increase in the GDP growth rate reduces the positive effect of firms' productivity on the probability of being granted a loan around 33% (from 0.022 to 0.015). On the other hand, a one percentage point increase in the GDP growth rate would reduce the negative effect of ex-ante credit risk on the loan granting probability in 35% (from –0.013 to –0.008). It is worth highlighting that the positive effect of firms' TFP on loan granting probability vanishes when annual GDP growth is above 3.2%, the 75th percentile in the sample. These effects remain very similar when we control for time or bank-time fixed effects in columns (5) and (6). Finally, the lack of statistical significance of the triple interaction terms (*TFP*SCORING**ΔGDP and *TFP*SCORING**ΔIR) suggests that the substitutability between credit risk and productivity discussed above does not vary with macroeconomic conditions.

Finally, we are also interested in how banks' lending policies vary with macroeconomic conditions depending on their balance sheet strength. In particular, we aim to answer the question: Do different banks account for firms' productivity and credit risk differently over the business cycle?.

Table 4 reports the coefficient estimates for the triple interaction terms of firm characteristics (TFP and SCORING) with bank characteristics (*ROA*, *LIQUIDITY, BANK CAPITAL RATIO*…) and macroeconomic variables (*GDP* and *INTEREST RATE*), which correspond to the parameters $\beta_{Bc1s}, \beta_{Bc2s}, \beta_{Bc1p}, \beta_{Bc1p}$ in specification (3) above.[14]

13 Only when firm fixed effects and bank-time fixed effects are included the coefficient for the interaction of TFP and annual overnight interest growth rate is marginally significant (p-value of 0.12), although it's economic impact is almost unaltered.

14 Other bank balance sheet variables are also included as controls in the regressions reported in Table 4 together with all the remaining controls considered in equation (3).

These coefficients would capture heterogeneous changes in banks' lending standards over the cycle as a function of banks' balance sheet characteristics. To be more concrete, we focus on three variables that reflect banks' balance sheet strength, bank's liquidity, banks net worth, and banks' return on assets. The last variable can be understood as a proxy of banks' internal efficiency and as a measure of their risk appetite, in the sense that higher risk portfolios usually led to higher returns on assets. Column (1) includes firm, bank, and time fixed effects while column (2) includes bank-time fixed effects and firms' fixed effects instead of bank and time fixed effects separately. In a few words, the estimated results indicate that less capitalized, less liquid and the more profitable banks are those that soften the more their credit standards during upturns, especially in the case of firms' ex-ante credit risk. These results are robust to the consideration of different configurations of bank- and time- fixed effects, and highlight the need to design regulatory frameworks which lead banks to adequate capitalization and liquidity management, easing the evolution of the banking business to an environment where the basis for banks profitability to be an adequate creditor risk assessment, regardless the business cycle.

4 Robustness: Credit substitution mechanisms

Our loan application database excludes loan requests from firms to their current banks, i.e. loan applications for firm-bank pairs that already have a current banking relationship are not included in our sample. This is so because banks only process information requests for firms that are not borrowing from them because they automatically receive every month information about their current borrowers' credit exposure. In this section we investigate whether this sample selection is biasing our results. In other words, we want to analyze whether firms are able to substitute credit with their current lenders, and to offset changes in credit standards over the cycle by resorting to their current banks. We check for the potential effect of this substitution mechanism by means of two different exercises: i) we first condition the analysis on firms that did not have any bank relationship in the previous period, and therefore cannot substitute credit, and, ii) indirectly, we also analyze whether a firm gets a loan from any bank (including its current lenders) given that the firm has at least one loan application to non-current banks.

Table 5 reports the results of these two exercises. Column 1 includes an additional main bank fixed effect in an attempt to control for the possible impact of the main current bank on our results. In Colum 2 we restrict the sample to those firms that don't have any credit exposures in the previous period. From Column 3 onwards we check by an indirect procedure the credit substitution mechanisms effect. We regress our explanatory variables on an indicator that takes value one if the firm gets a bank loan from any bank (including its current lender) and zero otherwise. For this specification the number of observations decrease because we collapse our main dataset at firm-time level. Column 3 reports baseline estimates and Column 4 adds an additional main bank fixed effect.

In all cases, estimates are fairly robust and remain virtually unaltered with respect to our baseline results in Table 3. We thus conclude that firms are not able to substitute credit and that sample selection in our loan applications database is not a source of concern.

4.1 Conclusions

In this paper we investigate the impact of macroeconomic conditions on the loan portfolio composition of Spanish banks. In particular, we analyze whether bank lending policies are influenced by the business cycle or the monetary policy stance. We consider two variables at the firm level that summarize banks' loan portfolio characteristics and that can be interpreted as proxies for firms' quality as debtors: firms' ex ante credit risk and firms' total factor productivity. While the former measures firms' future loan default default probability, the latter measures firms' allocative efficiency in production.

From our knowledge, this is the first paper that analyzes explicitly the role played by firms' productivity when banks assess loan applications. We study whether banks soften their credit standards during booms to tighten them during busts and show how the economic cycle and monetary policy change the appetite for risk of banks. During upturns (or episodes of loose monetary policy) banks soften their lending standards and firms with higher credit risk and lower productivity have a higher probability of being granted a loan than during recessions (or episodes of tight monetary policy).

This cyclicality in lending standards is more pronounced among less capitalized, less liquid, and more profitable banks. In this sense, changes in capital, liquidity and systemic

banks' regulation introduced by Basel III with the aim of reinforcing the financial stability, improve bank management and strengthen banks' transparency, would also smooth banks' lending-standards-cyclicality according to our results. Thus, leading to an allocation of credit better aligned with firms' productivity and credit risk in the current juncture.

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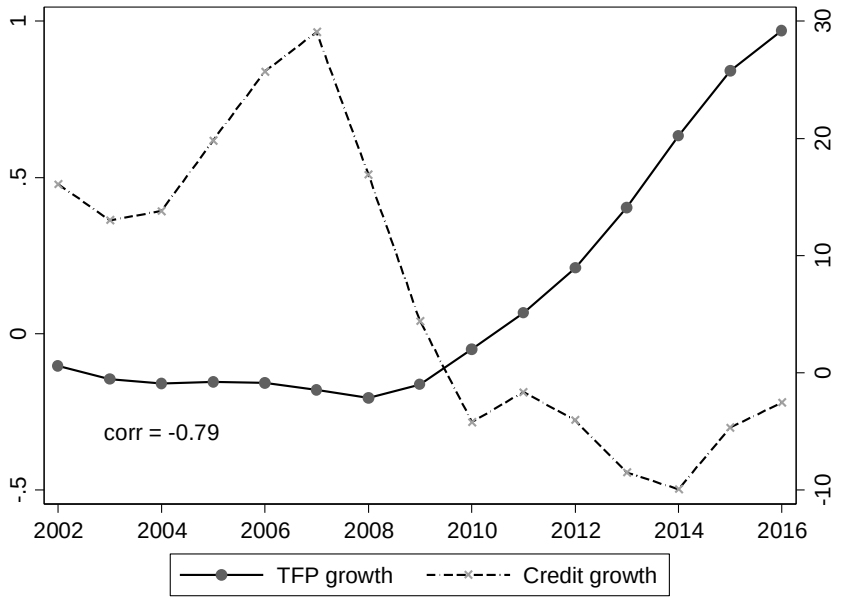
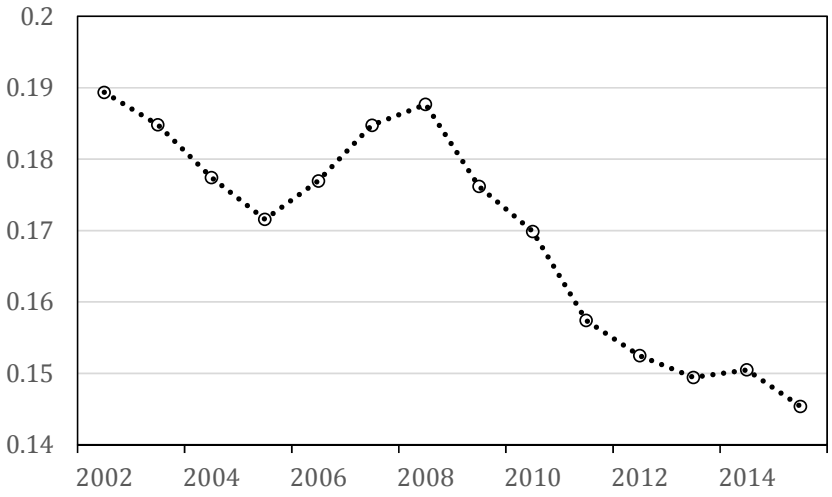
Figure 1. Credit, investment and TFP in Spain



Notes. Credit refers to bank credit to non-financial corporations taken from Banco de España and Total Factor Productivity (TFP) is sourced from (Cuadrado & Moral-Benito, 2016).

Figure 2. Average predicted firm's defaulted probability



Notes. Own calculations, from a linear probability model that provides a score for each borrower. The score is the total summation of the product between the repressors and their respective coefficients.

Table 1. Descriptive statistics

DEPENDENT VARIABLE						
	Mean	*Sd*	*Median*	*25^{pth}*	*75^{pth}*	*Max*
LOAN APPLICATION IS GRANTED$_{ibt}$	0.356	0.479	0.000	0.000	1.000	1.000
INDEPENDENT VARIABLES						
Macroeconomic conditions (t)						
	Mean	*Sd*	*Median*	*25^{pth}*	*75^{pth}*	*Max*
ΔGDP_t	0.775	2.596	0.614	-1.673	3.262	4.176
ΔIR_t	-0.279	1.183	-0.023	-0.740	0.443	1.407
Firm characteristics (i)						
	Mean	*Sd*	*Median*	*25^{pth}*	*75^{pth}*	*Max*
TOTAL FACTOR PRODUCTIVITY$_{i,t-1}$	-0.091	0.550	-0.092	-0.401	0.219	1.744
SCORING$_{i,t-1}$	-1.312	0.745	-1.170	-1.575	-0.871	1.241
ln(NUMBER OF BANK RELATIONSHIPS)$_{ibt-1}$	1.426	0.543	1.386	1.099	1.792	2.890
Bank characteristics (b)						
	Mean	Sd	Median	25^{pth}	75^{pth}	Max
ln(TOTAL ASSETS)$_{b,t-1}$	17.801	1.488	17.939	16.890	18.883	20.066
ln(LIQUIDITY RATIO)$_{b,\ t-1}$	14.755	6.607	13.929	10.210	17.810	43.229
ROA$_{b,t-1}$	0.573	0.657	0.601	0.331	0.871	2.872
ln(BANK CAPITAL RATIO)$_{b,t-1}$	-2.896	0.435	-2.912	-3.114	-2.650	-1.984
DOUBTFUL LOAN RATIO $_{b,t-1}$	5.243	5.145	4.058	0.855	7.255	22.625
SUPPLY SHOCK$_{bt}$	0.140	0.211	0.085	0.017	0.239	1.975

Notes: Table 1 reports means, standard deviations, first, second and third quartiles and maximum values for the variables considered in the analysis. The number of firms is 179,200 and the number of observations 921,637. The definition of the variables can be found in the Appendix.

Table 2. Baseline specification: Lending Standards over the Credit Cycle

Dependent variable: Loan Granted ibt=1 if the bank b grants a loan requested by firm i at time t within the period t to t+3, and equals zero otherwise			
	(1)	(2)	(3)
$PRODUCTIVITY_{it-1}$	0.023***	0.021***	0.021***
	(0.002)	(0.002)	(0.002)
$SCORING_{it-1}$	-0.015***	-0.014***	-0.014***
	(0.002)	(0.002)	(0.002)
$\ln (BANK\ RELATIONSHIPS+1)_{it-1}$	-0.129***	-0.129***	-0.121***
	(0.008)	(0.008)	(0.008)
ΔGDP_{t-1}	0.021***	0.021***	
	(0.002)	(0.002)	
$\Delta INTEREST\ RATE_{t-1}$	-0.014***	-0.014***	
	(0.004)	(0.004)	
$PRODUCTIVITY_{it-1}*SCORING_{it-1}$		0.022***	0.022***
		(0.002)	(0.002)
Observations	921,637	921,637	921,672
Firms	179,200	179,200	179203
Banks	174	174	174
R-squared	0.289	0.289	0.290
Firm Fixed Effect	YES	YES	YES
Bank Fixed Effect	YES	YES	YES
Firm-Time Fixed effect	NO	NO	YES
Time periods, months	167	167	167

Notes: The table reports estimates from our baseline specification. Column 2 adds the interaction for the firms' quality variables to capture differences in the slope for the probability of loan granting to allocative efficiency for firms with a certain level of risk. Bank covariates ($SUPPLY_{bt}$; TOTAL $ASSETS_{bt}$; LIQUIDITY $RATIO_{bt}$; ROA_{bt}; BANK CAPITAL $RATIO_{bt}$; DOUBTFUL LOANS $RATIO_{bt}$) are also included but their coefficients are not reported. We report standard errors in brackets. The dependent variable we use is a binary indicator that takes the value 1 if loan is granted by bank b to firm i in period t, and zero otherwise. See Table A.1 for the definition of the variables. One star denotes significance at the 10% level, two stars denotes significance at the 5% level and three stars denotes significance at the 1% percent level. For the definition of the variables see Appendix.

Table 3. Analyzing Compositional Effects of the cyclicality of lending standards: Bank-risk Taking

Dependent variable: Loan Granted ibt=1 if the bank b grants a loan requested by firm i at time t within the period t to t+3, and equals zero otherwise						
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
$PRODUCTIVITY_{it-1}$	0.022***	0.0209***	0.022***	0.022***	0.022***	0.022***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
$SCORING_{it-1}$	-0.014***	-0.014***	-0.014***	-0.014***	-0.013***	-0.013***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
ΔGDP_{t-1}	0.0217***	0.0216***	0.022***	0.022***		
	(0.002)	(0.002)	(0.002)	(0.002)		
$\Delta INTEREST\ RATE_{t-1}$	-0.014***	-0.014***	-0.014***	-0.014***		
	(0.004)	(0.004)	(0.004)	(0.004)		
$PRODUCTIVITY_{it-1}*SCORING_{it-1}$	0.021***	0.025***	0.024***	0.024***	0.023***	0.023***
	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
$PRODUCTIVITY_{it-1}*\Delta GDP_{t-1}$	-0.007***		-0.007***	-0.007***	-0.006***	-0.008***
	(0.001)		(0.001)	(0.001)	(0.001)	(0.001)
$PRODUCTIVITY_{it-1}*\Delta INTEREST\ RATE_{t-1}$	0.003**		0.003*	0.003*	0.003	0.004**
	(0.002)		(0.002)	(0.002)	(0.002)	(0.002)
$SCORING_{it-1}*\ln(\Delta GDP)_{t-1}$		0.005***	0.005***	0.005***	0.005***	0.004***
		(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
$SCORING_{it-1}*\Delta INTEREST\ RATE_{t-1}$		-0.003**	-0.003**	-0.003**	-0.003**	-0.002
		(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
$PRODUCTIVITY_{it-1}*SCORING_{it-1}*\Delta GDP_{t-1}$				-0.001	-0.001	-0.001
				(0.001)	(0.001)	(0.001)
$PRODUCTIVITY_{it-1}*SCORING_{it-1}*\Delta INTEREST\ RATE_{t-1}$				0.001	0.001	0.001
				(0.002)	(0.002)	(0.002)
Observations	921,637	921,637	921,637	921,637	921,637	921,287
Firms	179,200	179,200	179,200	179,200	179,200	179145
Banks	174	174	174	174	174	173
R-squared	0.289	0.289	0.289	0.289	0.292	0.313
Firm Fixed Effect	YES	YES	YES	YES	YES	YES
Bank Fixed Effect	YES	YES	YES	YES	YES	NO
Time Fixed Effect	NO	NO	NO	NO	YES	NO
Bank-time fixed effect	NO	NO	NO	NO	NO	YES
Time periods, months	167	167	167	167	167	167

Notes: Table 3 reports estimates that enhance specification in Table 2 by adding interaction terms for the firms' quality and macroeconomic variables to capture differences in the slope for the probability of loan granting over the cycle. Bank covariates ($SUPPLY_{bt}$; TOTAL $ASSETS_{bt}$; LIQUIDITY $RATIO_{bt}$; ROA_{bt}; BANK CAPITAL $RATIO_{bt}$; DOUBTFUL LOANS $RATIO_{bt}$) are also included but their coefficients are not reported here. Standard errors are reported in brackets. The dependent variable we use is a binary indicator that takes the value 1 if loan is granted by bank b to firm i in period t, and zero otherwise. See Table A.1 for the definition of the variables. Scoring is defined as a measure of ex- ante risk that recaps firm's predicted probability of default in any of the 36 following months after a loan granted. Fifteen variables based on firms' financial ratios, balance sheet characteristics (financial indebtedness, solvency, liquidity, profitability, and expertise), structure and credit history plus its quadratic, cubic and fourth power are the set of information to compute the numerical value for the scoring. See Table A.1 for the definition of the variables. One star denotes significance at the 10% level, two stars denotes significance at the 5% level and three stars denotes significance at the 1% percent level. For the definition of the variables see Appendix.

Table 4. Heterogeneous lending standards over the credit cycle by type of bank

Dependent variable: Loan Granted$_{ibt}$=1 if the bank b grants a loan requested by firm i at time t within the period t to t+3, and equals zero otherwise		
	(1)	(2)
PRODUCTIVITY$_{it-1}$*ΔGDP$_{t-1}$*LIQUIDITY RATIO$_{bt-1}$	-0.00006	-0.00006
	(0.000)	(0.000)
PRODUCTIVITY$_{it-1}$*ΔGDP$_{t-1}$*ROA$_{bt-1}$	-0.00096	-0.00083
	(0.001)	(0.001)
PRODUCTIVITY$_{it-1}$*ΔGDP$_{t-1}$*BANK CAPITAL RATIO$_{bt-1}$	0.006***	0.006***
	(0.002)	(0.001)
SCORING$_{it-1}$*ΔGDP$_{t-1}$*LIQUIDITY RATIO$_{bt-1}$	-0.0002**	-0.0002*
	(0.000)	(0.000)
SCORING$_{it-1}$*ΔGDP$_{t-1}$*ROA$_{bt-1}$	0.003***	0.003***
	(0.001)	(0.001)
SCORING$_{it-1}$*ΔGDP$_{t-1}$*BANK CAPITAL RATIO$_{bt-1}$	0.001	0.001
	(0.002)	(0.002)
PRODUCTIVITY$_{it-1}$*ΔINTEREST RATE$_{t-1}$*LIQUIDITY RATIO$_{bt-1}$	-0.001**	-0.0004
	(0.000)	(0.000)
PRODUCTIVITY$_{it-1}$*ΔINTEREST RATE$_{t-1}$*ROA$_{bt-1}$	-0.00038	-0.002
	(0.004)	(0.004)
PRODUCTIVITY$_{it-1}$*ΔINTEREST RATE$_{t-1}$*BANK CAPITAL RATIO$_{bt-1}$	-0.00478	-0.007
	(0.004)	(0.004)
SCORING$_{it-1}$*ΔINTEREST RATE$_{t-1}$*LIQUIDITY RATIO$_{bt-1}$	0.0004*	0.0003
	(0.000)	(0.000)
SCORING$_{it-1}$*ΔINTEREST RATE$_{t-1}$*ROA$_{bt-1}$	-0.010***	-0.009***
	(0.004)	(0.003)
SCORING$_{it-1}$*ΔINTEREST RATE$_{t-1}$*BANK CAPITAL RATIO$_{bt-1}$	-0.00133	-0.003
	(0.003)	(0.003)
Observations	921,637	921,252
Firms	179,200	179,142
Banks	174	173
R-squared	0.293	0.313
Firm Fixed Effect	YES	YES
Bank Fixed Effect	YES	NO
Time Fixed Effect	YES	NO
Bank and Time Fixed Effect	NO	YES
Time periods, months	167	167

Notes: The table reports estimates that enhance specification in Table 3, by adding interaction terms for the firms' quality variables with banks and macroeconomic variables to capture cyclical fluctuations in the slopes that would reveal a heterogeneous change in banks' lending standards over the cycle. Productivity, Scoring, Bank covariates (SUPPLY$_{bt}$;TOTAL ASSETS$_{bt}$; LIQUIDITY RATIO$_{bt}$; ROA$_{bt}$; BANK CAPITAL RATIO$_{bt}$; DOUBTFUL LOANS RATIO$_{bt}$) and all the double and triple interactions between and macroeconomic variables are included as a controls although not reported here. Standard errors are in brackets. The dependent variable is a binary indicator that takes the value 1 if loan is granted by bank b to firm i in period t, and zero otherwise. Scoring is defined as a measure of ex- ante risk that recaps firm's predicted probability of default in any of the 36 following months after a loan is granted. Fifteen variables (firms' financial ratios, balance sheet characteristics such as financial indebtedness, solvency, liquidity, profitability, and expertise, firms' structure and credit history plus its quadratic, cubic and fourth power are the set of information used to compute the numerical value for the scoring. See Table A.1 for the definition of the variables. One star denotes significance at the 10% level, two stars denotes significance at the 5% level and three stars denotes significance at the 1% percent level. For the definition of the variables see Appendix.

Table 5. Robustness, credit substitution effects

	(1)	(2)	(3)	(4)
Dependent variable: (If a Loan is Granted by a firm i by a bank b within the period t to t+3)=1, zero otherwise	**A new bank**		**A (new or current) bank**	
$PRODUCTIVITY_{it-1}$	0.022***	0.023***	0.025***	0.024***
	(0.002)	(0.002)	(0.002)	(0.002)
$SCORING_{it-1}$	-0.012***	-0.011***	-0.033***	-0.034***
	(0.002)	(0.002)	(0.002)	(0.002)
ln (BANK RELATIONSHIPS+1)$_{it-1}$	-0.130***	-0.132***	-0.126***	-0.129***
	(0.008)	(0.008)	(0.006)	(0.006)
ΔGDP_{t-1}	0.021***	0.021***	0.030***	0.030***
	(0.002)	(0.002)	(0.001)	(0.001)
ΔINTEREST RATE$_{t-1}$	-0.014***	-0.014***	-0.020***	-0.020***
	(0.004)	(0.004)	(0.002)	(0.002)
$PRODUCTIVITY_{it-1}*SCORING_{it-1}$	0.024***	0.024***	0.021***	0.026***
	(0.002)	(0.003)	(0.002)	(0.002)
$PRODUCTIVITY_{it-1}*\Delta GDP_{t-1}$	-0.007***	-0.007***	-0.003***	-0.003***
	(0.001)	(0.001)	(0.001)	(0.001)
PRODUCTIVITY $_{it-1}*\Delta$INTEREST RATE$_{t-1}$	0.003*	0.003*	0.004**	0.004**
	(0.002)	(0.002)	(0.002)	(0.002)
$SCORING_{it-1}*\ln(\Delta GDP)_{t-1}$	0.005***	0.005***	0.008***	0.008***
	(0.001)	(0.001)	(0.001)	(0.001)
$SCORING_{it-1}*\Delta$INTEREST RATE$_{t-1}$	-0.003**	-0.003*	-0.005**	-0.005**
	(0.001)	(0.001)	(0.002)	(0.002)
Observations	911,967	793,363	834,372	834,360
R-squared	0.289	0.306	0.356	0.359
Firm Fixed Effect	YES	YES	YES	YES
Bank Fixed Effect	YES	YES	NO	NO
Main Bank Fixed Effect	YES	NO	NO	YES
Time Fixed Effect	NO	NO	NO	NO
Bank-time fixed effect	NO	NO	NO	NO
Firms	176,770	173,727	171,353	171,350
Banks	174	171	-	-
Time periods, months	167	167	167	167
Sample restricted (Banks relationships$_{t-1}$=0)	NO	YES	NO	NO

Note: Table 5 reports robustness checks regarding previous estimates. Bank covariates ($SUPPLY_{bt}$; TOTAL $ASSETS_{bt}$; LIQUIDITY $RATIO_{bt}$; ROAbt; BANK CAPITAL $RATIO_{bt}$; DOUBTFUL LOANS $RATIO_{bt}$) are also included but their coefficients are not reported here. Standard errors are reported in brackets. The dependent variable in Columns 1 and 2 is a binary indicator that takes the value 1 if loan is granted by bank b to firm i within the period t and t+3, and zero otherwise. Columns 2 reports estimates for the subsample of firms with zero bank relationships in the previous period. The dependent variable in Columns 3 and 4 is a binary indicator that takes the value 1 if loan is granted by bank b (new or current) to firm i within the period t and t+3 and zero otherwise. Columns 1 to 3 reports estimates at bank-firm-time level.Column 4 reports estimates at firm-time level. See Table A.1 for the definition of variables. Scoring is defined as a measure of ex- ante risk that recaps firm's predicted probability of default in any of the 36 following months after a loan granted. Fifteen variables based on firms' financial ratios, balance sheet characteristics (financial indebtedness, solvency, liquidity, profitability, and expertise), structure and credit history plus its quadratic, cubic and fourth power are the set of information to compute the numerical value for the scoring. See Table A.1 for the definition of the variables. One star denotes significance at the 10% level, two stars denotes significance at the 5% level and three stars denotes significance at the 1% percent level. For the definition of the variables see Appendix.

Appendix

Variable Name	Unit	Definition
Dependent variables		
$I(\text{GRANTING OF LOAN APPLICATIONS})_{tbi}$	%	A dummy variable, which equals 1 if the loan application made in month t to bank *b* by firm i is successful and the loan is granted in t to t+3, and equals cero otherwise.
Independent variables		
Firm characteristics		
$PRODUCTIVITY_{it}$	0.0x%	Total Factor Productivity (TFP), computed as the residual in a production function, where output is measured as real value added and three inputs are considered (labor, capital and intermediate materials
$SCORING_{it}$	1	Firm's likelihood to fulfill her commitments with any bank based on lagged balance sheet information: financial ratios, financial indebtedness, solvency, liquidity, profitability, and expertise, structure, credit history and provincial and sectorial dummies,plus their quadratic, cubic and fourth power
$\ln(\text{BANK RELATIONSHIPS}+1)_{it}$	0.0x%	Log of the number of loans that a firm holds with a bank each period plus one,
Macroeconomic conditions		
ΔGDP_{t-1}	%	Annual growth of rate of Spanish gross domestic product in real terms at t-1
$\Delta \text{INTEREST RATE}_{t-1}$	%	Annual change of overnight interbank interest rate at t-1
Bank characteristics		
Total Assets_t	0.0x%	Log of the total assets in euros of the bank
ROAt	0.0x%	Banks' return on assets: ratio of profit before taxes over banks' average total assets
Liquidity ratio_t	0.0x%	The ratio of liquid assets that the bank holds over total assets of the bank
$\text{Ln(Bank capital ratio)}_t$	0.0x%	The logged ratio of equity over bank total assets
$\text{Doubtful loans ratio}_t$	0.0x%	Ratio of doubtful loans over total loans
Supply shock_t	0.0x%	Difference in the residuals of two weighted linear regressions where the dependent variable is the bank credit growth from period t and period t=0 (January 2002), over total credit granted by each bank in t=0 and t, where the former includes firms fixed effects and the latter firms and banks fixed effects

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