Credit Supply and Monetary Policy:
Identifying the Bank Balance-Sheet Channel with Loan Applications

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We analyze the impact of monetary policy on the supply of bank credit. Monetary policy affects both loan supply and demand, thus making identification a steep challenge. We therefore analyze a novel, supervisory dataset with loan applications from Spain. Accounting for time-varying firm heterogeneity in loan demand, we find that tighter monetary and worse economic conditions substantially reduce loan granting, especially from banks with lower capital or liquidity ratios; responding to applications for the same loan, weak banks are less likely to grant the loan. Finally, firms cannot offset the resultant credit restriction by applying to other banks. (*JEL* E32, E44, E5, G21, G28)

Do contractive monetary policy and adverse economic conditions reduce bank loan supply (Bernanke and Gertler (1989), Bernanke and Gertler (1995))? And does the reduction in credit availability depend on bank balance-sheet strength (Bernanke and Gertler (1987), Bernanke and Blinder (1988), Bernanke (2007))? That is, do agency costs of borrowing between banks and their financiers – proxied by bank capital- and liquidity-to-total-assets ratios as in Holmstrom and Tirole (1997) and Diamond and Rajan (forthcoming) for example – make lending significantly more problematic during periods of higher monetary policy rates or lower economic activity? Put differently, is a bank balance sheet channel operational, and if so, and how potent is it?

To convincingly answer these questions two major identification challenges need to be addressed. First, the supply of credit needs to be disentangled from its demand. Tighter monetary conditions and lower economic growth may reduce both loan supply <u>and</u> demand. Supply may contract because – as already indicated – agency costs of banks may increase, but demand may contemporaneously fall because firm net worth and expectations for investment are reduced and the cost of financing is higher.[1] In addition, firms affected more by monetary and economic conditions may borrow more from affected banks (Gertler and Gilchrist (1994)). All this implies that any analysis based only on macro data (Bernanke and Blinder (1992)) or bank level data (Kashyap and Stein (2000)) may suffer from an omitted-variables problem. Second, if country business cycle conditions completely determine short-term interest rate changes, which may be the case in many countries (e.g., through a Taylor (1993)-rule), separating the effects of monetary conditions from those of economic activity is problematic.

Our main contribution to the literature consists in taking crucial steps in addressing both identification challenges. In particular, we analyze the effects of monetary conditions and economic activity on the granting of loans with individual loan application records depending on the strength of bank balance-sheets measured by bank capital and liquidity ratios,

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[1] See Bernanke and Gertler (1995) and Bernanke, Gertler and Gilchrist (1996). The external finance premium in lending depends inversely on the borrowers' net worth (see Freixas and Rochet (2008)). When borrowers have little wealth at stake, the potential divergence of interests between the borrower and the suppliers of external funds is larger, increasing agency costs. In equilibrium, lenders must be compensated. As borrower net worth is pro-cyclical (because profits and asset prices are pro-cyclical), the external finance premium is countercyclical, amplifying the changes in credit availability (Bernanke, Gertler and Gilchrist (1999), Matsuyama (2007)). In Holmstrom and Tirole (1997) the agency problems depend on the capital-to-total-assets ratio, in Bernanke, Gertler and Gilchrist (1999) net worth is also associated with the liquidity of the assets. Since banks not only face agency problems with their borrowers, but banks themselves are also borrowing funds from their depositors and other financiers, bank net worth may determine their own agency costs of borrowing (Bernanke (2007), (Gertler and Kiyotaki (2010)). See also Stiglitz and Weiss (1981). Boivin, Kiley and Mishkin (2010) review the recent literature review.

controlling for time-varying observed and unobserved firm heterogeneity with firm-month fixed effects (i.e., there is a dummy for every firm – year: month combination). The data are from Spain, a country where most firms are bank dependent and where monetary policy has been fairly exogenous.

Unique features of the *Credit Register* of Spain (CIR), which is collected by the *Banco de España* acting in its capacity as bank supervisor, help us to attain identification. During the last nine years the CIR recorded all monthly information requests lodged by banks on borrowers. Because banks monthly receive information on all outstanding loans and defaults of their current borrowers from CIR, they only file information requests following *loan applications* from firms that are currently not borrowing from them. Because the CIR database also contains detailed monthly information on *all*, new and outstanding, loans (over 6,000 Euros) to non-financial firms granted by all credit institutions operating in Spain since 1984, we can match the set of corresponding loan applications with the loan that is actually granted by a bank. The loans granted to noncurrent borrowers surely do not involve simply the renewal or evergreening of outstanding loans. Moreover, *Banco de España* has complete monthly bank balance-sheet information also collected in its role as bank supervisor and has access to key firm characteristics, including *identity*. We analyze 2,335,321 loan applications in total.

The unique features of the CIR allow us to address the two major identification challenges. First, to separate bank loan supply from demand we study loan applications and exploit theoretically motivated interactions between economic and monetary conditions on the one hand and bank balance-sheet strength variables on the other (Bernanke, Gertler and Gilchrist (1996), Kashyap and Stein (2000)). The definition of the bank capital- and liquidity-to-total-assets ratios we employ closely follows the theoretical literature that attributes a prominent role to net worth in reducing the agency costs of borrowing (Holmstrom and Tirole (1997), Holmstrom and Tirole (1998), Bernanke, Gertler and Gilchrist (1999), Gertler and Kiyotaki (2010)), which sharpens the interpretation of the coefficients on their interactions with monetary and economic conditions.

To achieve identification we further focus on the set of *loan applications* made *in the same month by the same borrower* or *for the same loan* to different banks of varying balance-sheet strengths (by including in the specifications firm-month or alternatively loan fixed effects). Within this set of loan applications, for which the (observed and unobserved) quality of potential borrowers is constant as in the credit crunch definition by Bernanke and Lown (1991), we study how monetary and economic conditions affect the granting of loans

depending on bank capital and liquidity. Moreover, we analyze whether firms that get rejected in their initial loan application can undo the resultant reduction in credit availability by successfully applying to other banks.

Second, to distinguish between the impact of monetary and economic conditions, we rely on the observation that monetary policy in Spain has been fairly exogenous during the sample period. Spain accounts for around 10% of the Euro area output and as a peripheral country its business cycle did not converge with those of the core countries of the Euro area (Giannone, Lenza and Reichlin (2010)).

Our study yields the following robust results: Higher short-term interest rates or lower GDP growth reduce the probability that a loan application is granted. The negative effect of higher short-term interest rate on loan granting is statistically stronger for banks with low capital or liquidity, whereas the negative effect of lower GDP growth is statistically stronger for banks with low capital.[2] The estimated effects are also economically relevant. A 100-basis-point increase (decrease) in the interest rate (GDP growth) reduces loan granting by weak banks by 11 (5) percent more than by strong banks (i.e., a weak bank is in the 10th percentile in both bank capital and liquidity, a strong bank is in the 90th percentile).

All findings are robust to multiple controls, in particular to the inclusion of firm-month or loan fixed effects, implying that *within* the set of applications made in the same month or for the same loan by the same firm to different banks, banks with weaker balance-sheets grant fewer loan applications when short-term interest rate are higher or when GDP growth is lower. The first evidence – we think – that clearly identifies that, under tighter monetary or economic conditions, low bank capital or liquidity begets a credit crunch. Finally, we find that firms that get rejected in their initial loan application cannot undo the resultant reduction in credit availability by applying to other banks, especially in periods of tighter monetary and economic conditions.

Overall our results suggest that the strength of bank balance-sheets plays a statistically significant and economically relevant role in channeling changes in short-term interest rates and economic growth to the availability of credit. The rest of the paper proceeds as follows.

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[2] Loan applications have been available only during the last nine years. Hence, we also analyze the impact of monetary and economic conditions on the intensive margin of lending by employing all granted business loans in Spain during the 1988:Q2-2008:Q4 period. We saturate the specifications – which we further leave unreported – with firm-quarter fixed effects to account for unobserved (and observed) time-varying firm heterogeneity, where 80 percent of the credit volume is from firms with multiple banking relationships. We similarly find that for the same firm borrowing from at least two different banks in the same quarter the amount borrowed from the weaker bank declines more when monetary or economic conditions are tighter.

Section I presents the hypotheses we test, the database we analyze, and the empirical strategy we employ. Section II explains the variables in detail, and presents and discusses the results. Section III concludes and discusses the policy implications.

I.   Hypotheses, Data and Empirical Strategy

A. *Hypotheses*

The theory modeling how monetary and economic conditions affect loan supply, which we briefly summarized in the Introduction, yields two key testable hypotheses:

(H1) Higher short-term interest rates or lower GDP growth contract credit availability.

(H2) The negative impact of higher short-term interest rates or lower GDP growth on credit availability is stronger for banks with lower capital or liquidity.

We address the main identification challenge with monthly loan application data and an empirical strategy based on interactions of monetary and economic conditions with bank capital- and liquidity-to-total-assets ratios and combinations of fixed effects, notably firm-month or loan fixed effects.[3] We first discuss the data set and then the empirical strategy we employ.

B. *Data*

The *Credit Register* of the *Banco de España* (CIR) contains confidential information on virtually *all* business loans granted by *all* banks operating in Spain. In particular, we focus on applications for commercial and industrial (C&I) loans (82 percent of total loans) by non-financial publicly limited and limited liability companies (that account for around 95 percent of all firms) to commercial banks, savings banks and credit cooperatives (that account for

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[3] A large empirical literature has investigated the bank- and firm-balance sheet channels of monetary policy and the business cycle independently, with the analysis done at either the bank or the firm level. On the bank side, see Bernanke and Blinder (1992), Jayaratne and Morgan (2000), Kashyap and Stein (2000), Kishan and Opiela (2000), Ashcraft (2006) and Black, Hancock and Passmore (2009), among others. On the firm side, see Gertler and Gilchrist (1994) and Bernanke, Gertler and Gilchrist (1996), for example. The literature accounted for loan demand through observed firm characteristics like industry or by interactions between economic/monetary conditions and bank/firm characteristics. There is also an empirical literature analyzing the balance sheet channels, see Gan (2007), Khwaja and Mian (2008), Chaney, Sraer and Thesmar (2009) among others. However, as far as we are aware, no paper so far has analyzed loan applications *and* included firm-month fixed effects to account for observed and unobserved time-variation in firm loan demand and quality. As we argue in this Section, loan applications and firm-time fixed effects are *both necessary* to identify the bank lending channel of monetary policy.

more than 95 percent of the entire Spanish financial system).[4] The CIR is almost comprehensive, as the reporting threshold for a loan is only 6,000 Euros. Given that we consider only C&I loans, this threshold is very low which alleviates any concerns about unobserved changes in bank credit to small and medium sized enterprises (which may be more influenced by changes in monetary policy and business cycle under the credit channel theory for example).[5] More than 350 banks and 130,000 firms are active in the CIR at any moment in time.

All banks in Spain automatically receive monthly updated information on the total current credit exposures and (possible) loan defaults – vis-à-vis all banks in Spain – of their own current borrowers. This information is extracted for the banks from the CIR. Any bank can also request this information on potential borrowers, which are defined as "any firm that seriously approaches the bank to obtain credit." The monetary cost of requesting this information is zero. But a Law stipulates that a bank cannot ask for the information without consent by the potential borrower, indicating a seriousness of intent regarding the "financial relationship between bank and firm."

We observe *all* requests for information on potential borrowers after 2002:02 (before this date the requests were not stored). Though the requests can be made at any time, they are collated monthly and uniquely link borrowers with banks. Requests for information on firms that are currently borrowing from the requesting bank would yield information that is already known to this bank. Consequently, requesting information from the CIR is only useful if the firm has never before received a loan from the bank (that is requesting the information) or when the relationship between the firm and the bank ended before. In this way, the information requests focus on a key category of borrowers that do not simply renew or even evergreen existing loans at their current bank, but that seek new loans from another bank, i.e., the extensive margin of new lending.[6]

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[4] Delgado, Salas and Saurina (2007) explain the main features of the Spanish banking system, focusing on the differences in behavior of commercial banks, savings banks and credit cooperatives. All of them compete under the same rules. See also Jiménez, Salas and Saurina (2006).

[5] See e.g. Gertler and Gilchrist (1993), Gertler and Gilchrist (1994), Bernanke and Gertler (1995) and Bernanke, Gertler and Gilchrist (1996). The Credit Register contains more than 2,400,000 loans in the last month of 2008. The commercial and financial loans we study in this paper represent 82.6 percent of all loans that are granted (excluding leasing, factoring and other specialized loans). Incomplete coverage of the widely used U.S. (National) Survey of Small Business Finances or Loan Pricing Corporation datasets for example may complicate any analysis of bank lending.

[6] Since we cannot observe firm loan applications to their current banks, we also study firms that do not have any bank loan outstanding at the time of the loan application in robustness. These firms are noncurrent for all banks and hence we have the loan applications from all the banks. Credit needs and application propensity for this set

We analyze all requests lodged until 2008:12. Following the intensification of the crisis during the autumn of 2008 the European Central Bank took unprecedented action via both standard and non-standard measures, altering the operation of the bank lending channel of monetary policy we wish to investigate. Nonetheless, in robustness we analyze our benchmark regression to an extension of the sample period to 2010:06.

For each request lodged between 2002:02 and 2008:12, we also observe whether the loan is accepted and granted, or not, by matching the loan application database with the CIR database, which contains the stock of all loans granted. Therefore, if multiple banks request information on a particular borrower within a three-month period, we can infer the bank that granted the loan and the banks that did not (results are unaltered when we use two- and one-month matching periods). In case a bank requests information but does not grant the loan, either the bank denied the firm credit or the firm perceived the offered conditions by the bank to be less attractive than those of the loan it eventually took. Hence, we can link loan granting for the same firm within each month to bank balance-sheet strength.

We match the application dataset with bank and firm datasets, so that we have balance-sheet information for each bank that receives a loan application and/or grants a loan and for each firm that applies for a loan. The banks' dataset, at a monthly frequency starting in 1984, is owned by the *Banco de España* in its role as banking supervisor. The firms' dataset is available from the Spanish Mercantile Register at a yearly frequency and commences in 1992. We can match (to the firm level data) 816,852 loan applications constituting the starting sample.[7]

C. *Empirical Strategy*

As we have the loan applications plus bank characteristics, in particular their capital and liquidity ratios as measures of their balance sheet strength, plus firm characteristics including

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of firms may also be more similar. Notice that approximately one fifth of the loans to borrowers entirely new to the bank are granted without any information request on record during the last sample quarter. This statistic shows that while the monetary cost of requesting the information is zero, non-pecuniary costs may not be. For example, an information request may slight borrowers (whose consent is required), involves waiting, uses management time processing the information, and/or may result in a loss of reputation vis-à-vis the *Banco de España* if prospects turn idle. Especially for the very good or connected borrowers that don't take a "check-and-wait" for an answer or during economic expansions when capacity constraints at the bank become binding, these non- pecuniary costs may be relevant. Banks may further not request information about the largest firms for example because these firms deal with many banks, are well-known, and/or do not seek regular loans. Our unreported empirical work on the intensive margin using *all* the actual loans granted to *all* firms addresses ensuing concerns on this account.

[7] When the firm characteristics are replaced in the specifications by the various sets of fixed effects we commence again from the initial sample of 2,335,321 loan applications.

identity, we are able to better disentangle the supply from the demand for loans. Through the loan applications, loan demand for each bank is in a sense given and observed, and each bank has to decide only on the granting of each loan – "its loan supply" – knowing the firm. As far as we are aware, ours is the first paper that analyzes the impact of monetary and economic conditions on the probability loans are granted following *applications* from firms.

To analyze the bank lending channel we exploit the cross-sectional implications of the sensitivity of credit availability to monetary and economic conditions according to the strength of the bank balance sheets (see e.g. Kashyap and Stein (2000)). Following the theoretical literature we focus on bank net worth and liquidity. Because of lack of data, most other studies had to rely on size or debt as a proxy for net worth. Following Holmstrom and Tirole (1997) we define net worth as the capital-to-total-assets ratio.[8] Following Bernanke and Gertler (1995), Kashyap and Stein (2000) and Gertler and Kiyotaki (2010) we also feature a liquidity measure. As many banks actively deal with loan applications there is ample cross-sectional variation in both measures. To maximize variation in balance sheet strengths across banks, we follow Kashyap and Stein (2000) and control for key time-varying bank characteristics (and only in robustness we include bank fixed effects).

Last but not least, to fully convincingly identify bank loan supply changes (as in the definition of Bernanke and Lown (1991)) we focus on models that include either firm-month or loan fixed effects. Such models analyze the success of loan applications made by the same firm within the same month (or within three months for the same loan) to multiple banks that possibly differ in capital and liquidity. If monetary and economic conditions affect firm balance sheet strength and/or loan demand (Bernanke and Gertler (1995)), identification of loan supply requires controlling for all observed <u>and</u> unobserved time-varying firm heterogeneity through either firm-month or loan fixed effects. To analyze and quantify the *total* effect of monetary and economic conditions on loan granting, we can only include observable firm characteristics and firm fixed effects in the specifications, thereby inevitably weakening loan supply identification. Therefore, we report specifications with and without firm-month or loan fixed effects.

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[8] Off-balance sheet volumes are very small in Spain. Hence, total bank assets cover most of the banks' businesses. Banks did not develop conduits or Structured Investment Vehicles (SIVs) because the prevailing accounting rules made banks consolidate these items and set aside sufficient capital.

Finally, we investigate whether the loan supply restrictions we identified so far are binding and cannot be fully offset by firms turning to other banks.[9] Since firms may shift their applications between banks of different balance sheet strengths possibly neutralizing the supply effect measured with loan applications, we also study the success of future loan applications by firms that were either denied credit or, in general, the granting of any bank loans for firms that had applied to at least one bank.

Monetary policy in Spain has been fairly exogenous during the last twenty years, first when it was linked to the Bundesbank and then, as of January 1, 1999, within the Eurosystem (see Banco de España (1997) and Jiménez et al. (2008)). Moreover, economic conditions in Germany (or the other core Euro area countries) and Spain were only weakly correlated during the sample period. Consequently, there is a significant exogenous variation in monetary conditions allowing us to disentangle its effects from those of local Spanish economic conditions.

Motivated by Bernanke and Gertler (1989), Bernanke, Gertler and Gilchrist (1999), Ruckes (2004), and Dell'Ariccia and Marquez (2006), among others, and because of the presence in our sample of many small firms we concurrently study the effect of both monetary and economic conditions on lending to firms. Though the current recession in Spain for example was partly initiated by the financial crisis abroad providing a modicum of exogeneity to its start, in general economic conditions are hardly exogenous to bank lending. But, for a given firm, economic conditions are fairly exogenous and, in key specifications, all time-varying firm heterogeneity will be absorbed by firm-month fixed effects. Therefore, both to analyze the impact of economic conditions on loan granting and as a key control for monetary conditions (i.e., in a Taylor-rule setting GDP growth determines short-term interest rates for example), we also feature economic conditions in all benchmark regressions. In robustness we nevertheless also exclude it (and its interactions).

To analyze the bank lending channel, we use simple measures of monetary and economic conditions, i.e., the change in a short-term interest rate and GDP growth, which we detail and motivate further soon. To complete our specifications we include inflation, as an important economic determinant of short-term interest rates, and month, or firm-month, fixed effects that control for other macroeconomic factors.

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[9] We analyze substitution of credit whithin the bank system given both the time frequency of the available data and the fact that Spain has a bank-dominated financial system and, therefore, bank loans constitute the majority of firm debt.

II. Dependent Variable, Independent Variables and Results

In this section we provide the main results of the paper. We first define the main dependent variable, the independent variables, and the estimated specifications. Then we discuss the results.

A. *Main Dependent Variable: LOAN APPLICATION IS GRANTED*

Table 1 defines the dependent and independent variables employed in the first set of empirical specifications, as well as their descriptive statistics. The dependent variable we feature first is LOAN APPLICATION IS GRANTED (we recurrently shorthand this as "loan granting"), which equals one if the loan application by firm i at time t is approved by bank b and the loan is granted in month t to $t+3$, and equals zero otherwise (results are unaffected if the loan is granted in t to $t+1$ or in t to $t+2$). The average value of *loan granting* equals 42 percent (Appendix A reports the number of loan applications and the loan granting probabilities simply by bank and firm capital ratio and total assets; some of the patterns that arise will be overturned in our analysis that controls for many more bank and firm characteristics and includes firm or firm-month fixed effects).

We match each loan application with its relevant bank and firm characteristics, in particular firm identity. The inclusion of firm (or firm-month) fixed effects in a logit (or probit) model naturally restricts the sample to those firms that filed at least one application that did result in a loan granted and one application that did not during the sample period (or in a month). To avoid this selection problem we employ linear probability models in the main regressions, but study logit models in robustness. An additional advantage of employing linear probability models is that for the interaction terms, the main focus of the analysis, the estimated coefficients are directly interpretable and the standard errors require no corrections.[10]

B. *Independent Variables*

As independent variables we include an array of macroeconomic conditions and bank/firm characteristics to control for changes in the quality and the propensity during the business cycle of different type of firms to apply for loans to a potentially varying set of banks that

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[10] In non-linear models the ordinarily reported standard errors and marginal effects of interacted variables require corrections (Ai and Norton (2003), Norton, Wang and Ai (2004)). For the benchmark specification we compare the standard errors of the linear probability model, with the non-corrected and corrected standard errors of the logit model. In all cases the results are very similar.

TABLE 1 -- SUMMARY STATISTICS

Variable	Units	Definition	Mean	SD	Min	P25	Median	P75	Max
Dependent variable									
LOAN APPLICATION IS GRANTED$_{bt}$	0/1	=1 if the loan application by a firm is approved and the loan is granted by a bank, =0 otherwise	0.42	0.49	0	0	0	1	1
Independent Variables									
Macroeconomic conditions (t)									
ΔIR_t	%	Annual change of Spanish 3-month interbank interest rates	0.19	0.83	-1.56	-0.48	0.19	0.98	1.41
ΔGDP_t	%	Annual change of Spanish gross domestic product in real terms	3.13	0.93	-0.85	2.95	3.35	3.78	3.98
ΔCPI_t	%	Annual change of Spanish Consumer Price Index	3.33	0.77	1.43	2.67	3.40	3.89	5.27
Bank characteristics (b)									
BANK CAPITAL RATIO$_{bt-1}$	%	The ratio of bank equity over total assets of the bank	5.37	2.07	0.00	4.00	4.82	6.05	63.15
BANK LIQUIDITY RATIO$_{bt-1}$	%	The ratio of 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	17.02	8.03	0.04	11.23	15.83	21.79	92.07
Ln(TOTAL ASSETS$_{bt-1}$)	-	The log of the total assets of the bank	17.39	1.47	9.57	16.40	17.61	18.53	19.90
TOTAL ASSETS$_{bt-1}$	000,000 EUR	The total assets of the bank	78.00	87.60	0.01	13.30	44.20	112.00	437.00
ROA$_{bt-1}$	%	The total net income over assets of the bank	0.94	0.55	-8.93	0.66	0.91	1.12	11.92
DOUBTFUL LOANS RATIO$_{bt-1}$	%	The doubtful loan ratio of the bank	0.83	0.85	0.00	0.34	0.56	0.96	31.24
HERFINDAHL BY INDUSTRY$_{bt-1}$	%	The Herfindahl-Hirschman index of the bank's credit portfolio by industry	26.35	8.86	12.77	20.02	23.20	30.43	87.94
Firm characteristics (i)									
FIRM CAPITAL RATIO$_{it-1}$	%	The ratio of own funds over total assets of the firm	24.52	20.73	0.00	8.35	18.67	35.19	100
FIRM LIQUIDITY RATIO$_{it-1}$	%	The ratio of current assets over total assets of the firm	41.14	26.91	0.00	18.03	38.26	61.31	100
TOTAL ASSETS$_{it-1}$	000 EUR	The total assets of the firm	6.98	75.95	0.00	0.47	1.32	3.91	27,200.00
Ln(TOTAL ASSETS$_{it-1}$)	-	The log of the total assets of the firm	7.26	1.62	0.86	6.16	7.19	8.27	17.12
AGE$_{it-1}$	years	The age of the firm	10.30	9.25	0	4	8	14	132
Ln(1+AGE$_{it-1}$)	-	The log of one plus the age of the firm	2.10	0.86	0.00	1.61	2.20	2.71	4.89
ROA$_{it-1}$	%	The return on assets of the firm	6.46	9.74	-36.07	2.19	4.89	9.09	63.16
I(DOUBTFUL LOANS AT THE TIME OF THE REQUEST$_{it-1}$)	0/1	=1 if the firm had doubtful loans the month before the loan was requested, =0 otherwise	0.01	0.09	0	0	0	0	1
I(DOUBTFUL LOANS BEFORE THE TIME OF THE REQUEST$_{it-1}$)	0/1	=1 if the firm had doubtful loans before the previous month to the loan was requested, =0 otherwise	0.09	0.29	0	0	0	0	1
NUMBER OF MONTHS WITH THE BANK$_{ibt-1}$	months	The duration of the relationship between firm and bank	7.84	23.48	0	0	0	0	278
Ln(1+NUMBER OF MONTHS WITH THE BANK$_{ibt-1}$)	-	The log of one plus the duration of the relationship between firm and bank	0.63	1.36	0	0	0	0	5.63
NUMBER OF BANK RELATIONSHIPS$_{ibt-1}$	-	The number of banks the firm is currently borrowing from	3.90	3.66	0	1	3	5	102
Ln(1+NUMBER OF BANK RELATIONSHIPS$_{ibt-1}$)	-	The log of the number of bank relationships of the firm	1.35	0.65	0	0.69	1.39	1.79	4.63
Industry characteristic (s)									
INDUSTRY DOUBTFUL LOANS RATIO$_{st-1}$	%	The doubtful loan ratio of the industry in which the firm operates	0.91	0.60	0.06	0.44	0.73	1.31	4.91
Province characteristic (p)									
NUMBER OF BANKS$_{pt-1}$	-	The number of banks in the province where the firm is located	116.52	32.52	11	90	111	148	179
Ln(NUMBER OF BANKS$_{pt-1}$)	-	The log of the number of banks in the province where the firm is located	4.72	0.29	2.40	4.50	4.71	5.00	5.19

Notes: The number of observations equals 816,852. t: 1 to 83, b: 1 to 184, i: 1 to 267,618 s: 1 to 10, and p: 1 to 52. EUR = 2008 Euros.

request information and approve the loans. The specifications do not include the characteristics of the loans that are granted, because these are the outcome of the application and granting process, but loan fixed effects that comprehensively account for loan-level quality heterogeneity are included later (Appendix B provides summary statistics for all 346,884 loans granted; Appendix C provides the mean loan characteristics by total firm assets).

1. Macroeconomic Conditions

As macroeconomic conditions we include a short-term interest rate measure of the annual changes in monetary policy conditions, annual GDP growth, and the annual inflation rate. According to Hypothesis 1 (H1) we expect the coefficient on the interest rate to be negative and the coefficient on GDP growth to be positive.

Our measure for the changes in monetary conditions, ΔIR, is the change in the Spanish 3-month interbank interest rate during the last year. The average change in the 3-month interest rate during the sample period was 0.23 percent, ranging between -1.56 and 1.41 percent. The use of variations in the short-term interest rate as a measure that proxies the change in the stance of monetary policy is fully in line with the literature analyzing the credit channel at the micro level.[11] Our main results are unaffected if we employ the level rather than the change in this interest rate. The use of a 3-month interest rate is in line with many articles in Angeloni, Kashyap and Mojon (2003) for example that also use European data. Using the change in the overnight interbank interest rate yields very similar results, not surprisingly as the correlation between the two series equals 0.95.

GDP growth, ΔGDP, is available only quarterly, while both the interest rate changes and the inflation rate are measured monthly. Hence, to be consistent with the frequency of loan applications and the other macroeconomic measures, we interpolate GDP growth for all intermediary months (results are unaffected if we do not interpolate). Thus defined, GDP growth averages 3.14 percent and varies between -0.85 and 3.98 percent. Finally, the average inflation rate, ΔCPI, during the sample period was 3.33 percent, with the minimum and maximum were 1.43 and 5.27 respectively.

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[11] See Jayaratne and Morgan (2000), Kishan and Opiela (2000), Ashcraft (2006) and Black, Hancock and Passmore (2009) among others. Kashyap and Stein (2000) find very similar results using either the variation in the federal funds rate, the Boschen and Mills (1995) index or the Bernanke and Mihov (1998) measure.

2. Bank Characteristics

The summary statistics of Table 1 are based on the observations used in the first three regressions (that include only firm fixed effects). Bank balance-sheet data is taken at the end of the previous month (t-1) and bank performance information over the previous month. We employ lagged values as monetary and economic conditions may determine the capital and liquidity ratios banks optimally choose.

The key bank balance-sheet variables we are interested are the bank's CAPITAL RATIO as a measure of the bank's net worth and the LIQUIDITY RATIO as a measure of its' liquidity position (to distinguish them clearly from the corresponding firm ratios we add BANK in their label). The capital ratio is defined as the ratio of core capital over total assets of the bank (as in Bernanke and Lown (1991) for example). Core capital is defined as total equity plus retained earnings. As we use the book value of equity and assets are not risk adjusted, our measure is equivalent to a pure leverage ratio. Thus defined it has an average value of 5.4 percent. Unlike in the U.S., there is no regulated minimum leverage ratio in Spain; hence its minimum is very low (but results are not driven by this institutional difference as we show in robustness).

The LIQUIDITY RATIO is the ratio of liquid assets held by the bank (i.e., cash and deposits with central banks and other credit institutions, and public debt with a maturity up to one year) and the total assets of the bank. Banks on average held almost 17 percent of their balance-sheet in liquid assets.

Lending behavior may vary across banks, hence we control for bank variables that may affect bank lending (and in robustness also feature bank fixed effects). We therefore include: Ln(TOTAL ASSETS), the log of the total assets of the bank (in 2008 Euros); ROA, the return on assets of the bank; DOUBTFUL LOANS RATIO, the doubtful loan ratio of the bank; and the HERFINDAHL BY INDUSTRY, the Herfindahl-Hirschman index of the bank's credit portfolio by industry.

3. Firm Characteristics

The composition of the pool of borrowers may change over time and different firms may have different degrees of success in obtaining loans from banks. To control for these changes on the demand-side, we include a broad set of firm characteristics and firm fixed effects. This set of effects controls for time-invariant unobserved firm heterogeneity. Later we introduce encompassing firm-month or loan fixed effects to account for all time-variant firm heterogeneity.

As firm-risk variables we feature: The CAPITAL RATIO, which is the ratio of own funds over total assets of the firm; the LIQUIDITY RATIO, the current assets over total assets of the firm; Ln(TOTAL ASSETS), the log of the total assets of the firm (in 2008 Euros); Ln(1+AGE), the log of one plus the age of the firm in years; ROA, the return on assets of the firm; I(DOUBTFUL LOANS AT THE TIME OF THE REQUEST), a dummy variable that equals one if the firm had doubtful loans the month before the loan was requested, and equals zero otherwise; and, I(DOUBTFUL LOANS BEFORE THE TIME OF THE REQUEST), a dummy variable that equals one if the firm had doubtful loans any time previous to the month before the loan was requested, and equals zero otherwise.

As firm – bank relationship variables we include: Ln(1+NUMBER OF MONTHS WITH THE BANK), which is the log of one plus the number of months that the firm had a working relationship with the bank (i.e., had outstanding loans with the bank; though the firm currently does not borrow from the bank as we are analyzing borrowing from new banks, the firm may have previously borrowed from the bank); and, Ln(1+NUMBER OF BANK RELATIONSHIPS), the log of the number of bank relationships of the firm.

As an industry time-varying characteristic we include INDUSTRY DOUBTFUL LOANS RATIO, which is the doubtful loan ratio of the industry in which the firm operates to control for the probability of loan rejections over the business cycle in the industry of the firm. As a province time-varying characteristic, we include Ln(NUMBER OF BANKS) which is the log of the number of banks in the province where the firm is located (a province in Spain roughly corresponds to a Metropolitan Statistical Area in the United States), and which may capture the number of banks that a firm can approach and the intensity of local bank competition.[12]

C. *Specifications*

The specifications we estimate are at the loan application level and we match the loan application outcomes (whether the loan is granted or not) with the associated macroeconomic, bank, firm, industry, and province information. That is, we control for – and exploit – the strength of the balance sheets of the banks associated with each loan application. Our empirical specifications assessing the probability a loan application is granted are broadly structured as follows (variable names are abridged):

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[12] All time-invariant firm characteristics, likely industry affiliation, location etc., are comprised by the firm fixed effects that are included in the specifications.

$$LOAN\ GRANTED_{ibt}$$

(1)
$$= \beta_I \Delta IR_t + \beta_G \Delta GDP_t + \beta_{IC} \Delta IR_t * CAP_{bt-1} + \beta_{IL} \Delta IR_t * LIQ_{bt-1}$$
$$+ \beta_{GC} \Delta GDP_t * CAP_{bt-1} + \beta_{GL} \Delta GDP_t * LIQ_{bt-1} + macro_t$$
$$+ bank_{bt-1} + firm_{it-1} + other_{t-1} + \varepsilon_{ibt}$$

The coefficients on the change in the short-term interest rate (*IR*) and GDP growth (*GDP*), and their interactions with bank capital (*CAP*) and liquidity (*LIQ*), comprise our two hypotheses. The null of Hypothesis 1 is: $\beta_I < 0$ and $\beta_G > 0$. The null of Hypothesis 2 is: $\beta_{IC} > 0$, $\beta_{IL} > 0$, $\beta_{GC} < 0$, and $\beta_{GL} < 0$. The sets of macro, bank, firm and other variables will be replaced consecutively by appropriate combinations of fixed effects. In particular we first feature firm fixed effects, then additively introduce both firm and month fixed effects, and finally, introduce firm and month fixed effects multiplicatively (i.e., firm-month) or include loan fixed effects.[13]

D. *Results*

We first discuss the estimated impact of monetary and economic conditions (ΔIR and ΔGDP) and, second, and more importantly, the estimated coefficients of the interactions between the economic and monetary conditions and the strength of the bank balance sheets – proxied by BANK CAPITAL RATIO and BANK LIQUIDITY RATIO.

1. Economic and Monetary Conditions

Table 2 reports for the baseline linear probability model the estimated coefficients, in a second column the standard errors that are clustered at the bank-month level, i.e., the level at which the interaction terms – which are the main focus of our analysis – vary (see Moulton (1986) for example),[14] and followed in a third column by the corresponding significance levels.

We start analyzing the direct effects of monetary and economic conditions on the probability that the LOAN APPLICATION IS GRANTED. In Model (1) of Table 2 we find that short-term interest rate hikes reduce loan granting while GDP growth spurs loan granting (i.e., consistent with H1). A 100-basis-point change in the interest rate or GDP (their standard

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[13] In robustness, we further control for bank fixed effects and other variables.

[14] ΔGDP is interpolated from a quarterly series; we alternatively aggregate and cluster at the bank-quarter level. We also multi-cluster errors simultaneously at the bank, firm, and month level (as in Cameron, Gelbach and Miller (2011)) and employ the procedure advocated by Petersen (2009). The key specifications from Table 2 are included in Appendix E.

TABLE 2 -- REGRESSION RESULTS, LOAN GRANTING AND MONETARY CONDITIONS
(*dependent variable: LOAN APPLICATION IS GRANTED $_{ibt}$*)

Independent variable	Model (1) Coefficient	S.E.	(2) Coefficient	S.E.	(3) Coefficient	S.E.	(4) Coefficient	S.E.	(5) Coefficient	S.E.	(6) Coefficient	S.E.	(7) Coefficient	S.E.
Macroeconomic controls (t)														
ΔIR_t	-1.394	0.254 ***	-5.960	0.625 ***										
ΔIR_t*BANK CAPITAL RATIO$_{bt-1}$			33.384	6.973 ***	29.991	6.979 ***	28.566	6.822 ***	30.081	7.737 ***	19.873	5.681 ***	49.477	16.241 ***
ΔIR_t*BANK LIQUIDITY RATIO$_{bt-1}$			15.396	1.951 ***	13.343	2.044 ***	11.548	2.019 ***	12.269	2.286 ***	5.190	1.926 ***	10.412	4.537 **
ΔGDP_t	4.734	0.256 ***	6.769	0.552 ***										
ΔGDP_t*BANK CAPITAL RATIO$_{bt-1}$			-28.580	6.725 ***	-28.728	6.539 ***	-31.426	5.669 ***	-37.078	5.994 ***	-25.668	3.175 ***	-12.594	15.468
ΔGDP_t*BANK LIQUIDITY RATIO$_{bt-1}$			-3.340	2.433	-2.916	2.525	-1.602	2.035	-1.877	2.166	-2.375	1.109 **	6.947	4.945
ΔCPI_t	-0.081	0.183	-0.027	0.183										
Bank characteristics (b)														
BANK CAPITAL RATIO$_{bt-1}$	-0.671	0.058 ***	0.225	0.218	0.187	0.214	0.308	0.184 *	0.389	0.191 **	0.175	0.093 *	-0.810	0.503
BANK LIQUIDITY RATIO$_{bt-1}$	-0.069	0.017 ***	0.032	0.080	0.011	0.084	-0.075	0.066	-0.062	0.070	-0.055	0.035	-0.489	0.162 ***
LN(TOTAL ASSETS$_{bt-1}$)	0.001	0.001	0.001	0.001	0.001	0.001	-0.001	0.001	-0.003	0.001 ***	0.001	0.001	-0.006	0.002 ***
ROA$_{bt-1}$	0.447	0.275	0.473	0.267 *	0.758	0.259 ***	1.252	0.233 ***	1.355	0.261 ***	1.434	0.218 ***	1.371	0.533 **
DOUBTFUL LOANS RATIO$_{bt-1}$	0.307	0.154 **	0.355	0.151 **	0.237	0.146	0.158	0.145	0.136	0.164	-0.286	0.088 ***	-0.693	0.337 **
HERFINDAHL BY INDUSTRY$_{bt-1}$	0.031	0.016 *	0.057	0.016 ***	0.075	0.016 ***	0.016	0.015	0.018	0.017	0.002	0.014	0.056	0.033 *
Firm characteristics (i)														
FIRM CAPITAL RATIO$_{it-1}$	0.015	0.009 *	0.015	0.009 *	0.019	0.009 **								
FIRM LIQUIDITY RATIO$_{it-1}$	-0.003	0.005	-0.003	0.005	-0.003	0.005								
Ln(TOTAL ASSETS$_{it-1}$)	0.000	0.002	0.000	0.002	0.001	0.002								
Ln(1+AGE$_{it-1}$)	0.020	0.005 ***	0.018	0.005 ***	0.026	0.004 ***								
ROA$_{it-1}$	0.082	0.010 ***	0.083	0.010 ***	0.083	0.010 ***								
I(DOUBTFUL LOANS AT THE TIME OF THE REQUEST$_{it-1}$)	-0.092	0.009 ***	-0.092	0.009 ***	-0.090	0.009 ***								
I(DOUBTFUL LOANS BEFORE THE TIME OF THE REQUEST$_{it-1}$)	-0.037	0.007 ***	-0.037	0.007 ***	-0.033	0.007 ***								
LN(1+NUMBER OF MONTHS WITH THE BANK$_{ibt-1}$)	0.006	0.001 ***	0.007	0.001 ***	0.007	0.001 ***	0.010	0.001 ***	0.013	0.001 ***	0.011	0.001 ***	0.026	0.004 ***
Ln(1+NUMBER OF BANK RELATIONSHIPS$_{ibt-1}$)	-0.162	0.003 ***	-0.162	0.003 ***	-0.161	0.003 ***								
Industry characteristic (s)														
INDUSTRY DOUBTFUL LOANS RATIO$_{st-1}$	-0.597	0.193 ***	-0.712	0.192 ***	-1.109	0.180 ***								
Province characteristic (p)														
LN(NUMBER OF BANKS$_{pt-1}$)	0.109	0.014 ***	0.110	0.014 ***	0.107	0.014 ***								
Firm Fixed Effects	yes		yes		yes		--		--		--		--	
Month Fixed Effects	no		no		yes		--		--		--		--	
Firm-Month Fixed Effects	no		no		no		yes		no		yes		yes	
Loan Fixed Effects	no		no		no		no		yes		no		no	
Number of Observations	816,852		816,852		816,852		328,891		263,042		427,364		55,025	
Number of Bank-Month Clusters	9,910		9,910		9,910		8,714		8,310		10,637		6,022	
Sample Period	2002:02-2008:12		2002:02-2008:12		2002:02-2008:12		2002:02-2008:12		2002:02-2008:12		2002:02-2010:06		2002:02-2008:12	

Notes: The table reports the estimated coefficients and robust standard errors (S.E.) clustered at the bank-month level from linear probability models estimated using least squares. The sample employed in Model (7) includes only borrowers that are noncurrent to all banks. Fixed effects are included ("yes"), not included ("no"), or comprised by another set of fixed effects that are included ("--"). The set of month fixed effects includes a fixed effect for every (but one) year:month during the sample period. The variable definitions and summary statistics are in Table 1.

    *** Significant at the 1 percent level.
     ** Significant at the 5 percent level.
      * Significant at the 10 percent level.

deviations equal 83 and 92 basis points, respectively) changes the probability a loan application is granted by 1.4 and 4.7 percentage points, respectively. As the average probability of *loan granting* equals 42 percent, the estimated semi-elasticities equal 3.3 and 11.2 percent, respectively.

But of course the specification is still incomplete. Though a comprehensive set of observable firm characteristics and firm fixed effects is included, the specifications do not yet account for unobserved time-variant firm heterogeneity (i.e., changes over time in the quality in the pool of applicant firms that apply for and obtain loans from different banks) nor identify the effects of the changes in monetary and economic conditions on loan granting through the strength of the balance sheets of banks. Before tackling both issues, we discuss the coefficients on the bank and firm characteristics once and, then, turn back to the focus of our study.

2. Bank and Firm Characteristics

The estimated coefficients on a number of bank and firm characteristics are across all specifications statistically significant, economically relevant, stable and in line with straightforward priors. These results suggest therefore that these controls are at once needed and relevant.

More solvent and liquid banks are less prone to lend to new borrowers. Riskier banks (i.e., with higher NPL ratios and more industry concentrated loan portfolios) have a higher probability of granting loans to new borrowers. These results are further robust to the inclusion of firm-month or loan application fixed effects for example (unreported). Therefore, either using capital and liquidity ratios or other measures of bank strength, we find a negative sign. The introduction of interactions of bank capital and liquidity with the change in the interest rate or GDP growth rate reverses the signs on these variables.

The coefficient on firm capital and liquidity are only marginally or not significant, though capital becomes significant in models featuring interactions of bank capital and liquidity with economic and monetary conditions. Loan applications from older and more profitable firms, from firms with fewer doubtful loans at or prior to the loan application or from an industry with a lower doubtful loan ratio, and from firms with longer and fewer bank relationships located in a province with many banks may be more successful in applying. Hence, *ceteris paribus* more firms with a stronger balance-sheet and with a longer and more impeccable track record can rely more on external financing (as in Jensen and Meckling (1976)), and so can firms with stronger and bilateral relationships in competitive banking markets (see

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Freixas and Rochet (2008) and Degryse, Kim and Ongena (2009) for reviews of theory and empirical evidence).

Overall, we find these estimated coefficients reasonable and their statistical significance and stability reassuring for our investigation of the different credit channels (as the working of these channels require the imperfect substitutability between external and internal financing that is especially acute for small and opaque firms).

3. Bank Balance Sheet Channel

Model (2) analyzes the impact of monetary and economic conditions on loan granting through the bank balance sheet channel. Model (2) therefore includes the interactions of the change in the short-term interest rate and GDP growth with bank capital and liquidity ratios suggested by Hypothesis 2 (H2). As explained in the previous Sections, interest rate changes and GDP growth are not highly correlated in Spain because of the relatively low level of synchronization of economic activity in Spain vis-à-vis the largest euro area countries, even after 1999 (Giannone, Lenza and Reichlin (2010)). This allows us to exploit simultaneously the variation in monetary conditions and output interacted with bank capital and liquidity.

The estimates in Model (2) suggest that the negative effect of positive changes in the short-term interest rate or lower GDP growth on the probability that a LOAN APPLICATION IS GRANTED is stronger for banks with low capital or liquidity. To put it differently, "weaker" banks are more pro-cyclical (in interest rate or GDP) in terms of loan granting than stronger ones. Hence overall H2 is confirmed.

We now further explore the economic relevance of these estimated effects. We calculate the difference in semi-elasticities following changes in the short-term interest rate or GDP growth for banks with a low versus high capital or liquidity ratio (10th versus 90th percentile, as in Kashyap and Stein (2000)), i.e., at banks with a capital ratio of 3.5 versus 8.4 percent or a liquidity ratio of 7.7 versus 27.7 percent.

A 100-basis-point increase in the interest rate decreases loan granting by lowly capitalized banks by 3.9 percent more than by highly capitalized banks, and by 7.3 percent more by lowly than by highly liquid banks. Therefore, weak banks (with both low capital and liquidity) on average decline loan granting by 11.4 percent more than strong banks. A 100-basis-point decrease in GDP growth decreases loan granting by lowly capitalized banks by 3.4 percent more than by highly capitalized banks, and by 1.6 percent more by lowly than by

highly liquid banks (the latter difference is not statistically significant however).[15] Hence, the change in the interest rate for the bank lending channel has a much larger differential impact in this case on loan granting than a similarly-sized change in GDP growth (recall that their standard deviations were both close to 100 basis points), though the effect goes especially through bank liquidity.

Our estimates capture the <u>immediate</u> impact on the <u>probability</u> of loan granting across <u>all</u> banks.[16] The estimated effects are sizeable, yet the total impact on bank lending may be even larger if banks are slow to react to the changes in monetary or economic conditions for example. The estimates strongly suggest that the bank balance sheet channel of monetary policy is very potent.

4. Various Effects Models

We now present the estimates of various fixed effects models in the rest of Table 2. In Model (3) we add month fixed effects to the firm fixed effects. The set of month fixed effects includes a fixed effect for every (but one) year: month during the sample period. Month fixed effects capture the changes in economy-wide conditions, such as current and future expectations of GDP growth, inflation and interest rates and general shocks affecting the economy. Hence, all variables at the country level are dropped from the empirical model and the identification entirely comes from the interactions. The estimated coefficients are similar to those in Model (2).

In Model (4), our benchmark regression, we replace the firm and month fixed effects by firm-month fixed effects.[17] A firm-month fixed effects model accounts for the impact on loan granting of all *observed* time-varying firm characteristics (e.g., firm size and credit rating) and *unobserved* time-varying firm characteristics such as firm risk, quality, investment

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[15] The calculations are: for the interest rate: $0.039 = (0.01 * 33.384 * (0.035 - 0.084))/0.42$ and $0.073 = (0.01 * 15.396 * (0.077 - 0.277))/0.42$; for GDP: $0.034 = (-0.01 * -28.580 * (0.035 - 0.084))/0.42$ and $0.016 = (-0.01 * -3.340 * (0.077 - 0.277))/0.42$.

[16] Kashyap and Stein (2000) find that four quarters following a 100-basis-point hike in the federal funds rate the level of C&I loans of the illiquid small bank will be between 0.6 and 5.3 percent lower than that of the liquid small bank. For large banks, there may be no or even a positive effect. The ratio of securities plus federal funds sold to total assets of the small banks (< 95 percent by asset size) varies between 21 and 60 percent (i.e., the 10th versus 90th percentile). See also Bernanke and Lown (1991) who estimate that changes in credit following changes in economic conditions may be modest.

[17] Though not included in Kashyap and Stein (2000) for example, we further add bank fixed effects that capture the still-unaccounted-for bank heterogeneity that is fixed over time. We report representative estimates in Appendix G. Results are unaffected throughout, except for the coefficient on the interaction between GDP growth and bank liquidity which turns statistically significant and the coefficient on the interaction between the interest rate changes and bank capital which reduces in absolute size. The latter finding is not surprising as the largest part of variation of bank capital is between but not within banks.

opportunities, the strength of the firm's bank relationships, and access to market finance (Petersen and Rajan (1994), among others). Including the set of *all* time dummies for *each* firm in the sample implies that all the independent firm characteristics (in addition to macro variables) have to be dropped from the model. In addition, to be included in the regression a firm must have filed more than one loan application within the same month, reducing in turn the number of observations from 816,852 to 328,891 (summary statistics are provided in Appendix D). All estimated coefficients are similar to Models (2) and (3), and so is the resulting economic relevancy of these estimates. A 100-basis-point increase in the interest rate decreases loan granting by lowly capitalized banks by 3.8 percent more than by highly capitalized banks, and by 6.2 percent more by lowly than by highly liquid banks. A 100-basis-point decrease in GDP growth decreases loan granting by lowly capitalized banks by 3.4 percent more than by highly capitalized banks, and by 1.6 percent more by lowly than by highly liquid banks.[18]

In addition, in Model (5) we present estimates from a loan fixed effects model, where a firm must have filed multiple applications within the same month for the same loan to different banks that resulted in at most one granted loan. The number of observations decreases to 263,042 (summary statistics are again provided in Appendix D). Results are again very similar to Model (3).

The estimates are further robust to the inclusion of the recent exceptionally severe crisis period in Spain, which increases the number of observations to 427,364. The estimates are tabulated in Model (6). Therefore, despite the fact that monetary policy was executed in different ways during the recent crisis, the bank lending channel of monetary policy (through changes in short-term interest rates) retained its potency.

Estimates are also robust to: The inclusion of the double balance-sheet interactions with the Herfindahl-Hirschman Index of bank lending in the province;[19] the use of a logit specification (as discussed earlier employing Logit models reduce the number of observations to 155,167); the left-censoring of bank capital ratio at four percent (as in the U.S. for example); the inclusion of interactions of the change in the short-term interest rate and GDP

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[18] The calculations are: for the interest rate: 0.038 = (0.01 * 28.566 * (0.035 – 0.084))/0.37 and 0.062 = (0.01 * 11.548* (0.077 – 0.277))/0.37; for GDP: 0.042 = (-0.01 * -31.426 * (0.035 – 0.084))/0.37 and 0.009 = (-0.01 * -1.602 * (0.077 – 0.277))/0.37.

[19] If product market competition is a strong substitute for corporate governance (Giroud and Mueller (2009)), then in regions with tougher competition among banks agency costs may be reduced so that the bank balance sheet channel may be less potent. We find this to be the case for GDP - capital ratio interaction, but not for the other three interactions suggesting that in banking more competition not necessarily reduces moral hazard.

growth with all (other) bank characteristics; the removal of the interactions with GDP growth; and the inclusion of a variable capturing the number of loans the firm currently obtains from the bank. In each case, the estimates for at least the most-demanding, benchmark model using firm-month fixed effects are reported in Appendices 6 and 7.

In sum, Models (4) and (5) show that *within* the set of applications made in the same month by the same firm to different banks, and *within* the set of different applications made for the same loan, fewer loans are granted by banks with low capital or liquidity when short-term interest rate increases are larger or by banks with low capital when GDP growth is lower. Assuming that the very small changes in firm quality that occur during each month are not correlated with the quality of the approached banks − which is the case for example if firm quality is constant within each month − our results imply that under tighter conditions (e.g., tighter monetary policy or a recession) a capital crunch begets a credit crunch. This is a key result since Bernanke and Lown (1991) define credit crunch as "a significant leftward shift in the supply curve for loans, *holding constant both the safe real interest rate and the quality of potential borrowers*" (our italicizing). As far as we are aware we are the first to identify and document in such a clear-cut way (i.e., it is the *same firm* that *do apply at the same time* or for *the same loan* to several banks) the occurrence of a credit crunch.

5. Loan Applications from Current Borrowers

Our estimations so far focused on the probability that loan applications from noncurrent borrowers get approved. However, firms may initially apply to banks they currently don't borrow from, but if their applications fail return to their current lenders to obtain new loans there. These "applications of last resort" with current lenders will not trigger information requests because lenders automatically obtain monthly information from the CIR on all their current borrowers. Not including such applications may bias our findings.

To address this potential problem, Model (7) studies lending to all borrowers without any outstanding bank debt (hence borrowers without any current lender). The estimation in Model (7) is based on 55,025 loan applications made by firms that have no bank debt outstanding at *t-1*. The coefficients on the interaction terms again confirm the existence of a bank balance sheet channel of monetary policy.

6. Credit Substitution

Finally, we want to investigate whether the loan supply restrictions we identified so far are binding and cannot be fully offset by firms turning to other banks. We look at this possible

substitution mechanism in two ways: (1) directly by conditioning on firms that did not get any loan following an initial round of loan applications, and then determining whether such a firm receives a loan from an alternative bank after a new round of applications in the subsequent three months; (2) indirectly by analyzing whether a firm gets a bank loan from any bank (including its current lenders) given that the firm has at least one loan application.

The first dependent variable is FUTURE LOAN APPLICATION IS GRANTED FOLLOWING REJECTION, which equals one if at least one loan application by a firm within three months is approved and the loan is granted by a bank given that loan applications did not result in a loan, and equals zero otherwise. The upper panel in Table 3 provides the summary statistics for the 117,152 observations. The probability that at least one application within three months following a rejection is successful equals 37 percent.

We are interested both in knowing whether credit substitution is more difficult during periods of tighter monetary policy or worse economic conditions, and whether this process is affected by the strength of bank balance sheets. We control for the balance sheet quality of the assessing bank and of the average bank approached by the firm (indexed **b**), and as before for firm, industry and province characteristics (to conserve space these estimates are left unreported). Table 4 displays two representative models: Model (1) features firm fixed effects, Model (2) firm and month fixed effects.[20]

The estimated coefficients indicate that an increase in the interest rate or a decrease in GDP growth increases the probability that subsequent loan applications by a firm will be rejected (and especially when the bank is weakly capitalized or liquid).[21]

Next, we analyze the second variable called FUTURE LOAN APPLICATION IS GRANTED AFTER EARLIER APPLICATION IS MADE, which equals one if at least one loan is granted by *any* bank to a firm within the next three months given that a loan application was made in that month, and equals zero otherwise. The number of observations increases to 746,341 (from 117,152), while the mean probability that a loan is granted increases to 79 percent (from 37 percent).

Table 4 displays representative models with firm fixed effects (3) and with firm and month fixed effects (4). We find that higher interest rates or lower GDP growth reduce the

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[20] Obviously, it is not possible to answer these set of questions with firm-time fixed effects.

[21] The difference in semi-elasticities for a 100-basis-point increase (decrease) in the interest rate (GDP growth) between low and high bank capital and liquidity ratios equals 1.3 (2.5) and 4.9 (0.2) percent, respectively.

TABLE 3 -- SUMMARY STATISTICS

Variable	Units	Definition	Mean	SD	Min	P25	Median	P75	Max
Dependent variable									
FUTURE LOAN APPLICATION IS GRANTED FOLLOWING REJECTION$_{ibt}$	0/1	=1 if at least one future loan application by a firm is approved and the loan is granted by a bank given that a loan application was rejected during the previous three months, =0 otherwise	0.37	0.48	0	0	0	1	1
Independent Variables									
Macroeconomic conditions (t)									
ΔIR_t	%	Annual change of Spanish 3-month interbank interest rates	0.26	0.82	-1.56	-0.40	0.43	1.04	1.41
ΔGDP_t	%	Annual change of Spanish gross domestic product in real terms	3.01	1.09	-0.85	2.84	3.35	3.78	3.98
ΔCPI_t	%	Annual change of Spanish Consumer Price Index	3.35	0.84	1.43	2.60	3.40	3.96	5.27
Bank characteristics (b)									
BANK CAPITAL RATIO$_{bt-1}$	%	The ratio of bank equity over total assets of the bank	5.31	2.04	0.00	4.05	4.83	5.91	61.75
BANK LIQUIDITY RATIO$_{bt-1}$	%	The ratio of 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	16.50	7.86	0.04	10.77	15.52	20.99	91.62
Ln(TOTAL ASSETS$_{bt-1}$)	-	The log of the total assets of the bank	17.36	1.45	10.06	16.40	17.56	18.47	20.76
TOTAL ASSETS$_{bt-1}$	000,000 EUR	The total assets of the bank	76.50	91.00	0.02	13.20	42.40	105.00	1,030.00
ROA$_{bt-1}$	%	The total net income over assets of the bank	0.93	0.55	-8.93	0.66	0.90	1.12	11.92
DOUBTFUL LOANS RATIO$_{bt-1}$	%	The doubtful loan ratio of the bank	0.90	0.92	0.00	0.35	0.61	1.02	17.36
HERFINDAHL BY INDUSTRY$_{bt-1}$	%	The Herfindahl-Hirschman index of the bank's credit portfolio by industry	27.21	9.21	12.77	20.29	24.15	32.16	87.94
Average approached bank characteristics (b)									
BANK CAPITAL RATIO$_{bt-1}$	%	The ratio of bank equity over total assets of the bank	5.25	1.89	0.00	4.04	4.77	5.82	61.75
BANK LIQUIDITY RATIO$_{bt-1}$	%	The ratio of 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	16.37	7.48	0.04	11.03	15.53	20.65	91.37
Ln(TOTAL ASSETS$_{bt-1}$)	-	The log of the total assets of the bank	17.49	1.39	10.14	16.63	17.69	18.52	20.76
TOTAL ASSETS$_{bt-1}$	000,000 EUR	The total assets of the bank	80.80	91.20	0.03	16.70	48.20	110.00	1040.00
ROA$_{bt-1}$	%	The return on assets of the bank	0.93	0.50	-8.93	0.66	0.89	1.11	11.92
DOUBTFUL LOANS RATIO$_{bt-1}$	%	The doubtful loan ratio of the bank	0.96	1.01	0.00	0.36	0.62	1.06	31.24
HERFINDAHL BY INDUSTRY$_{bt-1}$	%	The Herfindahl-Hirschman index of the bank's credit portfolio by industry	27.10	8.69	13.88	20.58	24.45	31.61	86.67
Dependent variable									
FUTURE LOAN APPLICATION IS GRANTED AFTER EARLIER APPLICATION IS MADE$_{ibt}$	0/1	=1 if at least one future loan application by a firm is approved and the loan is granted by a bank given that a loan application was made during the previous three months, =0 otherwise	0.79	0.41	0	1	1	1	1
Independent Variables									
Macroeconomic conditions (t)									
ΔIR_t	%	Annual change of Spanish 3-month interbank interest rates	0.18	0.83	-1.56	-0.50	0.11	0.98	1.41
ΔGDP_t	%	Annual change of Spanish gross domestic product in real terms	3.13	0.92	-0.85	2.95	3.35	3.78	3.98
ΔCPI_t	%	Annual change of Spanish Consumer Price Index	3.32	0.77	1.43	2.67	3.40	3.89	5.27
Bank characteristics (b)									
BANK CAPITAL RATIO$_{bt-1}$	%	The ratio of bank equity over total assets of the bank	5.66	1.27	0.00	4.78	5.49	6.32	50.03
BANK LIQUIDITY RATIO$_{bt-1}$	%	The ratio of 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	16.88	5.35	0.04	13.14	16.22	20.07	91.21
Ln(TOTAL ASSETS$_{bt-1}$)	-	The log of the total assets of the bank	18.07	0.88	9.91	17.74	18.27	18.64	19.90
TOTAL ASSETS$_{bt-1}$	000,000 EUR	The total assets of the bank	91.90	56.30	0.02	50.40	86.20	124.00	437.00
ROA$_{bt-1}$	%	The total net income over assets of the bank	1.02	0.33	-8.93	0.84	1.00	1.17	5.25
DOUBTFUL LOANS RATIO$_{bt-1}$	%	The doubtful loan ratio of the bank	0.81	0.60	0.00	0.46	0.63	0.92	20.50
HERFINDAHL BY INDUSTRY$_{bt-1}$	%	The Herfindahl-Hirschman index of the bank's credit portfolio by industry	26.07	6.21	13.44	20.98	25.30	29.99	81.02
Selected firm characteristics (i)									
NUMBER OF BANK RELATIONSHIPS$_{ibt-1}$	-	The number of bank relationships of the firm	3.66	3.47	0	1	3	5	102
Ln(1+NUMBER OF BANK RELATIONSHIPS$_{ibt-1}$)	-	The log of the number of bank relationships of the firm	1.33	0.64	0	0.69	1.39	1.79	4.63

Notes: The number of observations equals 117,152 in the top panel and 746,341 in the bottom panel. EUR = 2008 Euros.

TABLE 4 -- REGRESSION RESULTS, LOAN GRANTING AND PAST APPLICATIONS

(*dependent variable: FUTURE LOAN APPLICATION IS GRANTED FOLLOWING REJECTION$_{ibt}$ in (1) and (2), and FUTURE LOAN APPLICATION IS GRANTED AFTER EARLIER APPLICATION IS MADE$_{ibt}$ in (3) to (6)*)

Model	(1)		(2)		(3)		(4)		(5)		(6)	
Independent variable	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.
Macroeconomic controls (t)												
ΔIR_t	-7.083	1.407 ***			-3.184	0.743 ***			-5.781	1.344 ***		
ΔIR_t*BANK CAPITAL RATIO$_{bt-1}$	23.892	10.967 **	17.980	10.618 *	12.337	7.007 *	12.486	6.942 *	39.628	16.046 **	37.993	15.600 **
ΔIR_t*BANK LIQUIDITY RATIO$_{bt-1}$	23.888	4.175 ***	15.367	3.548 ***	7.491	2.146 ***	6.643	1.679 ***	14.740	4.310 ***	13.292	3.995 ***
ΔGDP_t	5.451	0.857 ***			4.968	0.545 ***			8.162	1.156 ***		
ΔGDP_t*BANK CAPITAL RATIO$_{bt-1}$	-33.757	9.170 ***	-34.035	9.403 ***	-35.679	5.784 ***	-31.473	5.431 ***	-87.526	17.132 ***	-83.131	16.768 ***
ΔGDP_t*BANK LIQUIDITY RATIO$_{bt-1}$	0.169	2.944	-0.070	2.549	-7.539	2.283 ***	-3.200	1.486 **	0.757	4.639	4.614	4.260
ΔCPI_t	-1.363	0.553 **			-0.078	0.123			-0.099	0.120		
Bank characteristics (b)												
BANK CAPITAL RATIO$_{bt-1}$	0.084	0.095	0.035	0.093	1.284	0.198 ***	1.061	0.188 ***	2.988	0.592 ***	2.844	0.577 ***
BANK LIQUIDITY RATIO$_{bt-1}$	-0.019	0.027	-0.016	0.027	0.224	0.080 ***	0.041	0.054	-0.109	0.153	-0.229	0.139
LN(TOTAL ASSETS$_{bt-1}$)	0.001	0.001	0.001	0.001	0.003	0.001 ***	0.007	0.001 ***	0.003	0.001 ***	0.007	0.001 ***
ROA$_{bt-1}$	-0.052	0.270	0.248	0.278	0.171	0.203	0.691	0.196 ***	0.111	0.203	0.624	0.198 ***
DOUBTFUL LOANS RATIO$_{bt-1}$	-0.362	0.227	-0.240	0.240	0.282	0.182	0.132	0.179	0.222	0.183	0.098	0.181
HERFINDAHL BY INDUSTRY$_{bt-1}$	0.034	0.028	0.040	0.025	-0.026	0.020	0.073	0.020 ***	-0.013	0.019	0.075	0.020 ***
Average approached bank characteristics (b)												
BANK CAPITAL RATIO$_{\mathbf{b}t-1}$	1.083	0.287 ***	1.051	0.294 ***								
BANK LIQUIDITY RATIO$_{\mathbf{b}t-1}$	-0.016	0.089	-0.002	0.077								
LN(TOTAL ASSETS$_{\mathbf{b}t-1}$)	0.037	0.002 ***	0.036	0.002 ***								
ROA$_{\mathbf{b}t-1}$	0.952	0.437 **	1.339	0.417 ***								
DOUBTFUL LOANS RATIO$_{\mathbf{b}t-1}$	1.038	0.341 ***	1.061	0.306 ***								
HERFINDAHL BY INDUSTRY$_{\mathbf{b}t-1}$	0.111	0.029 ***	0.094	0.030 ***								
Selected Firm characteristics (i)												
Ln(1+NUMBER OF BANK RELATIONSHIPS$_{ibt-1}$)	-0.164	0.010 ***	-0.165	0.010 ***	-0.002	0.003	-0.001	0.003	0.059	0.023 **	0.070	0.024 ***
Interactions with Ln(1+NUMBER OF BANK RELATIONSHIPS)												
ΔIR_t*Ln(1+NUMBER OF BANK RELATIONSHIPS$_{ibt-1}$)									2.193	0.681 ***	2.004	0.827 **
ΔIR_t*BANK CAPITAL RATIO$_{bt-1}$*Ln(1+NUMBER OF BANK RELATIONSHIPS$_{ibt-1}$)									-21.042	9.284 **	-19.165	9.320 **
ΔIR_t*BANK LIQUIDITY RATIO$_{bt-1}$*Ln(1+NUMBER OF BANK RELATIONSHIPS$_{ibt-1}$)									-6.127	2.517 **	-5.780	2.959 *
ΔGDP_t*Ln(1+NUMBER OF BANK RELATIONSHIPS$_{ibt-1}$)									-2.304	0.657 ***	-2.275	0.711 ***
ΔGDP_t*BANK CAPITAL RATIO$_{bt-1}$*Ln(1+NUMBER OF BANK RELATIONSHIPS$_{ibt-1}$)									39.880	11.314 ***	39.325	11.185 ***
ΔGDP_t*BANK LIQUIDITY RATIO$_{bt-1}$*Ln(1+NUMBER OF BANK RELATIONSHIPS$_{ibt-1}$)									-6.113	2.805 **	-5.908	2.870 **
Ln(1+NUMBER OF BANK RELATIONSHIPS$_{ibt-1}$)*BANK CAPITAL RATIO$_{bt-1}$									-1.295	0.391 ***	-1.355	0.384 ***
Ln(1+NUMBER OF BANK RELATIONSHIPS$_{ibt-1}$)*BANK LIQUIDITY RATIO$_{bt-1}$									0.263	0.089 ***	0.215	0.089 **
Other firm (i), industry (s) and province (p) characteristics, constant	yes		yes		yes		yes		yes		yes	
Firm Fixed Effects	yes		yes		yes		yes		yes		yes	
Month Fixed Effects	no		yes		no		yes		no		yes	
Number of Observations	117,152		117,152		746,341		746,341		746,341		746,341	
Number of Month Clusters	83		83		83		83		83		83	
Period	2002:02-2008:12		2002:02-2008:12		2002:02-2008:12		2002:02-2008:12		2002:02-2008:12		2002:02-2008:12	

Notes: The table reports the estimated coefficients and robust standard errors (S.E.) clustered at the monthly level from linear probability models estimated using least squares. The set of included bank (b), firm (i), industry (s) and province (p) characteristics are the same as in Table 2. Fixed effects are included ("yes") or not included ("no"). The set of month fixed effects includes a fixed effect for every (but one) year:month during the sample period. The variable definitions and summary statistics of selected variables are in Table 1.

 *** Significant at the 1 percent level.
  ** Significant at the 5 percent level.
   * Significant at the 10 percent level.

probability of obtaining any bank loans, after an initial loan application by a firm is made (and, for monetary policy, these effects are stronger for weaker banks).

All in all, from the two models we find that a firm cannot simply turn to other banks to undo a rejection of a loan application that is due to tightening monetary or economic conditions channeled.

We interact in Models (5) and (6) the number of bank relationships (which equals the number of banks the firm is currently borrowing from) with the change in the interest rate or GDP growth, and with bank capital or liquidity. That is, we examine whether the bank lending channel is less potent as banking relationship is stronger.

Results are striking and take one additional last step in identifying a bank balance sheet channel. The estimated coefficients on the newly introduced double and triple interactions are not only statistically significant, but also economically meaningful (Appendix H). Improving conditions increase the difference between the loan granting probabilities of weak and strong banks *but* this effect is mitigated for firms that are engaged with several banks. For firms that are engaged with three banks the difference is one third the difference for firms that currently do not have a bank relationship.

III.   Conclusions and Policy Implications

Do the stance of monetary policy and business cycle fluctuations affect credit supply? And, if so, how relevant is the bank balance-sheet channel? These questions are not only key for macroeconomics in general, but also for policy-making (the handling of the current crisis in particular). However, to answer these questions there are two main identification challenges: (1) Monetary and economic conditions affect both credit demand and supply. (2) Separating the effects of monetary conditions and economic activity is also problematic as short-term interest rate changes may be completely determined by the business cycle.

Our contribution to the literature lies in meeting these two identification challenges. We use a unique and comprehensive loan-level dataset that is managed by the bank supervisor in Spain. The dataset contains for the last nine years all monthly information requests by banks following loan applications from firms that are currently not borrowing from them (we also use the information on all granted loans to non-financial firms by all credit institutions data for the last twenty years in robustness). This dataset helps us to separate loan supply from demand. Spain is a bank-dominated country with pronounced business cycles including a severe contraction under way and a fairly exogenous monetary policy.

We analyze the extensive margin of lending with loan applications and find the following two results: (1) Higher short-term interest rates or lower GDP growth reduce loan granting. (2) The negative effect of higher short-term interest rates or lower GDP growth on credit availability is stronger for banks with low capital or liquidity. Hence the monetary policy and the business cycle effects work through a bank lending channel. Moreover, within the set of different applications *from the same firm in the same month* or *for the same loan* to different banks (i.e., keeping constant the quality of potential borrowers), we find that banks with low capital or liquidity grant fewer loans when short-term interest rates are higher or GDP growth is lower. Therefore, our results suggest that, *under tighter monetary and economic conditions, a reduction in bank capital begets a credit crunch*. Finally, we investigate whether the so-identified loan supply restrictions are binding and cannot be offset by firms turning to other banks. We find they cannot, especially not by firms that have no or few existing bank relationships.

As our estimates indicate the bank lending channel is potent, the implications of our analysis for both theory and policy are generally obvious and immediate. In particular, given that we find that expansive monetary policy has more potency when bank balance sheets are weak, during a crisis like the recent one the use of monetary policy rates to support credit supply seems advisable.

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