

**Identifying Loan Supply and Firm – Bank Balance-Sheet Channels
with Loan Applications***

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Abstract

To identify the effects of economic and monetary conditions on credit supply, we analyze individual loan-level data matched with complete firm and bank information. We employ a uniquely comprehensive micro-dataset that contains monthly information on firm loan applications for the last seven years and information on all granted loans by all banks for the last seventeen years. The records are from Spain, a bank-dominated country with exogenous macroeconomic variation. We find robust evidence that both adverse economic and tight monetary conditions reduce net loan supply, particularly for firms and banks with lower capital- and liquidity-to-total-assets ratios.

Keywords: firm borrowing capacity, loan supply, business cycle, monetary policy, financial accelerator, credit channel, credit crunch, capital crunch, net worth, capital, liquidity.

JEL: E32, E44, E5, G21, G28.

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Executive Summary

Do adverse economic conditions and contractive monetary policy reduce both firm borrowing capacity and bank loan supply? If so, does the loan reduction depend equally on the firm and bank balance-sheet strength? That is, do agency problems between firms and banks and between banks and their financiers (proxied by firm and bank capital-to-total-assets ratio) make lending significantly more problematic during economic downturns or monetary contraction periods? And, does the loan reduction also depend on firm and bank liquidity? These questions are not only of direct interest to academics, but – given the current financial crisis and possible associated capital and credit crunch – also to policymakers.

To convincingly answer these questions three major identification challenges need to be addressed. First, the supply of credit needs to be disentangled from its demand. Low economic growth and tight monetary conditions may lower both loan demand and supply. Demand may fall because the expectations for investment are depressed and the cost of financing is high. Supply may contract because, as already indicated, the agency costs of lending may increase. Second, borrowers may be both balance-sheet constrained and bank-dependent, and weak firms with low-quality balance sheets may borrow more from weak banks. Estimating firm and bank balance-sheet channels simultaneously is therefore essential. Third, if country business cycle conditions completely determine short-term interest rate changes, which is the case in many countries, separating the effects of monetary conditions from those of economic activity is problematic.

Our main contribution to the literature consists in meeting these three identification challenges. We analyze a uniquely comprehensive micro-dataset that contains quarterly information for the last seventeen years on *all* granted loans to non-financial firms by *all* credit institutions matched with *both* firm and bank identity and balance-sheet data, including precise capital- and liquidity-to-total-assets ratios which proxy for net worth and balance-sheet strength in general. In addition, from 2002:M2 to 2008:M12 the dataset also identifies loan applications, information that helps to separate loan supply from demand. The dataset is from Spain, a bank-dominated country with pronounced business cycles, including a severe contraction that is under way, and a fairly exogenous monetary policy, further enabling us to disentangle GDP growth from monetary policy effects.

We find four robust results: (1) Lower GDP growth or larger increases in the short-term interest rate decrease the probability that a loan application results in a loan granted. (2) A decrease in firm capital decreases the probability that a loan application results in a loan granted. (3) A decrease in bank capital has an ambiguous effect on the probability that a loan application results in a loan granted. (4) However, the negative effect of lower GDP growth or higher short-term interest rates on the probability that a loan application results in a loan granted is stronger for both firms with low capital or liquidity and (independently) for banks with low capital or liquidity. Both the business cycle and monetary policy effects work strongly through the bank balance-sheet channel, while the level of firm capital plays a substantial role in channeling changes in GDP growth. In addition, within the set of different applications for a loan from the same firm in the same month 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 GDP growth is lower or short-term interest rates are higher. Our results therefore suggest that *under tight conditions a capital or liquidity crunch begets a credit crunch*. Moreover, weak firms not only face a higher likelihood of being rejected but also obtain fewer loans when economic and monetary conditions are tight. Hence, loan supply restrictions are binding and cannot be offset by firms turning to other banks.

Identification makes interpreting the estimated coefficients possible and allows us to draw conclusions that are relevant for the current financial crisis. In particular, our estimates have direct bearing on the effects of the developing capital and credit crunches and on the usefulness of monetary policy, recapitalizations and liquidity injections in banks and firms to ameliorate supply conditions.

I. Introduction

The dramatic events unfolding in the global economy over the last two years have again highlighted the key role played by firm and bank balance sheets in determining the supply of credit. Capital and liquidity positions of both firms and banks have been severely deteriorated by the economic slowdown following the financial crisis. Observers and policy makers alike recurrently worry about the deleterious effects of this weakening in balance sheets for the availability of credit. Many recapitalizations and liquidity injections later, and after an exceptionally expansionary monetary policy period, it is still unclear whether the important measures pursued by all major central banks and governments around the world have been adequate to avert a full-blown credit crunch.¹

But do adverse economic conditions and contractive monetary policy reduce both firm borrowing capacity and bank loan supply? And does the loan reduction depend equally on the firm and bank balance-sheet strength as in Stiglitz and Weiss (1981), Bernanke, Gertler and Gilchrist (1996), Kiyotaki and Moore (1997), Stein (1998), Bernanke, Gertler and Gilchrist (1999), Diamond and Rajan (2006), Matsuyama (2007) and Bernanke (2007)? That is, do agency problems between firms and banks and between banks and their financiers – proxied by both firm and bank capital- and liquidity-to-total-assets ratios as in Holmstrom and Tirole (1997) and Diamond and Rajan (2009) for example – make lending significantly more problematic during economic downturns or monetary contraction periods?

To convincingly answer these questions three major identification challenges need to be addressed. First, the supply of credit needs to be disentangled from its demand. Low economic

¹ Bernanke and Lown (1991) define a 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.” They further relate a credit crunch to a capital crunch and provide empirical evidence on the US economic crisis in the early 1990s (see also Peek and Rosengren (1995)). For recent evidence see for example Chari, Christiano and Kehoe (2008), Cohen-Cole, Duygan-Bump, Fillat and Montoriol-Garriga (2008), Huang (2009), Ivashina and Scharfstein (2009), Puri, Rocholl and Steffen (2009) and Tong and Wei (2009).

growth and tight monetary conditions may lower both loan demand and supply. Demand may fall because the expectations for investment are depressed and the cost of financing is high. Supply may contract because – as already indicated – the agency costs of lending may increase. Second, borrowers may be both balance-sheet constrained and bank-dependent (Gertler and Gilchrist (1994)), and weak firms with low-quality balance sheets may borrow more from weak banks.² Hence, any analysis based only on firm (or bank) level data suffers from an omitted-variables problem. Estimating firm and bank balance-sheet channels simultaneously is therefore essential, and this requires an analysis at the *individual loan level* of contract information matched with *both* firm and bank characteristics. Third, if country business cycle conditions completely determine short-term interest rate changes, which is the case in many countries (through for example a Taylor (1993)-rule setting), separating the effects of monetary conditions from those of economic activity is problematic.

Our main contribution to the literature consists in meeting these three identification challenges. In particular, we analyze the effects of economic activity and monetary conditions on the supply of bank loans at the individual loan level and account simultaneously for both firm and bank balance sheets channels. The empirical micro literature (we review later) was confined by the unavailability of comprehensive loan-level data and has mainly addressed these questions at the firm or bank level. We, instead, use a rich and comprehensive dataset of bank loan applications and loans granted, matched with extensive firm and bank identity and accounting information, from a country where most firms are bank dependent and where monetary policy has been fairly exogenous.

² Peek and Rosengren (2005) and Caballero, Hoshi and Kashyap (2008) for example argue that during the Japanese financial crisis banks with capital ratios closer to the minimum binding levels lent more to zombie firms. Hence, the quality of the banks' balance-sheets was positively correlated with the quality of the borrowing firms' balance-sheets.

The *Credit Register* of the *Banco de España* (CIR) has recorded: (1) During the last twenty-five years detailed monthly information on all, new and outstanding, loans (over 6,000 Euros) to non-financial firms by all credit institutions in Spain; (2) During the last seven years all monthly information requests by banks following loan applications from firms that are currently not borrowing from them, which totals more than 800,000 applications. Moreover, the more than fifty million granted loans on record avert any concerns about unobserved changes in bank lending and will further be used to deal with the non-randomness in bank information requests. The CIR contains loan conditions and tracks key firm and bank characteristics, including identity. Since 1992 the dataset is augmented with complete accounting information – including accurate measures of capital and liquidity – that are recorded monthly for banks and yearly for firms.

The resultant richness of the data allows us to meet the three identification challenges. First, to separate bank loan supply from demand we rely on loan-application stage information, i.e., we study the received loan applications from the borrowers and we analyze whether the business cycle and also the firm and bank balance sheet strength conditions affect the loan granting probability. In addition, we also employ theoretically motivated interactions between economic and monetary conditions on the one hand and balance-sheet strength variables on the other (Bernanke, Gertler and Gilchrist (1996), Kashyap and Stein (2000)). Our precise capital- and liquidity-to-total-assets ratios– for both firms and banks – closely follow the theoretical literature that attributes a prominent role to net worth and balance-sheet strength in general. The correspondence with the theoretical models sharpens the interpretation of the interactions of economic and monetary conditions with these ratios that serve to identify supply.

Second, to disentangle firm and bank balance-sheet channels we study micro-data (as strongly advocated by Kashyap, Stein and Wilcox (1996)) but at *the individual loan level* and

matched with *both* firm and bank complete information. In addition, not only do we control for both firm and bank variables, but also exploit all relevant interactions. Moreover, to tackle the first and second identification challenges jointly, we further focus on the set of loan applications that are made in one month by the same borrower to multiple banks of varying balance-sheet strengths. Within each such set of loan applications for which both the safe real interest rate and the quality of potential borrowers is constant as in Bernanke and Lown (1991),³ we study how bank capital and liquidity affects the granting of loans.

Third, to distinguish between the impact of real activity and monetary conditions, we rely on the observation that monetary policy in Spain has been fairly exogenous during the last twenty years. It was basically “set in Frankfurt”, first by the *Bundesbank* and then by the European Central Bank. Their mandates focused on price stability and the correlation of GDP growth between Germany (Euro Area) and Spain has never been strong. Moreover, the two economic recessions that took place during the sample period were partially triggered and/or worsened by financial and economic conditions from abroad (in particular the significant hike in the interest rate by the *Bundesbank* in 1992 / 1993 and the subprime crisis in US in 2007).

We analyze this uniquely comprehensive dataset from a bank-dominated country with a fairly exogenous monetary policy and find four robust results: (1) Lower GDP growth or higher short-term interest rate hikes reduce the probability that a loan application results in a loan granted. (2) A decrease in firm capital decreases the probability that a loan application results in a loan granted. (3) A decrease in bank capital has an ambiguous effect on the probability that a loan application results in a loan granted. (4) The negative effect of lower GDP growth or higher short-term interest rate on the probability that a loan application results

³ A firm-month fixed effects model accounts both for the *time-varying impact of observable* firm characteristics (e.g., firm size and credit rating) on loan granting and for the *impact of time-varying unobservable* firm characteristics such as the strength of the firm’s bank relationships and political connections (Petersen and Rajan (1994), Faccio (2006), among others).

in a loan granted is (statistically) stronger both for firms with low capital or liquidity and (independently) for banks with low capital or liquidity. Firm capital plays an economically relevant role when channeling changes in GDP growth. Bank capital and liquidity matter in case of both GDP growth and changes in the short-term interest rate.

All findings are robust to the inclusion of firm, bank and month fixed effects (in varying combinations). *Within* all the loan applications received by a bank in a month we find that firms with low capital or liquidity get less granted loans when the GDP growth is lower or short-term interest rates are higher. *Within* the set of different applications for a loan made in the same month by the same firm to different banks, banks with low capital or liquidity grant fewer loans when GDP growth is lower or short-term interest rates are higher. Our results, therefore, suggest that under tight conditions a bank capital or liquidity crunch begets a credit crunch.

Finally, given that the bank information requests are not random (i.e., these requests follow loan applications by firms that are currently not borrowing from the bank), and because these requests are recorded only for seven years, we also analyze the records on *all* granted loans for the extended 1992:Q1 to 2008:Q4 period. This period comprises two economic recessions. We find that lower GDP growth or higher short-term interest rate increases *similarly* decrease both the probability that a firm with low capital or liquidity obtains new loans and that a bank with low capital or liquidity grants new loans. These results, moreover, imply that weak firms not only face a higher likelihood of being rejected but also obtain fewer loans when economic and monetary conditions are tight. Hence, loan supply restrictions are binding and cannot be offset by firms turning to other banks.

Identification makes interpreting the estimated coefficients possible and allows us to draw conclusions that are relevant for the current financial crisis. In particular, our estimates have direct bearing on the effects of the developing capital and credit crunches and on the

usefulness of monetary policy, recapitalizations and liquidity injections in banks and firms to ameliorate supply conditions.

The rest of the paper proceeds as follows. Section II provides a brief review of the literature highlighting the testable hypotheses from theory and the identification challenges from the empirical studies. Section III presents our empirical strategy. Section IV explains the data in detail, and presents and discusses the results. Section V concludes and discusses the policy implications.

II. Literature Review, Testable Hypotheses and Identification Challenges

This Section provides a brief review of the literature highlighting both the testable hypotheses from theory and the identification challenges present in the empirical studies (for an excellent and short recent literature review see Bernanke (2007)).

A. Theory

In standard models of lending with asymmetric information and/or incomplete contracting, the external finance premium depends inversely on the borrowers' net worth (see Freixas and Rochet (2008) for a review). When borrowers have little wealth to contribute to the financing of their projects, 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 of the pro-cyclical nature of profits and asset prices for example), the external finance premium is countercyclical, amplifying the changes in credit availability and thus in investment, spending, and production (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 (firms), 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)). The capital-to-total-assets ratio of the bank determines its own stake and incentive to exert effort to monitor in Holmstrom and Tirole (1997). Hence, higher bank capital implies easier access to finance for banks thus allowing more lending to firms. On the other hand, higher bank capital implies lower short-term debt for banks, tightening their hard-budget constraint and decreasing their ability to provide liquidity and hence credit (Diamond and Rajan (2000)).

However, – during bad times – banks with less capital and more illiquid assets have an incentive to increase their capital and liquidity, and restrict lending due to their fear of liquidity shocks, their own needs for future liquidity, and/or the potential use of liquidity for buying distressed assets in the market (Diamond and Rajan (2009)).⁴

Finally, higher levels of short-term interest rates reduce borrowers' net worth in turn worsening the agency problems between lenders and their borrowers (Bernanke and Gertler (1995)), both between firms and their banks, and also between banks and their financiers (Bernanke (2007)).⁵

Consequently, one can distinguish the effects of business cycle and monetary policy on credit availability depending on firm and bank-balance sheet strength, i.e., through the so-called firm and bank balance-sheet channels (the latter is also known as the bank lending channel). Given the agency costs on both sides of the bank, the sketched framework exhibits a "financial

⁴ During bad times lower bank capital constrains lending because: (1) Wholesale depositors and bank investors demand higher levels of capital as a buffer for losses and to reduce bank moral hazard problems, (2) bank incentives to monitor and screen new borrowers are lower, and (3) capital levels get closer to the regulatory limits. During normal times bank equity is considerably more expensive than bank short-term debt. During bad times the situation worsens, hence it may not be optimal or feasible for bank shareholders to raise bank equity then. Banks with low levels of liquid assets similarly may try to increase their holdings of liquid assets during bad times, thus reducing new lending.

⁵ Short-term interest rates may not only affect banks' incentives for lending but also for risk-taking (Jiménez, Ongena, Peydró and Saurina (2008), Ioannidou, Ongena and Peydró (2009)).

accelerator": Endogenous developments in credit markets work to propagate and amplify economic and monetary shocks to the macroeconomy.⁶

In sum, the testable hypotheses from theory are:

(1) Loan supply is reduced by lower GDP growth (Holmstrom and Tirole (1997), Bernanke, Gertler and Gilchrist (1999), Matsuyama (2007)) and/or higher short-term interest rates (Stiglitz and Weiss (1981), Bernanke and Gertler (1995), Holmstrom and Tirole (1997)).

(2) Lower firm capital reduces firm borrowing capacity (Bernanke, Gertler and Gilchrist (1996), Holmstrom and Tirole (1997)).

(3) Lower bank capital has an ambiguous effect on loan supply (Holmstrom and Tirole (1997), Diamond and Rajan (2000)).

(4) The negative impact of lower GDP growth and/or higher short-term interest rates on loan supply is stronger for firms with low capital or liquidity, and for banks with low capital or liquidity (Stiglitz and Weiss (1981), Bernanke, Gertler and Gilchrist (1999), Diamond and Rajan (2006), Matsuyama (2007), Bernanke (2007), Diamond and Rajan (2009)).

B. Empirical Work

Due to the unavailability of comprehensive loan-level data, a large empirical literature has mostly addressed the two channels independently, with the analysis done at either the firm or the bank level. We briefly review this literature here.

Lang and Nakamura (1995) and Bernanke, Gertler and Gilchrist (1996) analyze changes in borrowing across firms in response to changes in business cycle and monetary conditions. Both studies use size as a proxy for borrower quality and find that output or monetary contractions result in more borrowing by higher-quality firms. Bernanke and Blinder (1992)

⁶ See also Stiglitz and Weiss (1981), Bernanke (1983), Bernanke and Gertler (1989), Bernanke and Blinder (1988), Stein (1998), Stiglitz and Greenwald (2003) and Diamond and Rajan (2006).

focus on the bank side. They find that a monetary contraction is followed by a significant decline in aggregate bank lending.

To better control for loan demand, Kashyap and Stein (2000) analyze whether there are also important cross-sectional differences in the way that banks respond to monetary policy shocks. They find that, following a monetary contraction, small banks with liquid balance sheets cut their lending less than other small banks. Similarly, Kishan and Opiela (2000), Jayaratne and Morgan (2000), Ashcraft (2006) and Black, Hancock and Passmore (2009) examine the differentiation across bank capitalization, core deposits, bank holding company status and bank business strategies, respectively.⁷

However, the empirical literature continues to grapple with three main identification challenges. (1) Low economic growth and tight monetary conditions lower both loan demand and supply. Analyzing the success of loan applications helps to disentangle supply from demand. Interactions of precise measures of capital and liquidity with economic and monetary conditions also assist in this identification. (2) Weak firms may borrow from weak banks. Identifying firm balance-sheet and bank lending channels simultaneously is therefore imperative; otherwise omitted variables bias the estimated coefficients. Analyzing individual loan data matched with identity and balance-sheet information of both firms and banks can counter this bias. (3) Economic conditions may determine short-term interest rates, which is the case in a Taylor-rule setting for example. Analyzing an economy, where the monetary policy rate is set fairly exogenously is of help to separate the effects of economic and monetary conditions on loan supply through the firm and bank balance-sheet channels.⁸

⁷ Khwaja and Mian (2008) for example examine the drop in lending by different banks to similar firms following shocks to banks' liquidity that are induced by unanticipated nuclear tests in Pakistan. They find that in this context banks pass their liquidity shortages to firms. But large firms, i.e., those with strong business or political ties, can turn to alternative sources in the credit market. Small firms are unable to do so.

⁸ Bernanke and Blinder (1992) and Christiano, Eichenbaum and Evans (1996) use vector auto regressions to identify monetary policy shocks. However the literature analyzing the credit channel at the micro level has

III. Empirical Strategy

In the previous two Sections we have discussed the three main identification challenges for empirical studies that analyze whether – and through which channels – economic and monetary conditions affect loan supply. In this Section we discuss our empirical strategy in detail.

A. The Credit Register

Analyzing the *Credit Register* of the *Banco de España* (CIR) helps to meet the three identification challenges. The register contains seventeen years of monthly comprehensive information on bank loans matched with detailed firm and bank accounting data (including identity, capital, liquidity, and many other variables) and seven years of monthly bank information requests corresponding to a sample of 800,000 loan applications. During this entire period Spain had a reasonably exogenous monetary policy and experienced two (partly exogenously induced) economic recessions.

We aim to study the impact of economic and monetary conditions on bank loan supply. The CIR contains confidential and very detailed information at the loan level on *all* commercial and industrial (C&I) loans granted by *all* credit institutions operating in Spain during a twenty-five year period. The CIR is *almost* comprehensive, as the reporting threshold for a loan is only 6,000 Euros. This very low threshold, especially as we only consider C&I loans, alleviates any concerns about unobservable changes in bank credit to small and medium sized

mainly used variations in the short-term interest rate as a measure of the stance of monetary policy (Jayaratne and Morgan (2000), Kashyap and Stein (2000), Kishan and Opiela (2000), Ashcraft (2006) and Black, Hancock and Passmore (2009)). In fact, 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. Controlling for both inflation and GDP growth, we use changes in the three-month interbank rate as our main indicator of monetary conditions, in line with many articles in Kashyap, Mojon and Angeloni (2003) for example that also use European data. We employ the changes in the overnight rate in robustness.

enterprises (which may be more influenced by changes in business cycle and monetary policy under the credit channel theory for example).⁹

Our sample consists of business loans, granted to non-financial firms, in particular to publicly limited and limited liability companies (around 95% of all firms), by commercial and savings banks and also by credit cooperatives (representing more than 95% of the entire Spanish financial system). We match CIR compiled at a quarterly frequency starting in 1984:Q4 with complete firm and bank balance sheets. These are available at a yearly frequency starting in 1992 for firms and, given that the *Banco de España* is the banking regulator and supervisor in Spain, at a monthly frequency starting in 1984 for banks.

B. Loan Applications and Loans Granted

To identify loan supply from demand we first focus on seven years of monthly loan application records for the 2002:M2 – 2008:M12 period, which includes the current economic crisis. We then also aggregate all information at the yearly frequency for the 1992:Q1 – 2008:Q4 period, which includes two economic recessions. Both sample periods witnessed ample volatility in the short-term interest rates.

To analyze the availability of credit, we rely on two measures of bank lending: (i) Whether or not the firm is granted a loan given the firm applied for it; and (ii) Whether or not the firm has received one or more loans. We adjust the empirical specification to each measure. To separate bank loan supply from demand we rely on loan-application stage information. To absorb the variation in loan demand and supply quality over the business and monetary policy

⁹ 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. Commercial and financial loans, i.e., the loans we study in this paper, represent 82.6% of the total 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 may complicate any analysis of bank credit provision.

cycles, we include a wide array of firm and bank characteristics, including identity (fixed effect), capital, liquidity, assets, age, profitability, and other characteristics. As far as we are aware this is the first paper that analyzes the impact of business cycle and monetary conditions on the probability of loans being granted following applications.

C. Firm and Bank Capital and Liquidity

Then, as in Bernanke, Gertler and Gilchrist (1996) and Kashyap and Stein (2000), we exploit the cross-sectional implications of the sensitivity of credit availability to economic and monetary conditions according to the strength of the firm and bank balance sheets. Motivated by the theoretical literature we focus on net worth and liquidity. Because of lack of data, most other studies have to rely on size or debt as a proxy for net worth. Following Holmstrom and Tirole (1997) we define net worth – both for firms and for banks – as the capital-to-total-assets ratio.¹⁰ Following Bernanke and Gertler (1995), Bernanke, Gertler and Gilchrist (1999), Bernanke (2007) and Diamond and Rajan (2009) we – again both for firms and for banks – feature a liquidity measure. The 100,000 firms and 200 banks active in the loan application dataset provide ample cross-sectional variation in both measures.

Weak banks likely lend to weak firms (Gertler and Gilchrist (1994)). This is indeed the case in Spain. For example, the median capital ratio of the banks lending to the lowest quartile of firms according to this ratio is 17 basis points lower than the median capital ratio for the banks lending to firms in the highest capital ratio quartile (5.57% versus 5.74% respectively). Disentangling the firm from the bank balance-sheet channel by assessing them simultaneously seems therefore imperative to avoid an omitted-variables problem.

¹⁰ Off-balance sheet volumes are very small in Spain. Hence, total bank assets cover most of the banks' business. Banks did not develop conduits or Special Investment Vehicles (SIVs) because the prevailing accounting rules make banks consolidate these items and set aside adequate capital.

We control for the quality of applicants by including firm fixed effects and, in some regressions, bank and month fixed effects. To identify loan supply contractions (Bernanke and Lown (1991)), we analyze the success of loan applications made in the same month by the same firm to multiple banks that differ in capital and liquidity. We also analyze variation within loan applications received in the same month by the same bank to assess how firm capital and liquidity affects bank loan granting following changes in economic and monetary conditions.

We also analyze the records on *all* granted loans for the extended 1992:Q1 to 2008:Q4 period because: (1) Firms may substitute between banks of different balance sheet strengths, (2) bank information requests are not random (i.e., these requests follow loan applications by firms that are currently not borrowing from the bank), and (3) these requests are recorded for only seven years.

D. Economic and Monetary Conditions

Separating the effects of economic activity from monetary conditions on bank lending is generally difficult as short-term interest rate changes are determined by the business cycle (as in a Taylor-rule setting for example). We start from the observation that monetary policy in Spain has been fairly exogenous during the last twenty years (see Jiménez, Ongena, Peydró and Saurina (2008) and Banco de España (1997)). Spain formally joined the European Monetary Mechanism in 1989, after joining the European Union in 1986. Monetary conditions consequently became basically “set in Frankfurt”, first through the fixed exchange rate policy with the *Deutsche Mark* and as of January 1, 1999 within the Eurosystem.

In addition, GDP growth in Germany and Spain were only weakly synchronized during the last twenty years. During the period 2002-2005 for example short-term interest rates were low given the slow economic growth in Germany, Italy and France (the three larger euro area

economies). But potentially these rates were less fitting Spain's much higher economic growth rates. Consequently, there is some exogenous variation in short-term interest rates allowing us to disentangle its effects from those of economic activity.

There is also exogenous variation in the two economic recessions that took place during the sample. The 1993 recession followed the German Re-Unification which drove the *Bundesbank* to hike its policy rate to counter an increase in German inflation thereby forcing the *Banco de España* to follow. In addition, the current recession in Spain was partly initiated by the financial crisis abroad, providing a modicum of exogeneity to its start. The European Central Bank also did not decrease its policy rates as much as the Federal Reserve, partly because its main mandate is to ensure price stability. However, the current economic contraction in Spain is very severe. In less than two years time Spain's unemployment rate for example more than doubled, from eight to more than seventeen percent (2007:Q2 to 2009:Q1).

To complete our specifications we include inflation as an important economic determinant of short-term interest rates in all specifications. Robustness exercises feature month, firm-month and bank-month fixed effects to control for other macroeconomic factors.

IV. Variables and Results

A. Main Dependent Variable: Loan Application Is Approved and Loan Is Granted

Table 1 defines the dependent and independent variables employed in the first set of empirical specifications (recorded in Tables 2 to 6) as well as their descriptive statistics. The dependent variable we feature first is LOAN APPLICATION IS APPROVED AND LOAN IS GRANTED (we shorthand this to "granting loans"). Salient institutional characteristics of the Spanish banking system allow us to construct this variable. We explain these features first.

[Table 1 around here]

All banks in Spain automatically receive monthly updated information on the total current credit exposures and (possible) loan defaults – vis-à-vis all other banks in Spain – of their own current borrowers. This information is extracted from the CIR by the *Banco de España*, which is the domestic banking regulator and supervisor. 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, enforced by the *Banco de España*, 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 between 2002:M02 and 2008:M12. Though the requests can be made at any time, they are collated monthly, pairing banks and borrowers. Requests for information on firms that are completely new to the CIR, i.e., firms that never borrowed from any bank reporting to the CIR, yield no information. Requests for information on firms that are currently borrowing from the requesting bank would yield information that is already known to this bank. In the same vein, requests for information on firms that were until very recently borrowing from the requesting bank would only update information. Consequently, requesting information from the CIR is especially 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 a long time ago. Nevertheless, even for the former group one sixth of the loans are granted without any information request on record.¹¹

¹¹ This statistic shows that while the monetary cost of requesting the information is zero, other non-pecuniary costs may not be. 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-

Between 2002:M02 to 2008:M12 we observe more than 800,000 bank requests for information.¹² For each request we also observe whether the loan is accepted and granted, or not. Therefore, if multiple banks request information on a particular borrower in the same month, we can infer the bank that granted the loan and the banks that did not (in contrast Brown, Kirschenmann and Ongena (2009) and Puri, Rocholl and Steffen (2009) observe a loan approval or denial for only one bank per application). 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 a month to bank balance-sheet strength.

Given these institutional characteristics the dependent variable LOAN APPLICATION IS APPROVED AND LOAN IS GRANTED 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 $t+2$). We also match each loan application with its relevant firm and bank characteristics. In the main regressions we include firm fixed effects, naturally restricting the sample to firms that face at least one rejection and one approval during the sample period (with an average value equal to 0.43, see Table 1). In robustness we will analyze all loan applications and the dependent variable then equals one for all firm – month combinations with one or more granted loans and equals zero otherwise.

and-wait” for an answer or during economic expansions when capacity constraints at the bank become binding these non-pecuniary costs may be relevant.

¹² As banks typically do not request information on current borrowers (because they receive this information automatically on a monthly basis), only 6% of the total number and value of new loans involves an information request.

B. Independent Variables

As independent variables we include an array of macroeconomic conditions and firm / bank characteristics to control for changes in the propensity during the business cycle of different type of firms to apply for loans to a potentially varying set of banks that request information and approve the loans. As macroeconomic conditions we include annual GDP growth (ΔGDP), a short-term interest rate measure of the annual changes in monetary policy conditions (ΔIR) and the inflation rate (ΔCPI).¹³ According to Hypothesis 1 we expect the coefficient on GDP growth to be positive and the coefficient on the interest rate to be negative.

The average GDP growth rate in Spain was 3.1 percent and varied between -0.9 and 3.8 percent. Our measure for the changes in monetary policy conditions, ΔIR , is the change in the Spanish 3-month interbank interest rate during the last year (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). The average change in the 3-month interest rate during the sample period was 0.2 percent ranging between -1.6 and 1.0 percent. The average inflation rate, ΔCPI , during the sample period was 3.3 percent. Both the interest rate and inflation are measured monthly. GDP growth is only available quarterly and to be consistent with the other macroeconomic measures we interpolate this series for all intermediary months (results are unaffected if we do not interpolate).

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 demand-side effects, we include a broad set of firm characteristics and, in most specifications, also firm fixed effects. In fact, the summary statistics of Table 1 are based on the observations used

¹³ GDP growth is measured quarterly while the short-term interest rate and the inflation rate are monthly. ΔIR measured each month is the change in the short-term interest rate over the last year.

in the regressions with firm fixed effects. We delay reporting the results without firm fixed effects until Table 6 Panel D. All firm characteristics are taken at-the-end-of or over the previous year ($t-1$).

The key firm balance-sheet variables are the CAPITAL RATIO measuring the firm's net worth and the LIQUIDITY RATIO capturing its liquidity position. According to Hypothesis 2 we expect the sign of the coefficients of both variables to be positive. The capital ratio is defined as the ratio of own funds over total assets of the firm and has an average value of 22.5 percent. Given the skewness of its distribution we employ the natural logarithm of the ratio in all regressions, but assess its economic relevancy in levels. The liquidity ratio is the current over total assets of the firm. It has an average value of 6.7 percent.

As other firm characteristics we include controls for firm risk, in particular: $\text{Ln}(\text{TOTAL ASSETS})$, the log of the total assets of the firm in 2008 euros; $\text{Ln}(1+\text{AGE})$, the log of one plus the age of the firm in years; ROA, the return on assets of the firm; $\text{I}(\text{DOUBTFUL LOANS AT THE TIME OF THE REQUEST})$, a dummy variable that equals one if the firm had doubtful loans the month before the loan was requested, and equals zero otherwise; $\text{I}(\text{DOUBTFUL LOANS BEFORE THE TIME OF THE REQUEST})$, a dummy variable that equals one if the firm had doubtful loans prior to the month the loan was requested, and equals zero otherwise; $\text{Ln}(1+\text{No. MONTHS WITH THE BANK})$, the log of one plus the number of months that the firm had a relationship with the bank; and $\text{Ln}(1+\text{NUMBER OF BANK RELATIONSHIPS})$, the log of the number of bank relationships of the firm.

As an industry characteristic we include INDUSTRY DOUBTFUL LOANS RATIO, which is the doubtful loan ratio of the industry in which the firm operates and which controls for the probability of loan rejections over the business cycle in the industry of the firm. As a province characteristic we include $\text{Ln}(\text{No. BANKS})$ which is the log of the number of banks in the province where the firm is located. Many firms borrow from local banks (Petersen and Rajan

(2002), Degryse and Ongena (2005)) so this variable controls for the number of banks that a firm may approach. The variable also partially captures the intensity of local bank competition.

Lending behavior may vary across banks, hence we control for bank variables that may affect bank lending behavior and, in robustness, we control for bank fixed effects.

Key balance-sheet variables again include 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. The capital ratio is defined as the ratio of bank equity (core-capital) over total assets of the bank (as in Bernanke and Lown (1991) for example).¹⁴ It has an average value of 5.4 percent. As with firm capital we take its natural logarithm but results are similar without this transformation. 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.

Other bank variables we include (that may affect bank lending) are: Ln(TOTAL ASSETS), the log of the total assets of the bank in 2008 euro; 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 credit portfolio by industry.

To sum up our empirical exercises (which we explained in the previous Sections) focus first on economic and monetary conditions (Δ GDP and Δ IR) and, second, and more importantly, on the interactions between Δ GDP and Δ IR, and the strength of the firm and bank balance sheets proxied by both Ln(CAPITAL RATIO) and LIQUIDITY RATIO. The regressions are at the loan application level and we match the loan application outcomes with the associated

¹⁴ Core-capital ratio is defined as total equity plus retained earnings over total assets. We use the book value of equity and assets are not risk adjusted. So our measure is equivalent to a pure leverage ratio.

firm, industry, province, bank and macroeconomic information. Given our empirical strategy, we do not simply compare loan application outcomes across different firms and banks, but we also control – and exploit – the strength of the balance sheets of both the firms and the banks associated with each loan application. In addition, firm fixed effects allow us to compare lending to the same firm under different economic and monetary conditions and for different bank strength. This is important since the pool of borrowers may change over the business cycle and across banks. Finally, we take a step further in identification and we compare within the different applications of a firm in a month to different banks. In this case the quality of the potential pool of borrowers is held constant.

C. Results

1. Firm and Bank Characteristics

Table 2 reports the estimated coefficients, the standard errors between parentheses, and the significance levels of three different conditional logit models (i.e., a logit that controls for firm fixed effects). Standard errors are clustered at the firm level.

[Table 2 around here]

We start analyzing the direct effects of economic and monetary conditions on granting loans. Following Hypothesis 1 we expect the estimated coefficient on ΔGDP to be positive as loan supply (corresponding improving firm and bank balance-sheet strength) increases with GDP growth. And following higher short-term interest rate increases we expect loan supply to decrease as agency costs of lending would increase. Hence we expect the coefficient on ΔIR to be negative.

In Table 2 Model I we indeed find that GDP growth spurs granting loans and that a contraction in monetary policy decreases the probability that a loan is granted. The semi-

elasticity column indicates that both effects are also economically relevant.¹⁵ At the mean of all variables a one standard deviation increase in GDP growth (from 3.14 to 4.07 percent), for example, increases the loan granting probability by almost 12 percent (from 43 to 48 percent), while a one standard deviation increase in the short-term interest rate (from 0.23 to 1.05 percent) decreases the loan granting probability by three and a quarter percent (from 43 to 41 percent).

We note that the estimated coefficients on GDP growth and the change in the interest rate are obtained in specifications that include a comprehensive set of firm characteristics, firm fixed effects, and bank characteristics. These variables absorb changes in loan demand quality over the business cycle, i.e., changes in the pool of applicant firms that apply for and obtain loans from different banks. In key specifications we also add the number of loan applications which may change over the business cycle. Results are virtually unaffected.

We now discuss the coefficients on the firm and bank characteristics once and then turn back to the focus of our study which are the effects of the changes in economic (and monetary) conditions through the strength of the balance sheets of firms (and banks) on the availability of credit.

The estimated coefficients on the firm characteristics are overall and across all specifications statistically significant, economically relevant, stable and in line with straightforward priors. These results suggest therefore that these controls for credit demand are at once needed and relevant. Applications from larger firms with a higher capital ratio are more likely to be successful. The coefficient on firm liquidity is not significant in Model I, but it becomes

¹⁵ The semi-elasticity ε of a change in a regressor x_j in a logit model equals its marginal effect divided by the conditional probability p that the dependent variable equals one. For $p = \Pr[y = 1 | \mathbf{x}]$ and

$$\Lambda(\mathbf{x}'\beta) = \frac{e^{\mathbf{x}'\beta}}{1 + e^{\mathbf{x}'\beta}}, \text{ the semi-elasticity is } \varepsilon = \left(\frac{\partial p}{\partial x_j} \right) / p = \{ \Lambda(\mathbf{x}'\beta)[1 - \Lambda(\mathbf{x}'\beta)]\beta_j \} / p.$$

significant in models where liquidity is also interacted with economic and monetary conditions. This indicates liquidity matters especially for firms that lack it when growth is low and short-term interest rates are high.

Loan applications from larger, 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 are also more successful. Hence, *ceteris paribus* more transparent 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)).

Overall, we find these estimated coefficients in line with standard priors and their statistical significance and stability reassuring for our investigation of the different credit channels (as the workings of these channels require the imperfect substitutability between external and internal financing that is especially acute for opaque firms with a low capital ratio).

In sum, controlling for firm and bank characteristics, we find that loan supply increases in good times, i.e., when GDP growth is higher and the cost of financing (short-term interest rate) is lower. Theory of the firm and bank balance-sheet channels predict the effects we have found so far, but also predict that these effects will work mainly through the strength of balance-sheet of firms and banks respectively. In the rest of this Section we will test these hypotheses.

2. *Economic Conditions and Firm Strength*

If a firm balance-sheet channel is operational, the impact of changes in economic activity on the availability of credit should be stronger for weak firms (and weaker for strong firms). Indeed, according to theory, the external finance premium increases in the intensity of the agency problems. According to Hypothesis 2 firms with a lower capital ratio face more agency problems, because they have less “skin in the game”. We therefore expect the estimated

coefficient on $\Delta\text{GDP} * \text{Ln}(\text{CAPITAL RATIO})$ to be negative. Table 2 Model II shows support for this hypothesis for the within-firm variation model.

However, it could still be the case – and this despite all of our firm and bank controls – that in response to an economic contraction firms with a higher capital ratio would adjust their loan demand differently than firms with a lower capital ratio vis-à-vis banks with different capital ratios. Even by including the firm fixed effects we do not account for this possibility entirely because firm-bank relationships may change during our sample period. Hence, we take additional steps of identification by also including bank, time and/or bank-time fixed effects in various combinations in Table 6 (Panels A, B and C). We also drop the firm fixed effects in Table 6 (Panel D) so that firms that only faced rejections or approvals during the sample period can also be included.

Similarly, Table 2 Model III reports a negative coefficient for $\Delta\text{GDP} * \text{LIQUIDITY RATIO}$, and Table 6 Panels A and B report similar results with the different combinations of fixed effects.

3. Economic Conditions and Bank Strength

If a bank balance-sheet channel is operational, the impact of changes in economic activity on the availability of credit should be stronger for weak banks (and weaker for strong banks). Indeed, according to theory, the external finance premium for banks increases in the intensity of the bank agency problems. Banks with a smaller capital ratio face more agency problems with their lenders in economic downturns and monetary contractions. According to Hypothesis 4 we therefore expect the estimated coefficient on $\Delta\text{GDP} * \text{Ln}(\text{CAPITAL RATIO})$ to be negative as well. Table 3 shows support for this hypothesis for the within firm variation model. We find that the estimated coefficient on $\Delta\text{GDP} * \text{LIQUIDITY RATIO}$ is negative as

well. In addition, results hold if we drop the firm fixed effects or add bank and/or time fixed effects (in various combinations), as later exercises in Table 6 show.

[Table 3 around here]

Despite all of our firm and bank controls it is again possible that in response to an economic contraction banks with a higher capital ratio would receive (even) more applications for loans from stronger firms than banks with a lower capital ratio. Even by including firm characteristics and the firm and bank fixed effects we do not entirely account for this possibility since the frequency of the balance-sheet data for firms is annual, whereas loans and bank balance-sheet data are monthly. Hence, we take one additional step of identification by also including firm-month and loan application fixed effects later in Table 6C. We obtain similar results, i.e., *within* the set of different applications for a loan or *within* the set of applications coming from a borrower in the same month to different banks, we find that banks with low capital grant fewer loans when the GDP growth is lower, a key result.

To analyze simultaneously both the impact of the business cycle on the firm and bank balance sheet data, in Table 4 we include both the interaction of GDP growth with both firm and bank capital and liquidity. Results are very similar to Tables 2 and 3.

[Table 4 around here]

4. *Economic and Monetary Conditions*

We now analyze simultaneously *both* the impact of the business cycle and monetary policy on *both* the firm and bank balance sheet data. This is necessary to avoid a possible omitted-variables bias. Table 5 includes the interaction of both GDP growth and the change in the short-term interest rate with firm and bank capital and liquidity. Table 5 therefore contains our benchmark regressions. As explained in the previous Sections, GDP growth and interest rate changes are not highly correlated in Spain because of the relatively low level of synchronization of economic activity in Spain vis-à-vis Germany for the last 20 years, and vis-

à-vis the largest euro area countries since 1999. This allows us to exploit simultaneously the variation in output and monetary conditions interacted with firm and bank capital and liquidity.

[Table 5 around here]

Results show that the negative effect of lower GDP growth or higher short-term interest rate increases on the probability that a loan application results in a loan granted is stronger for firms with low capital or liquidity and (independently) for banks with low capital or liquidity.

In Figure 1 we further explore the economic relevancy of these estimated effects. Based on the estimates in Table 5 Model III, the figure plots the percentage change in the loan granting probability (LOAN APPLICATION IS APPROVED AND LOAN IS GRANTED) for a one standard deviation increase in GDP growth (Δ GDP) or the change in the short-term interest rate (Δ IR) for values in the 25th to 75th percentile ranges of the firm and bank CAPITAL RATIO (the values of both ratios are displayed in levels in the Figure).

[Figure 1 around here]

The effect of a one standard deviation increase in GDP growth on the loan granting probability is always sizeable and around 12 percent, but fairly equal across the changes in firm and bank capital ratios, although the effect of firm capital ratio on GDP growth is slightly higher. When both firm and bank capital ratios are high (75th percentile) the effect equals 9 percent, when both are low (25th percentile) the effect equals 16 percent.

The effect of a one standard deviation increase in the change in the short-term interest rate, on the other hand, depends mostly on the bank capital ratio. At the 25th percentile of the firm capital ratio for example, the effect varies between -3.5 percent for highly capitalized banks (75th percentile) and -7.5 percent for lowly capitalized banks. This finding suggests that – in contrast to changes in GDP growth that work through both firm and bank balance sheet channels – monetary policy changes work predominantly through the banking lending

channel.¹⁶ Findings for firm and bank LIQUIDITY are similar (see Figure 2), pointing out the important role played by bank liquidity and the bank balance sheet channel.

[Figure 2 around here]

The robustness checks we mentioned so far (but did not tabulate to conserve space) includes time windows shorter than three months during which loans can be granted following an application, the use of the overnight interest rate instead of the three-month interest rate, the use of non-interpolated quarterly variables, and the inclusion of the monthly number of loan applications as an independent variable.

5. *Fixed Effects*

Table 6 presents estimates of previous regressions with different combinations of fixed effects. As we have already discussed most estimates earlier in this Section, we only briefly refer now to the results in Panels A and B. Panel A shows very similar results to the previous regressions with both firm, bank and month fixed effects. Panel B features bank-month fixed effects. We find that within a bank and month, banks more often reject weaker firms, but do so especially during downturns or periods of higher short-term interest rates.

[Table 6 around here]

Panel C presents loan (or firm-month) fixed effects. *Within* the set of different applications for a loan made by a firm in the same month to different banks, we find that banks with low capital or liquidity grant fewer loans when GDP growth is lower or short-term interest rates are higher. 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 tight conditions a

¹⁶ See Adrian and Shin (2009), Brunnermeier, Crockett, Goodhart, Persaud and Shin (2009) and Shin (2009) for the importance of overnight rates for bank liquidity and behavior.

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*” (italics are ours). As far as we are aware we are the first to identify and document in such a precise way the occurrence of a credit crunch.

Panel D presents similar results when we do not include any type of fixed effect, in particular when we do not include firm fixed effects. The number of loan applications in this sample increases to 813,612 as firms with loan applications that were always accepted or rejected re-enter the sample. Results remain similar however.

6. *Granted Loans*

The set of loan applications we have used so far are loan applications during the period 2002:M02 – 2008:M12 to banks that ask the *Banco de España* for information about a borrower which is currently not a customer. We therefore now extend the analysis to the set of *all* granted loans for the period 1992 to 2008 during which there were two economic recessions (results employing all granted loans are very similar for the 2002 – 2008 sub-period that corresponds to the loan application sample). We can match the granted loans with firm and bank balance sheets and income statements culled from the Business Register and the monthly bank reports maintained by the *Banco de España*.

This extended sample offers a worse environment to try to disentangle loan supply from demand. Firms may not have new loans in a quarter either because they did not borrow, or because they tried to borrow but their loan applications were all rejected, or the loan conditions offered by the banks were not attractive enough. In consequence, there is an identification problem between loan supply and demand and, hence, a positive (negative) coefficient of GDP (interest rates) on granted loans may be due to either higher loan supply or higher loan demand, or both.

The identification problem is, however, much less severe than in other empirical work (see Section 2), since our analysis is at the firm level controlling for firm characteristics that determine loan demand, like for example identity (which controls for industry, province, and constant unobserved characteristics), capital, liquidity, sales, size, profits and others. Moreover, we are more interested in exploiting the interactions between GDP or the interest rate with firm and bank capital and liquidity, which further alleviates the supply identification problem. Notice that we can also condition on the characteristics of the banks the firm currently borrows from, but we cannot condition on the characteristics of the banks the firm did not get a loan from. As argued before, for this group of firms, the relevant bank conditions are most likely correlated with those of the banks located close by. Hence, the banks in the *province* are most likely the set of banks firms can obtain a new loan from, and their capital and liquidity are reasonably the relevant characteristics. Results are similar if we use the characteristics of the average bank at the *country* level in the relevant period.

Table 7 presents the summary statistics of the dependent and independent variables employed in the sample of granted loans. The dependent variable FIRM WAS GRANTED AT LEAST ONE LOAN IN YEAR t equals one if the firm i obtained at least a loan by the set of banks b during year t and equals zero otherwise. Its average value is 0.51, which is very similar to the earlier main dependent variable LOAN APPLICATION IS APPROVED AND LOAN IS GRANTED (see Table 1).

[Table 7 around here]

As independent variables in the models we include the same macroeconomic conditions, firm and bank characteristics as in the main sample of loan applications.¹⁷ Δ GDP has an average value of 3.4, the average Δ IR is -0.2, and the average Δ CPI is 3.2. The average firm CAPITAL

¹⁷ As we do not have all firm and bank information for the entire period, we rerun the earlier loan application regressions also with this more limited set of variables. Results are unaffected.

RATIO is 38.4 percent and the average firm LIQUIDITY RATIO equals 14.6 percent. The equivalent averages for banks are 6.0 and 23.4 percent, respectively.

Table 8 presents the estimated conditional logit models. The first column shows similar results to Table 2 Model 1. Higher GDP growth or lower short term interest rates imply more granted loans. Despite all our firm and bank controls, the results could still be due to both higher loan demand and/or higher loan supply. Hence, to further control for loan demand and to disentangle firm and bank balance-sheet channels, we introduce in Columns 2 and 3 interactions of economic and monetary conditions with firm and bank capital and liquidity. In Column 3 we also introduce time fixed effects. Results are very similar to those of the sample of loan applications. The negative impact of lower GDP growth or higher short-term interest rates on granted loans is stronger for both firms with low capital or liquidity and (independently) for banks with low capital or liquidity.

[Table 8 around here]

Figure 3 again plots the percentage change in the loan granting probability (i.e., FIRM WAS GRANTED AT LEAST ONE LOAN IN YEAR t) for a one standard deviation increase in GDP growth (Δ GDP) or change in the short-term interest rate (Δ IR) for values in the 25th to 75th percentile ranges of the firm and bank CAPITAL RATIO (the values of both ratios are again displayed in levels in the Figure).

[Figure 3 around here]

The effects for GDP growth and the change in the short-term interest rate are now very similar in magnitude and in the role played by the bank balance sheet channel. In both cases the effects are much larger in absolute value for lowly capitalized banks (25th percentile) than for highly capitalized banks (75th percentile). For the firm capital ratios set equal to their 25th percentile, for example, the effect of GDP growth ranges from close to 2 percent to almost 7 percent. The effect of the interest rate ranges from close to minus 10 to minus 5 percent. The

firm balance sheet channel, though statistically significant, plays in both cases economically speaking a minor role. The same is true for the effects of GDP growth and the change in the short-term interest rate across firm and bank LIQUIDITY (see Figure 4).

[Figure 4 around here]

Remember that Tables 5 and 6 show that engagements between firms and banks with low capital or liquidity are more likely to result in a loan rejection, especially during adverse economic and monetary conditions. Table 8 and Figures 3 and 4 similarly show that, during adverse economic and monetary conditions, firms and banks with low capital or liquidity are less likely to engage in a credit transaction. In non-reported regressions we also feature as dependent variables the number of loans and the total volume of credit that was granted. We find that weak firms or banks involve fewer loans and lower loan volumes.

Hence, the restrictions on the availability of credit identified with the loan application analysis are binding and have “net” effects in the sense that: (i) Weak firms that face a higher likelihood of a loan rejection cannot simply apply more to other banks and obtain loans there; (ii) Weak banks that reject more loan applications do not end up granting more loans as the number of applications to them increases.

In sum, our results suggest that it is not the case that in a capital and liquidity crunch, weak firms (with less capital and liquidity) can compensate their limited borrowing capacity with more loan applications or that reduced lending by weak banks is compensated by more lending from strong banks, especially not in times with worse economic and monetary conditions.

V. Conclusions and Policy Implications

Do the business cycle and the stance of monetary policy affect loan supply? And, if so, how relevant are the firm versus the bank balance-sheet channel both for the business cycle and for monetary policy?

To answer these questions there are three main identification challenges: (1) An economic downturn and/or high cost of financing may reduce both loan supply and demand. (2) Separating firm from bank balance-sheet channels, through which both business cycle and monetary policy may affect the availability of credit, creates an identification challenge since firms with low quality of balance-sheet strength that are more bank dependent may borrow more from banks with low quality of balance-sheet strength (Gertler and Gilchrist (1994)). Therefore, analyzing the questions at the firm, or the bank, level may imply an omitted-variables problem which may bias the results. Hence, these matching issues make it necessary – for identification – to analyze the questions *at the individual loan level*, matched with *both* firm and bank complete information. (3) Separating the effects of economic activity and monetary conditions is also problematic as short-term interest rate changes may completely be determined by the business cycle (as for example in a Taylor- rule setting).

Our contribution to the literature lies in meeting these three identification challenges. We use a uniquely and comprehensive micro-dataset that contains for the last seventeen years information on all granted loans to non-financial firms by all credit institutions matched with both firm and bank identity and complete balance-sheet data, including precise measures of capital and liquidity which proxy for the quality of the balance sheets. In addition, from 2002:M02 to 2008:M12 the dataset also records all bank credit file requests corresponding to a sample of loan applications, information that helps to separate loan supply from demand. The dataset is from Spain, a bank-dominated country with pronounced business cycles (including a

severe contraction under way) and a fairly exogenous monetary policy allowing us to disentangle output from monetary policy effects.

We find robust evidence that: (1) Lower GDP growth or a larger increase in the short-term interest rate reduces loan supply. (2) Firm capital and liquidity matter for the availability of credit in level (as in Holmstrom and Tirole (1997) for example), and so do bank capital and liquidity. (3) The GDP and interest rate effects on bank loan supply are stronger for firms with low capital or liquidity and (independently) for banks with low capital or liquidity (Stiglitz and Weiss (1981), Bernanke, Gertler and Gilchrist (1996), Holmstrom and Tirole (1997), Kiyotaki and Moore (1997), Stein (1998), Bernanke, Gertler and Gilchrist (1999), Diamond and Rajan (2006), Bernanke (2007), Matsuyama (2007), Diamond and Rajan (2009)). Though both the business cycle and monetary policy effects work strongly through the bank balance-sheet channel, firm balance sheets also play a substantial role in channeling changes in GDP growth (Bernanke and Gertler (1995), Bernanke, Gertler and Gilchrist (1996)).

In addition, within the set of different applications for a loan from the *same* firm in the *same* month to different banks, we find that banks with low capital or liquidity grant fewer loans when GDP growth is lower or short-term interest rates are higher. Our results therefore suggest that under tight conditions low bank capital and liquidity leads to a credit crunch as defined in Bernanke and Lown (1991), i.e., a reduction of the loan supply to potential borrowers with the *same* quality.

Improved identification makes the interpretation of the reduced-form coefficients more reliable. Our policy conclusions also have an immediate bearing on the current financial and economic crisis. First, the contracting effects of a slowdown in economic activity or an increase in the interest rate on the supply of bank loans may be amplified by low firm and bank capital. Capital crunch (eventually) begets credit crunch. Second, for the easing monetary policy to soften the credit crunch, especially bank capital matters; Only to a lesser

extent does firm capital matter. Moreover, in a credit crunch and with weakly capitalized banks it is more difficult for monetary policy to “exit” a low level of the short-term interest rate as loan supply reductions may be severe! Finally, firm and bank recapitalizations and liquidity injections will in principle increase the supply of bank loans. But the way in which this balance sheet strengthening is executed (e.g. seasoned equity offering or interbank market liquidity versus government or central bank assistance) may affect the credit expansion (we leave this conjecture for future research).

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