HAZARDOUS TIMES FOR MONETARY POLICY: WHAT DO TWENTY-THREE MILLION BANK LOANS SAY ABOUT THE EFFECTS OF MONETARY POLICY ON CREDIT RISK-TAKING?

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We identify the effects of monetary policy on credit risk-taking with an exhaustive credit register containing loan applications and contracts. We separate the changes in the composition of the supply of credit from the concurrent changes in the volume of supply and quality and volume of demand, with a two-stage model that analyzes the granting of loan applications in the first stage and the loan outcomes for the granted applications in the second stage. Our selection model controls for both observed and unobserved, time-varying, bank and firm heterogeneity through time*bank and time*firm fixed effects. We find that a lower overnight interest rate induces lowly capitalized banks on the extensive margin to grant more loan applications to ex-ante risky firms and on the intensive margin to commit larger loan volumes with fewer collateral requirements to these firms. These granted loans also have a higher ex-post likelihood of default. A lower long-term interest rate and other relevant macroeconomic variables have no such effects. (166 words)

KEYWORDS: monetary policy, financial stability, credit risk, credit supply composition, business cycle, bank capital.

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1. INTRODUCTION

DOES A LOW MONETARY POLICY RATE SPUR RISK-TAKING BY BANKS? Since the severe financial crisis of 2007-2009, this question is at the center of an intense academic and policy debate. Right from the start of the crisis in the summer of 2007 market commentators were swift to argue that during the long period of very low interest rates, stretching from 2002 to 2005, banks had softened their lending standards and taken on excessive risk, whereas others argued that low long-term rates and other aggregate factors were the culprit. But, at the same time, market participants continuously clamored for central banks to reduce the monetary policy rate to alleviate their financial predicament. Hazardous times for monetary policy indeed.[2]

While the impact of monetary policy on the aggregate *volume of credit* in the economy has been widely analyzed (Bernanke and Blinder (1992), Kashyap and Stein (2000), Jiménez, Ongena, Peydró and Saurina (2011)), and changes in the *composition of credit* in response to changes in the quality of the pool of borrowers have been documented (Gertler and Gilchrist (1994), Bernanke, Gertler and Gilchrist (1996)), this paper is the first to empirically study the

[2] Nominal rates were the lowest in almost four decades and below Taylor rates in many countries while real rates were negative (Taylor (2007), Rajan (2010), Reinhart and Rogoff (2010), among others, and multiple editorials and op-eds in *The Wall Street Journal*, *The Financial Times* and *The Economist*). Expansionary monetary policy and credit risk-taking followed by restrictive monetary policy possibly led to the financial crisis during the 1990s in Japan (Allen and Gale (2004)), while lower real interest rates preceded banking crises in 47 countries (Hagen von and Ho (2007)). A crucial factor in the development of financial crises according to Kindleberger (1978) is the amount of liquidity provided by the central banks: "Speculative manias gather speed through expansion of money and credit or perhaps, in some cases, get started because of an initial expansion of money and credit" (*op. cit.*, p.54). The regulatory arbitrage for bank capital associated with the high degree of bank leverage, the widespread use of complex and opaque financial instruments including loan securitization, and the increased interconnectedness among financial intermediaries may have intensified the resultant risk-taking associated to expansive monetary policy in the run-up to this crisis (Calomiris (2009), Mian and Sufi (2009), Acharya and Richardson (2010), Allen and Rogoff (2011)). While a low monetary policy rate may induce risk-taking by banks, increasing the probability that a financial crisis occurs, once the crisis starts the central banks may lower the rate to support the banking system, in turn sowing the seeds for the next credit bubble (see also Giavazzi and Giovannini (2010)). Others, notably Bernanke (2010), have argued that low long-term interest rates were more important (than a low policy rate) in driving risk-taking. It is therefore important to analyze the impact of both short- and long-term interest rates on bank risk-taking.

impact of the monetary policy rate on the *composition of the supply of credit*, in particular on banks' risk-taking.

Recent theoretical work suggests how changes in the monetary policy rate may affect credit risk-taking by financial institutions. Allen and Gale (2000), Allen and Gale (2004), Allen and Gale (2007) and Allen and Rogoff (2011), for example, show that under expansive monetary policy and in the presence of bank moral hazard, i.e., when too little bank capital is at stake, risk-shifting in lending may occur. Adrian and Shin (2011), in their chapter in the latest *Handbook of Monetary Economics*, present the risk-taking channel of monetary policy and show that expansive monetary policy increase lending and risk-taking by banks when their Value at Risk (VaR) constraint is binding in capital.[3] Acute agency problems in banks combined with a reliance on short-term funding, may therefore lead the short-term interest rate – more than the long-term interest rate – to spur risk-taking. Finally, a low short-term interest rate makes riskless assets less attractive and may lead to a search-for-yield by those financial institutions that have short-term time horizons (Rajan (2006), Blanchard (2008), Borio and Zhu (2008)).

On the other hand, higher interest rates may in general increase the risk-taking incentives of borrowers due to moral hazard (Stiglitz and Weiss (1981)), increase the opportunity costs for banks to hold cash thus making risky alternatives more attractive (Smith (2002)), or even reduce the banks' net worth or charter value enough to make a "gambling for resurrection"

[3] Adrian and Shin (2011) argue that VaR capital constraints are caused by bank moral hazard frictions. A lower short-term interest rate may also reduce the threat of deposit withdrawal allowing banks to relax their lending standards and to increase their credit risk-taking, as in Diamond and Rajan (2006), Diamond and Rajan (2012), Diamond and Rajan (2011)). In the latter models there is no credit risk, only liquidity risk, i.e., loans get terminated prior to maturity. However, these models yield similar results if a non-zero probability of loan default is introduced (in period 2). See also recent work by Agur and Demertzis (2010), Angeloni, Faia and Lo Duca (2010), Cociuba, Shukayev and Ueberfeldt (2011), Drees, Eckwert and Várdy (2012), and Valencia (2010), among others.

strategy attractive (Kane (1989), Keeley (1990)). These countervailing effects make the impact of the short-term interest rate on credit risk-taking ultimately a critical yet unaddressed empirical question.

Banks still are the main providers of credit in many economies. Banks arise to overcome key informational and contractual problems through screening and monitoring (Diamond (1984)) and lend to a wide range of opaque firms (Bolton and Freixas (2000)). Banks, moreover, were among the main "villains and victims" in the western financial crisis. Credit risk is their most important risk (Kuritzkes and Schuermann (2010)), and banks' risk-taking – and other compositional changes in their credit supply for that matter – directly impact future financial stability and economic growth (Matsuyama (2007), Rajan (2010)). Given the intensity of agency problems, social costs and externalities in the banking sector, the compositional effects can be studied independently of the adequacy of the banks' pricing of the credit risk.

Changes in interest rates may affect both the volume of credit supplied through the bank balance-sheet channel (Bernanke and Gertler (1995), Bernanke (2007)), the quality of the pool of borrowers through the firm balance-sheet channel, and the demand for investment and credit through the interest rate channel. Disentangling the impact of the changes in the monetary policy rate on the composition of the supply of credit from changes in the volume of the supply and changes in the quality and the volume of the demand – while accounting for the impact of other macro variables including long-term interest rates – is the decisive identification challenge we address. While the bank balance-sheet channel yields testable predictions at the *bank* level, and the firm balance-sheet and interest rate channels at the *firm* level, the bank risk-taking channel involves compositional changes in the supply of credit at the *bank-firm* level.

To meet the identification challenge we therefore turn to the credit register of Spain that contains uniquely comprehensive bank-firm level data. We access both the monthly information on loan applications made to banks by firms since 2002, and the exhaustive quarterly bank-firm level records of *all* outstanding business loan contracts since 1984. The thus compiled sample period runs until January 1st, 2009, and covers both the run-up to and relevant episodes of the western financial crisis.

Spain offers an ideal investigative setting with an economic system dominated by banks and, for the last twenty-two years, a fairly exogenous monetary policy, the stance of which we account for with the overnight interest rate, i.e., the Euro OverNight Index Average rate (EONIA), which is targeted by the European Central Bank and Eurosystem, and before 1998 the Spanish overnight interest rate.

With this dataset in hand, our identification strategy relies on three crucial components. First, we wield a two-stage model that explains the monthly granting of loan applications (i.e., at the extensive margin of lending) followed by the amount of credit banks commit to firms if loans are granted (i.e., at the intensive margin of lending). Hence the selection model uniquely encompasses the two key steps in bank lending. Within the second stage we further analyze other credit outcomes measuring risk, such as the future likelihood of loan default and the absence of collateral requirements. In robustness we also analyze the quarterly change in the amount of outstanding bank-firm credit with the sample of *all* business loans. While the changes in outstanding credit analyzed in the latter part are related to bank monitoring of existing clients, the granting of loan applications in the former selection model are evidently the result of bank screening of new client firms.

Second, we saturate specifications with time*bank and time*firm fixed effects (at a monthly or quarterly frequency) to absorb all time-varying, observed and unobserved, bank and firm heterogeneity potentially emanating from bank- and firm-balance sheet, and interest rate, channels. To isolate bank risk-taking we interact the changes in the overnight interest rate with a bank capital ratio and a measure of firm credit risk. Bank capital is the main theory-based measure for bank agency problems; it is the pertinent net worth variable financiers of the banks gauge in Holmstrom and Tirole (1997) and Gertler and Kiyotaki (2011) for example. But it may be correlated with other bank characteristics. Hence we concurrently include triple interactions (of the overnight rate and firm risk) with bank size, liquidity, profitability, non-performing loan ratio, and type. We also add bank*firm fixed effects and time-varying bank-firm characteristics (i.e., past credit volume) – where possible – to control for unobserved heterogeneity in bank-firm matching. In accordance with the focus of our analysis and the variation in our data, we multi-cluster standard errors at the time, bank, and firm level.

Third, we horserace the overnight rate, in its interaction with bank capital and firm risk, with the corresponding triple interactions of other key macro variables, i.e., the changes in Spanish aggregate output and prices, the ten-year government bond rate, bank securitization and current account deficit (i.e., capital inflows), and a U.S. ten-year government bond rate and the federal funds rate, respectively.

We find robust evidence that a lower overnight rate induces lowly capitalized banks to grant more loan applications to risky firms (than highly capitalized banks),[4] where firm risk is measured with the presence of a bad credit history with non-performing loans. When granting applications to these firms, lowly capitalized banks further commit more credit and require less collateral, yet their granted loan applications face a higher future likelihood of default.

[4] Throughout the paper we label "lowly capitalized" banks those that have a lower capital-to-assets ratio than "highly capitalized" banks. We parsimoniously label "risky" firms those that have a recent credit history with one or more non-performing loans (our writing does not imply that firms without non-performing loans in a recent past are risk-free however).

Similar effects are present in the sample with all business loans since 1988 for changes in the amount of outstanding credit.

All findings are statistically significant and economically relevant. A decrease of 1 percentage point in the overnight rate for example increases the probability that a loan will be granted by a lowly versus a highly capitalized bank (with a difference of one standard deviation between them) to a firm with non-performing loans in the previous 4 years by 9 percent (all reported changes are semi-elasticities), the resultant committed amount of credit increases by 19 percent, while the future likelihood of loan default of these loans increases by 5 percent, and the required collateral decreases by 7 percent. A lower long-term interest rate and other key aggregate bank and macro variables, such as changes in securitization or current account deficits, have no such effects.

In sum, our estimates suggest that a lower monetary policy rate spurs bank risk-taking and hence that monetary policy affects the composition of the supply of credit beyond the well-documented effects of both the bank- and firm balance-sheet channels and changes in the demand for credit. Consistent with "excessive" risk-taking are our findings that especially banks with less capital "in the game", i.e., those afflicted more by agency problems, grant more loan applications and resultant credit to ex-ante risky firms, that these banks require less collateral requirements from these firms, and that *ergo* these banks face more default on these granted loans in the future.

Our contribution to the literature resides first and foremost in the identification of the existence of endogenous variation in the composition of the supply of credit. In Matsuyama (2007) and Matsuyama (2007) the composition of credit in an economy with multiple projects will depend on the net worth of the borrower. While the argumentation in Matsuyama implies compositional changes at a low frequency, the variation in risk in credit supply we measure varies over the monetary cycle along the banks' capital-to-asset ratio. During long periods with low interest rates bank risk-taking may undermine financial stability with the aggregate consequences we witnessed recently.

Our own estimates strikingly demonstrate the additional contribution made by our identification strategy, i.e., based on *bank-firm level* data including *time*bank* and *time*firm* fixed effects (their inclusion alters the main coefficients of interest suggesting non-random matching between banks and firms) in a *selection model* of loan *applications* then *credit outcomes* (without the first stage our estimates of risk-taking in the second stage are always much smaller in absolute value). Our findings therefore possibly qualify the estimates in the extant credit channel literature that are based on macro- (Bernanke and Blinder (1992), Kashyap, Stein and Wilcox (1993)) and bank-level data (Kashyap and Stein (2000)), or loan-level data analyzed with one-stage models (Khwaja and Mian (2008)).

Jiménez, Ongena, Peydró and Saurina (2011) also use data from the credit register to assess the potency of the bank lending channel. In marked contrast, in this paper we identify changes in the *composition of the supply of credit*, in particular with respect to the credit risk banks take. Jiménez, Ongena, Peydró and Saurina (2011) only analyze loan applications, whereas we assess both the extensive and intensive margins of lending. We also feature more loan data by analyzing all business loans since 1984.

Ioannidou, Ongena and Peydró (2009) and this paper are the first to concurrently investigate the impact of monetary policy on banks' risk-taking.[5] Ioannidou, Ongena and Peydró (2009)

[5] Adrian and Shin (2011) in their discussion of the risk-taking channel of monetary policy document correlations between short-term interest rates and bank risk-taking (see also De Nicolò, Dell'Ariccia, Laeven and Valencia (2010)). Den Haan, Sumner and Yamashiro (2007) suggest that high short-term rates could imply a decline in bank risk-taking. Maddaloni and Peydró (2011) analyze the correlation between monetary policy rates and lending standards, and relate it to the strength of securitization activity and banking supervision. Gertler and

do not study loan applications then outcomes, nor include time*bank and time*firm fixed effects. Rather they analyze the risk-pricing by banks in Bolivia during the period 1999 to 2003, with the credit register from this developing economy and a different identification strategy. Their estimates show that, when the U.S. federal funds rate decreases, bank credit risk increases while loan spreads drop. Hence, despite accessing credit registers from different countries, time periods, and monetary policy regimes, and employing different methodologies, both papers find strikingly consistent results.

Following Ioannidou, Ongena and Peydró (2009) and this paper there is now much ongoing empirical work documenting the robust existence and potency of a bank risk-taking channel across countries and time periods, e.g., for the US (Altunbas, Gambacorta and Marquez-Ibañez (2010), Delis, Hasan and Mylonidis (2011), Paligorova and Santos (2012)), Austria (Gaggl and Valderrama (2010)), Colombia (López, Tenjo and Zárate (2010), López, Tenjo and Zárate (2010)), the Czech Republic (Geršl, Jakubík, Kowalczyk, Ongena and Peydró Alcalde (2012)), and Sweden (Apel and Claussen (2012)), among other countries.

The rest of the paper proceeds as follows. Section 2 introduces the datasets we analyze. Section 3 explains our empirical identification strategy. Section 4 discusses the results and Section 5 concludes.

Gilchrist (1994) show that contractionary monetary policy results in less bank lending to small firms, findings that are consistent not only with lower borrower net worth, but also with possibly less bank risk-taking. In a different setting, Bernanke and Kuttner (2005) find that higher interest rates reduce equity prices, interpreting that tight money may reduce the willingness of stock investors to bear risk, Rigobon and Sack (2004) show that higher interest rates reduce equity prices on NASDAQ where more risky firms are listed, and Bekaert, Hoerova and Lo Duca (2010) document a strong co-movement between monetary policy and stock market option-based implied volatility. Shiller (2007) discuss excess risk-taking in general.

2. DATA SETS

Banks continue to play a key role in the Spanish economy and in the financing of the corporate sector. Their deposits (credits) to GDP in 2006 for example equaled 132 percent (164 percent). Most non-financial firms had no access to bond financing and the securitization of commercial and industrial loans is still very low (4.8 percent in 2006). Important for identification with time*firm fixed effects, firms with multiple bank relationships account for 86 percent of all business loans, and employ three banks (which is both the mean and median number).

The exhaustive bank loan data, we have access to, comes from the *Credit Register* (CIR) of the *Banco de España*, which is the supervisor and regulator in Spain of the banking system. We discuss here the two key different datasets on loan applications and contracts for the first sample and all granted loans for the second sample.

2.1. Loan Applications and Contracts

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 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 the 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 between 2002:02 and 2008:12 (before 2002 the requests were not stored). Though the requests can be made at any time, they are collated monthly and uniquely link a borrower with a bank. 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 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 our analysis on a key category of borrowers that do not simply renew or even evergreen existing loans at their current bank.

For each request 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 on a monthly basis. 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 case a bank requests information but does not grant the loan, either the bank denied the firm credit or – following a revealed preference argument – the firm perceived the offered loan conditions by the bank to be more expensive than those of the loan it eventually took.

Our sample then consists of loan applications by non-financial publicly limited and limited liability companies to commercial banks, savings banks and credit cooperatives.[6] Only firms that are new to a bank are considered. We then match the loan applications at a monthly frequency with the bank credit dataset (see also next subsection) to know which applications are granted and for those that are granted we know the committed amount of credit, whether the loan made by the bank to the firm defaults afterwards, and whether or not there are

[6] 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.

collateral requirements. Identification with time*firm fixed effects again results in only those firms that lodge more than one loan application in a particular month during the sample period to be retained, leaving 271,291 different loan applications.

2.2. *Granted Loans*

We also analyze the records on the granted business loans for the extended 1988:II to 2008:IV period present in the CIR, which contains confidential and very detailed information at the loan level on virtually *all* loans granted by *all* banks operating in Spain. More than 130,000 firms and 200 banks are active in the database at any moment in time during two business cycles.

The CIR is *almost* comprehensive, as the monthly 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, see for example Gertler and Gilchrist (1994) and Lang and Nakamura (1995)). We match each loan both to bank balance-sheet variables and to selected firm characteristics, in particular firm identity, industry, location, and the level of credit, defaults and collateral requirements. Both the loan and bank datasets are owned by the *Banco de España* in its role as banking supervisor.

We exploit the relevant interactions between the bank capital ratio and measures of firm credit risk based on past credit performance recorded in the CIR. The unit of analysis is the *time-bank-firm* triplet, therefore loan level information is quarterly aggregated to this level. The entire database contains more than 50,000,000 loan credit exposure triplets (henceforth “loans”) and contains more than 2,400,000 “loans” in the last quarter of 2008 for example.

Computational capacity constraints make it impossible to deal with the vast amount of loan data available (and saturate the specifications with a large number of fixed effects). We therefore randomly sample 20 percent of the firms, based on the penultimate digit of the firm's fiscal identifier number, which is random and not related to its industry, legal status or location for example. Once a firm is selected, all its loans are included during the sample period.

3. IDENTIFICATION STRATEGY

Does a low monetary policy rate spur risk-taking by banks? To address this question one needs to disentangle the impact of the changes in the overnight interest rate on the risk of the supply of credit from changes in the volume of the supply and changes in the quality and the volume of the demand – while accounting for the impact of other key macro variables including long-term interest rates. This bank risk-taking channel involves compositional changes in the supply of credit at the *bank-firm* level.

Our identification strategy consisting of three crucial ingredients: (1) two-stage modeling with first loan applications then credit outcomes; (2) saturation with time*bank and time*firm fixed effects, while interacting the change in the overnight interest rate with bank capital and a firm credit-risk measure; (3) horseracing the overnight interest rate, in its interaction with bank capital and firm risk, with the corresponding triple interactions of other key macro variables.[7] We now motivate and discuss each of these three key strategy components in more detail along with our measures of credit.

[7] Unless absorbed by the sets of fixed effects we always include in the specifications all relevant variables from the triple interactions in double interactions and in levels. If thus used as controls we do not report their estimated coefficients in the Tables to save space and avoid unnecessary clutter.

3.1. Two-Stage Model

Our benchmark specification is a selection Tobit model, with the granting of loan applications in the first stage and, if the loan is granted, the credit amount the bank commits in the second stage. Loan application and amount granted are key steps in the supply of credit at the extensive and intensive margins, respectively. With the second stage the future likelihood of default and collateral requirements will also be analyzed. In robustness, we study twenty years of quarterly changes in the amount of committed bank-firm credit (capturing the monitoring of existing clients, rather than the screening of loan applications by new ones).

We employ the panel-data version of the classical sample-selection model, also known as a type 2 Tobit Model. The selection equation involves the granting of the loan applications, while credit amount and other terms are only observed for those successful applications that are granted. To obtain consistent estimates we follow the procedure in Kyriazidou (1997). This estimation procedure is similar to the Heckman (1979) two-step procedure to deal with sample selection. One needs to estimate the selection equation consistently and use the estimates to construct weights to be inserted in a weighted least-square regression of the equation of interest after taking first-differences.

Given the extensive sets of fixed effects we include and as we are primarily interested in the estimated coefficients of the triple interactions, we employ linear probability models. To make results comparable across specifications, all samples contain only firms that apply to multiple banks, and fail or succeed at least once during the entire sample period.

3.2. *Saturation with Fixed Effects and Triple Interactions*

3.2.1. *Time*Bank and Time*Firm Fixed Effects*

We aim to disentangle the impact of the changes in the overnight interest rate on the risk of the supply of credit, from changes in the volume of the supply and changes in the quality and the volume of the demand, while accounting for the impact of other key macro variables.

To suppress concurrent changes in the volume of credit supply we saturate specifications with time*bank fixed effects. With observed and unobserved time-varying bank heterogeneity accounted for, identification resides in comparing changes in lending during the same period (i.e., month in our main specifications) by the same bank to different firms (with respect to credit risk). All banks lend to more than one firm, hence there is no loss of observations.

To suppress concurrent changes in the quality (along balance sheet strength) and volume of the firm demand for credit, we similarly saturate specifications with time*firm fixed effects (Khwaja and Mian (2008), Jiménez, Ongena, Peydró and Saurina (2011)). Observed and unobserved time-varying firm characteristics accounted for include for example the net present value of firm projects, investment opportunities, agency problems, risk, pledgeable income and collateral. Identification comes from comparing changes in lending in the same period by different banks (with respect to their capital-to-asset ratios) to the same firm. Most firms apply to multiple banks, and similarly maintain multiple bank relationships. Indeed firms with multiple bank relationships account for 86 percent of all business loans. So the loss of observations for the exhaustive datasets we study is minimal.

In accordance with the focus of our analysis and the variation in our data, we multi-cluster standard errors at the time, bank, and firm level.

3.2.2. *Triple Interaction of Overnight Interest Rate, Bank Capital Ratio, and Firm Credit Risk*

Expansionary monetary policy may spur banks to lend more riskily and when afflicted by severe agency problems even excessively so. To distinguish between this intentional extra risk-taking and the risk that arises almost inevitably from the expansion of credit flowing through the bank and firm balance-sheet channels, it is essential to have a sharp measure for the intensity of the agency conflict that besets banks' own borrowing from their financiers. The bank capital-to-assets ratio is such a measure (Holmstrom and Tirole (1997), Freixas and Rochet (2008)).[8] The ratio is particularly meaningful in Spain because off-balance sheet activity by banks has been almost non-existent.[9]

We interact the change in the overnight interest rate with the lagged bank capital ratio (*à la* Kashyap and Stein (2000)), and a measure of firm credit risk (to be discussed shortly). As bank capital may be correlated with other bank characteristics, we also field besides time*bank fixed effects the corresponding triple interactions (i.e., in which bank capital is replaced) with bank size, liquidity, profitability, non-performing loan ratio, and type.[10]

Expansionary monetary policy may result in more risky credit as a consequence of changes in the quality and even changes in the volume of the demand for credit (i.e., the widely-discussed effects flowing through the firm balance sheet and interest rate channels,

[8] See also Gertler and Kiyotaki (2011), among others. Stiglitz and Greenwald (2003) conjectures similarly that banks may act risk aversely because of information, contract and competition imperfections. Consequently, the degree of their risk aversion may depend not only on their borrowers' but also on their own net worth. Lower interest rates increase the value of the banks' portfolio of securities and loans, thereby raising banks' net worth and capital. This, in turn, increases their ability and incentives to take credit risk and this effect may be most strongly felt by the lowly capitalized banks.

[9] Consequently total bank assets cover most of the banks' businesses. Banks did not develop conduits or Structured Investment Vehicles (SIVs) because the prevailing accounting and regulatory rules made banks consolidate these items and set aside sufficient capital.

[10] In robustness triple interactions of the inflation rate and firm credit risk with bank size, liquidity, profits and the non-performing loan ratio control exhaustively for changes in the price level (i.e., to arrive at a *real* overnight interest rate).

respectively). To isolate the role played by the supply we interact the change in the overnight interest rate with bank capital and a measure of firm credit risk. Our mainstay measure of firm credit risk is a variable that equals one if a firm had any non-performing loans outstanding during a four-year period prior to applying or borrowing, and equals zero otherwise. In robustness we also assess five, three, two, and one-year periods.

3.3. *Horseracing Triple Interactions*

3.3.1. *The Overnight Interest Rate*

Banks are mostly funded with short-term debt (Diamond and Rajan (2001), Adrian and Shin (2011), Diamond and Rajan (2012)), the interest rates of which will likely respond to changes in the monetary policy rate. For our study we employ as the monetary policy rate the Euro OverNight Index Average rate (EONIA), which recall is targeted by the European Central Bank and Eurosystem, and before 1998 the Spanish overnight interest rate. We interact the change in the overnight interest rate with bank capital and firm risk.

For the whole period short-term interest rates in Spain were decided mostly in Frankfurt, not in Madrid,[11] and Spanish interest rates converged to Euro area ones, assuaging any well-founded concerns of reverse causality (e.g., future higher risk may imply current monetary

[11] In 1986 Spain joined the European Union. Consequently, monetary policy started to pay more attention to the exchange rate with the *Deutsche Mark*. The monetary policy authorities in this way intended to incorporate more discipline and credibility in their fight against inflation. At the same time, capital restrictions were being eliminated. Implicitly from mid-1988 and explicitly from 1989 when Spain joined the European Monetary System and its exchange rate mechanism, the exchange rate target with the Deutsche Mark was the main objective of its monetary policy (Banco de España (1997)). Hence as of mid-1988, Spanish monetary policy was no longer independent from the German monetary policy according to the textbook 'Mundell-Fleming trilemma' (Krugman and Obstfeld (2006)). Spain did devalue its currency three times between 1992 and 1993 and also had temporary credit controls in the second half of 1989 and during 1990. Time effects account for these episodes. From 1999 onwards, Spain joined the Eurosystem, representing around 10 percent of the total economic activity in this group. Notice that the mandate given to both the *Bundesbank* and the ECB was primarily to preserve price stability, not to stimulate economic activity, or safeguard financial stability. Moreover, 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)).

expansion) and omitted variables (variables correlated with the stance of monetary policy that can also influence risk-taking). Further mitigating these concerns, time*bank and time*firm fixed effects absorb any observed and unobserved time-varying heterogeneity across *all* included banks and firms (comprising, for all practical purposes, the entire economy).

3.3.2. *Long-Term Interest Rates and Other Key Macro Variables*

Despite the predominance of banks' short-term funding, their risk-taking could also be affected by changes in long-term interest rates. Hence, the third crucial component in our identification strategy is to concurrently account for the effects of changes in a long-term interest rate (which may also capture firm investment opportunities and pledgeable income which often are long-term in nature). We therefore horserace the triple interaction between the Spanish ten-year government bond rate, bank capital and firm risk, with the equivalent triple interaction with the monetary policy rate. Similar triples with the changes in GDP growth and prices are also in the race (Bernanke and Blinder (1992), Christiano, Eichenbaum and Evans (1996)).[12]

And, we concurrently include triple interactions with other key macroeconomic variables such as changes in securitization and current account deficit (capital inflows), and U.S. ten-year government bond and federal funds rate, respectively, the latter possibly kept low by a savings glut and the deepening of financial globalization (Besley and Hennessy (2009), Bernanke (2010)).

[12] Banks' credit policies may fluctuate cyclically (Asea and Blomberg (1998), Rajan (1994)). Improvements in economic outlook and declining borrowers' default probabilities lowers their screening activity, intensifies price competition and boosts lending to low quality borrowers (Ruckes (2004)). Jiménez, Salas and Saurina (2006) show that collateral requirements are softened during expansions, while Delgado, Salas and Saurina (2007) find that average loan size increases in upturns.

All in all, given our comprehensive data, sample periods, identification strategy, and saturated specifications, we are confident that it is possible to make well-founded inferences on whether short-term monetary policy rates affect banks' credit risk-taking, and in general on whether macroeconomic shocks result in changes in the composition of the supply of credit.

4. RESULTS

4.1. *Model Line-Up*

This Section presents and discusses our estimates. In Tables II to VII we analyze the sample consisting of business loan applications lodged between 2002:02 to 2008:12 with a selection model, and in Table IX we analyze the sample consisting of all business loans granted between 1988:II to 2008:IV. Tables I and VIII present the summary statistics of the two different samples.

Our main Table II analyzes the risk-taking channel of monetary policy with a selection model, the first stage with the granting of loan applications and, for the granted applications, the second stage with the logarithm of the committed amount of granted loans. Included are time*firm fixed effects as of Model (5), then also time*bank fixed effects in (6).

Table III builds further to an exhaustive specification that contains triple interactions with all key macro controls in Model (10), while Table IV varies the time horizon of the measure of firm credit risk. Tables V and VI feature second stages with the future likelihood of loan default and collateral requirements as dependent variables.

Table VII links the two samples showing estimates from second-stage like regressions of loan outcomes without accounting for the first stage. Table IX then analyzes the change in (log) credit volume for the sample of all business loans between 1988:II-2008:IV.

4.2. *Granting of Loan Applications and Committed Amount of Granted Loans*

4.2.1. *Benchmark Estimated Model*

We estimate a selection model with loan applications in the first stage and the amount of committed loans in the second (variable names are abridged in the equations):

(1)
$$\mathrm{I(LOAN\ APPLICATION}_{tbi}) = \delta \Delta OVERNIGHT\ RATE_{t-1} * LN(BANK\ CAPITAL_{t-1b}) * I(FIRM\ RISK_{ti}) + \alpha_{tb} + \alpha_{ti} + Controls_{tbi} + \varepsilon_{tbi}$$

$$\mathrm{LN(COMMITTED\ LOANS}_{tbi}) = \delta \Delta OVERNIGHT\ RATE_{t-1} * LN(BANK\ CAPITAL_{t-1b}) * I(FIRM\ RISK_{ti}) + \alpha_{tb} + \alpha_{ti} + Controls_{tbi} + \varepsilon_{tbi}$$

The dependent variable in the first-stage regression in Tables II to VI is I(LOAN APPLICATION IS APPROVED BY A BANK AND THE LOAN IS GRANTED TO A FIRM THAT IS NEW TO THE BANK_{tbi}) which equals one if the loan application made in month *t* to bank *b* by firm *i* is successful and the loan is granted in *t* to *t+3*, and equals zero otherwise (all variable definitions are collected in an Appendix). Its mean of 0.36 (in Table I) implies 2.8 applications lodged per loan granted, with a standard deviation of 0.48. The dependent variable in the second-stage regression in Tables II to IV is LN(COMMITTED AMOUNT OF GRANTED LOANS_{tbi}) which, following a granted application in month *t* to bank *b* by firm *i*, equals the logarithm of the committed loan amount (in thousands of Euros) granted by bank *b* to firm *i* in *t* to *t+3*. The mean and standard deviation are 4.41 and 1.32, equivalent to around 82,000 and 3,750 Euros, respectively.

In the first stage we employ a linear probability model we can stepwise saturate with fixed effects and so we can make robust inferences on triple interactions. The sample period from 2002:02 to 2008:12 includes 65 months of run-up to and 18 months of financial crisis. The total number of loan applications equals 241,052. To make results comparable across specifications, the sample contains only firms that apply to multiple new banks, and fail or succeed at least once during the sample period.

We are interested in the coefficient, δ, on the triple interaction of the change in the overnight rate, bank capital, and firm risk. ΔOVERNIGHT INTEREST RATE$_{t-1}$ is the annual change in the Euro OverNight Index Average rate (EONIA) at *t-1*, with a mean equal to 0.26 and standard deviation of 0.71. LN(BANK CAPITAL$_{t-1b}$) is the capital ratio at time *t-1* defined as the logarithm of the ratio of bank equity and retained earnings over total assets (in percent) of bank *b*. Its mean equals 1.66 and its standard deviation 0.30.[13] I(FIRM CREDIT RISK$_{ti}$) equals one if in month *t* firm *i* had non-performing loans outstanding in the previous 4 years prior to *t*.[14] It has a mean equal to 3 percent, and a standard deviation of 17 percent. There is actually little or no correlation between the capital ratio of the banks that the firms apply to borrow from and firm credit risk (correlations range between 0.005 and 0.006).

A positive coefficient on this "triple" (interaction) implies that when the overnight rate declines lowly capitalized banks grant more applications and larger loan amounts to risky

[13] The mean (median) capital ratio equals 6.1 percent (5.4 percent), with a standard deviation that equals only 2.3 percent. But the ratio ranges between 0.3 and 92.5 percent; hence, we take its logarithm to have a more normal symmetric distribution, in turn also reducing the impact of the few high-value observations and accounting for the possibly decreasing marginal effect on risk-taking of increasingly higher capital ratios. Results are robust if we use the bank capital ratio without taking its logarithm.

[14] Following common practice we classify loans that are 90 days overdue as "non-performing", which includes "doubtful" loans where banks expected firms to overcome their temporary difficulties in repaying. We focus on a 4-year period to maintain consistency (i.e., the sample period for our robustness exercises starts in mid-1988 when the Spanish exchange rate regime changed, and the credit register has records as of 1984; the pre-1988 records are then needed to construct firm credit histories). Recent non-performance is also relevant for banks, so we also study shorter prior periods.

firms, i.e., these banks take more risk. In the end, we load in time*bank and time*firm fixed effects (represented by α_{tb} and α_{ti}), which are comprehensive sets of dummies for each *time – bank* and for each *time – firm* pair. Further included are bank controls, triples with other macro and bank variables, and the doubles and the levels of the variables when those are not absorbed by the fixed effects (not reported in the Tables). Standard errors in all specifications are multi-clustered at the time, bank, and firm level.

But before turning to the regression estimates from the two stages, Figures 1 and 2 provide a visual sneak preview of the findings. Representing the first stage, Figure 1 plots at a yearly and quarterly frequency: (a) the probability a loan application is granted (left-hand scale) by a bank with low versus high capital (by median) to an otherwise average firm with non-performing loans outstanding in the previous 4 years versus a firm without; and (b) the change in the overnight interest rate (right-hand scale). For the second stage Figure 2 similarly plots the logarithm of the committed amount of granted loans and the change in the overnight interest rate.

The figures show clearly that when the overnight interest rate decreases lowly capitalized banks grant more loan applications to risky firms than highly capitalized banks, and also than to firms without recent non-performing loans. The same is true for the committing of granted loan amounts. Spanish bank securitization or current account deficit (implying a capital inflow) for example which are not plotted but are well known to be higher in the latter part of the sample period (and which will also be featured in our regressions) can therefore not be driving bank risk-taking in lending.

4.2.2. *Main Results*

Model (1) introduces bank capital and firm risk in levels, and Model (2) their relevant interactions, while including time and firm fixed effects and bank controls, and in (2) also triples of GDP growth or inflation with bank capital and firm risk.

The estimates suggest that, although well capitalized banks do not necessarily lend less, risky firms unfailingly obtain less credit, i.e., their applications are less likely to be granted and if so banks commit lower loan amounts. When the overnight interest rate decreases banks grant and commit more credit to all firms,[15] but especially to risky firms, i.e., the estimated coefficients on the double ΔOVERNIGHT INTEREST RATE_{t-1} * I(FIRM CREDIT RISK_{ti}) in both stages are negative and statistically significant. This effect we find is strengthened for lowly capitalized banks, i.e., in both stages the estimated coefficients, $\hat{\delta}$, on the triple of overnight rate, bank capital, and firm risk is positive and statistically significant at the 1 percent level (we assess economic relevancy in the next subsection).

Model (3) adds time*firm fixed effects, to assess the differences in the granting and committing of credit following changes in the overnight interest rate in the same month by banks of different capital ratios to the same firm. $\hat{\delta}$ (again in both stages) remains positive and statistically significant at the 1 percent level. Model (4) adds triples (of the overnight rate and firm risk) with bank size, liquidity, profitability, non-performing loan ratio, and type (labeled "Bank Controls" in the Tables). $\hat{\delta}$ is virtually unaltered suggesting bank capital is exogenous to these key bank characteristics.

[15] In unreported specifications without time fixed effects (which account for all observed and unobserved variation in the macro environment) we find that the estimated coefficient on the overnight interest rate is consistently negative.

Model (5) adds bank fixed effects to the time*firm fixed effects, bank controls, the two parallel triples with GDP and inflation, and the six parallel triples with bank controls. With the level and the two relevant interactions of bank capital still in play, we consider this our benchmark specification which we will next subject to various robustness checks. One additional step is taken for example in Model (6) by adding time*bank fixed effects (we also return to this model later on). Despite the near-saturation with fixed effects and parallel triples, $\hat{\delta}$ remains largely unaffected in absolute value though statistically approaching "suffocation".

4.2.3. *Economic Relevancy and Robustness*

In Table II triples of bank capital and firm risk with Spanish GDP growth and inflation, respectively, horserace with the triples of the overnight rate. In Table III are entered into the race other macro variables which are correlated with the overnight rate and which could also cause more bank risk-taking. Specifically, Table III assesses the statistical significance and economic relevancy of the impact on risk-taking of the changes in the Spanish ten-year government bond rate, bank securitization, and current account deficit, and the U.S. ten-year government bond and federal funds rate.

For easy handicapping Column (1) in Table III contains the coefficients of our benchmark Model (5) of Table II, and an assessment of the economic relevancy in italics below the estimates for each stage: from now on we calculate the impact of a 1 percentage point decrease in the overnight interest rate for lowly versus highly capitalized banks (that differ by one standard deviation in capitalization) and for lending to risky firms (i.e., with non-performing loans in the previous 4 years). The granting of loan applications by lowly capitalized banks to risky firms increases by 3 percentage points more (than by highly capitalized banks) implying a semi-elasticity of 8 percent, while the committing in loan amounts increases by 19 percent more! These percentages suggest the economic importance of monetary policy for bank risk-taking.

The rest of Table III actually shows these estimates to be mostly conservative. Model (2) enters triples of inflation and firm risk with each one of the bank controls, i.e., size, liquidity, profitability, non-performing loan ratio, and type. Consequently, the overnight rate and inflation race one-for-one in all possible terms. The semi-elasticity in the second stage jumps to 28 percent, suggesting that the impact of the overnight interest rate once inflation is fully accounted is even more important for risk-taking.

Next, we field the change in the Spanish ten-year government bond rate, including the by-now well-known triple with bank capital and firm risk, horseracing it in Model (3) with the triple of the overnight rate, and running it by itself in (4). Either way, the estimated coefficients on the triple of this long-term interest rate are never statistically significant, while in Model (3) the triple of the overnight rate remains significant and relevant. Estimates therefore strongly suggest it is the change in the short-term rather than the long-term interest rate that matters for bank risk-taking.

U.S. long- and short-term interest rates enter, in triples with bank capital and firm risk (and in corresponding not-reported doubles) in Models (5) to (7). The U.S. ten-year government bond rate enters in (5), the U.S. federal funds rate in (6), and jointly in (7) (to conserve space we tabulate only the coefficients on the funds rate then). The estimated coefficients on changes in the U.S. long-term interest rate are never statistically significant; those on the U.S. short-term rate are significant at the 10 percent level in the first stage and at the 5 percent level in the second stage. The latter estimates always have the same sign than the estimated coefficients on the (EONIA) overnight rate, that are however statistically significant at the 5 and 1 percent levels, respectively, and double in size (though the standard deviation over the sample period on the federal funds rate equals 1.78, while on the overnight rate it only equals 0.71).

Model (8) enters Spanish bank securitization over GDP in the usual way, in triple (and double). More securitization results in more granting of applications by lowly versus highly capitalized banks to risky firms (i.e., the estimated coefficient on the triple in the first stage is negative and statistically significant), but not in more committing of loan amounts. Model (9) races the current account deficit over GDP. A higher current account deficit results in more committing by lowly versus highly capitalized banks to risky firms, but not in more granting. Importantly, in both models the estimated coefficients on the triple with the overnight rate remain statistically significant and economically relevant.

Finally, Model (10) races all aggregate variables with statistical significance so far (i.e., the federal funds rate, securitization and the current account deficit) on the most accidented track we have, i.e., the one with time*bank fixed effects (benchmark model results are similar). While the estimates of the coefficients on the funds rate, securitization and current account are no longer statistically significant, the overnight rate retains statistical significance and economic relevancy.

In sum, Table III shows the strength of the impact of the changes in the (EONIA) overnight rate on bank risk-taking in specifications with changes in aggregate output and prices, the ten-year Spanish government bond rate, the U.S. ten-year government bond, the federal funds rate, Spanish bank securitization and the current account deficit. A lower funds rate, higher securitization and higher current account deficits also result in more bank risk-taking. However, the overnight rate is the only key macro variable that has an impact on bank risk-taking that is robustly statistically significant and economically relevant.

Table IV further shows the robustness of the estimates to changes in the time period over which firm credit risk is being assessed, i.e., from 5 to 1 year prior to the loan application. The estimates of the coefficients on the triple interaction with the overnight rate in the benchmark model are stable, in sign, statistical significance and economic relevancy (semi-elasticities in the first stage vary between 8 and 12 percent, in the second stage between 14 and 30 percent).

4.3. *Future Credit Defaults and Lack of Collateral Requirements*

In Tables V and VI we study how the changes in monetary policy affect the likelihood of future (i.e., ex-post) loan default and the stringency of collateral requirements. Shown so far is that when the overnight rate decreases lowly capitalized banks supply more credit to ex-ante risky firms. Now we analyze if lowly capitalized banks are also more likely to grant loans to firms that default more *ex-post* or grant loans without collateral requirements, i.e., both loan outcomes are featured as complementary measures of bank risk-taking.

We again employ a selection model, with in the first stage the granting of loan applications, and in the second stage of Tables V and VI as dependent variables: I(FUTURE DEFAULT WITH THE $BANK_{tbi}$), a dummy variable which equals one when the loan that is granted at time t by bank b to firm i defaults at some point in the future; and I(LOAN GRANTED WITHOUT $COLLATERAL_{tbi}$), a dummy variable which equals one if the loan granted in month t by bank b by firm i is uncollateralized, and equals zero otherwise.

Table V documents that a decrease in the overnight rate leads especially lowly capitalized banks to grant more loan applications with a higher future likelihood of default: the double interaction of the change in the overnight rate and bank capital in the second stage is positive and statistically significant in all Models (2) to (6), and for example robust to the inclusion of bank, firm, and time fixed effects in (4), and time*firm fixed effects in (5) and (6). Model (6) is further padded with doubles of bank capital with changes in aggregate output and prices, the U.S. federal funds rate, Spanish securitization and current account deficit, bank fixed effects and (time-varying) bank controls, and doubles of the overnight rate with bank controls. In this demanding specification a 1 percentage point decrease in the overnight rate leads lowly capitalized banks to grant loans that are 5 percent more likely to default in the future than highly capitalized banks (that have one standard deviation more in capitalization), while the estimated coefficients on funds rate, securitization and current account are not statistically significant.

Table VI similarly analyzes the absence of collateral requirements with representative models from Tables II and III. Model (3) for example is the equivalent of the loaded specification (10) in Table III. The estimates show that a decrease in the overnight rate leads lowly capitalized banks to more likely grant loan applications to risky firms, and that the granted loans to these firms are more likely to be uncollateralized with a semi-elasticity of 7 percent while the estimated coefficients on funds rate, securitization and current account are again not statistically significant.

In sum, we find statistically robust and economically relevant evidence that a decrease in the overnight interest rate leads lowly capitalized banks to grant more loan applications (than highly capitalized banks) to risky firms and that, when granted to risky firms, the committed loan amounts are larger and more likely uncollateralized, and that the loans that are granted more likely to default in the future. A decrease in the long-term interest rate or a change in other relevant aggregate variables have no such effects.

4.4. *Twenty Years of Business Loans*

As a final robustness check we analyze the sample consisting of all business that were granted during the twenty years period between 1988:II and 2008:IV. We do not observe the granting of loan applications during this entire period, so we can only analyze the change in the logarithm of the committed credit granted. Without a selection model this analysis may therefore be biased.

To understand the direction and magnitude of such a bias, Table VII presents estimates from specifications that are similar to the second stage of representative models from Tables II to VI, but without actually estimating a first stage. As risk-taking takes place already in the granting of loan applications, not correcting for the sample selection bias reduces the potency of the risk-taking channel of monetary policy by 41, 48, and 37 percent, respectively, for the committed amount of granted loans, future default, and absence of collateral requirements.

These findings are not only important for the interpretation of the estimates in Table IX (we discuss shortly), but also raise the possibility of a bias in the extant empirical literature estimating the potency of the credit channel. With loan applications and time*firm fixed effects we can directly account for the effects from the firm-balance sheet and demand channels, with the first-stage model we can account for loan application granting (with only macro- or bank-level data as in Bernanke and Blinder (1992) and Kashyap and Stein (2000) for example, or with only loan-level data as in Khwaja and Mian (2008) for example, one needs to make more assumptions).

Table VIII presents the summary statistics for the quarterly change in the committed amount of granted loans and the independent variables that are used for a sample with 6,564,964 observations from the 1988:II - 2008:IV period (which recall is randomly drawn from the credit register containing virtually all granted business loans in Spain). The estimates in Table IX suggest that a decrease in the overnight rate leads lowly capitalized banks to increase lending to risky firms more (than highly capitalized banks). Results are robust to controlling for: time*bank and time*firm fixed effects; triples of GDP growth or inflation, bank capital, and firm risk; triples of the overnight rate and firm risk with each one of the bank controls, i.e., size, liquidity, profitability, non-performing loan ratio, and type; all corresponding doubles and variables in levels; and new in this context controls at the bank-firm level, i.e., the one-quarter lag of the dependent variable (as a time-varying bank-firm level control) and a comprehensive set of bank*firm fixed effects (as time-invariant controls).[16] The estimates further indicate economic relevancy of the effect: in Model (4) for example a 1 percentage decrease in the overnight rate leads lowly capitalized banks to lend 12 percentage points more to risky firms (than highly capitalized banks).

5. CONCLUSIONS

We identify the impact of the business cycle on the composition of the supply of credit. In particular, we analyze the impact of the overnight monetary policy rate on risk-taking by banks. Spain offers an ideal setting for identification. Its economic system is dominated by banks and it had a fairly exogenous monetary policy during the last twenty-two years. The Credit Register managed by the *Banco de España*, the banking supervisor, contains exhaustive data on *all* outstanding business loan contracts at a quarterly frequency since 1984:I and,

[16] In previous Tables robust standard errors are corrected for multi-clustering at the year-month, bank and firm level. Given the very large number of observations and the corresponding size of the three included sets of fixed effects we only succeed to cluster at the year-quarter, bank, or firm level. The estimates for clustering at the firm level is most conservative (i.e., standard errors increase the most) and hence reported, yet results are robust to clustering at the year-quarter or bank level.

crucial for our purposes, on loan applications with their loan outcomes at a monthly frequency since 2002:02.

To isolate the compositional changes in the supply of credit, we need to account for conventional bank- and firm-balance sheet channels and for firm loan demand. Balance sheet channels and demand operate at the bank or firm level, while the bank risk-taking channel situates itself at the *bank-firm* level. We therefore study exhaustive loan application and contract data in a selection model where we analyze the granting of loan applications in the first stage and the loan outcomes for the granted applications in the second stage. We control for time-varying observed and unobserved bank and firm heterogeneity with time*bank and time*firm fixed effects.

We find robust evidence that a lower overnight interest rate induces lowly capitalized banks to grant more loan applications to ex-ante risky firms than highly capitalized banks and that, when granted, the committed loans are larger in volume and are more likely to be uncollateralized. Granted applications by lowly capitalized banks also have higher ex-post likelihood of default (when the overnight rate is lower). A lower long-term interest rate and other key macro variables such as securitization and current account deficits (which entail capital inflows) have no such effects. In sum, monetary policy affects the composition of the supply of credit, in particular with respect to credit risk.

As we account for time-varying bank heterogeneity in our benchmark regressions (with a set of time*bank fixed effects), our results suggest that the intensity of risk-taking when the monetary policy rate is lower is not simply the result of more lending by capital-constrained banks (as in Adrian and Shin (2011)). Our findings are therefore more consistent with changes in risk-taking (and the composition of the supply of credit) driven by risk-shifting incentives, as in for example Allen and Gale (2000), Allen and Gale (2004) and Allen and Gale (2007).

As we find that monetary policy drives bank risk-taking which affects financial stability, our results lend support to the bestowing of new responsibilities to the Federal Reserve and the European Central Bank in the realm of macro-prudential supervision. Monetary and macro-pru policies may indeed not be independent (Goodhart (1988), Stein (2012)).

There are a number of natural extensions to our study. We currently focus on the impact of monetary policy on individual loan granting, but overlook the correlations between borrower risk and the impact on each individual bank's portfolio, or the correlations between all the banks' portfolios and the resulting systemic risk impact of monetary policy. In addition, we focus on the effects of one aggregate variable on one dimension of the composition of the supply of credit, i.e., monetary policy and firm credit risk. As highlighted by Matsuyama (2007) low-frequency macro variation and firm investment growth opportunities may be a natural and very interesting avenue for further exploration. We leave these and other extensions for future work.

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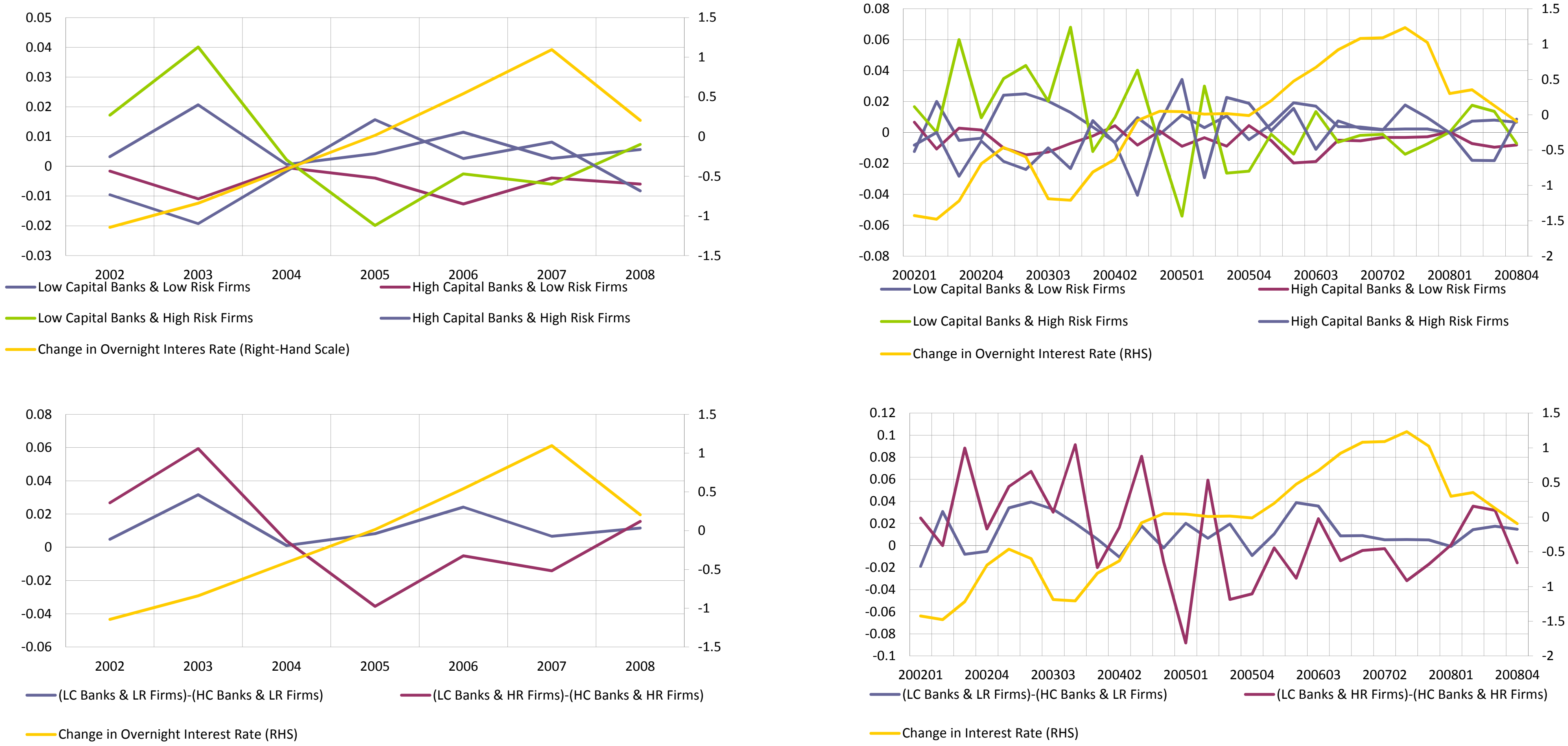

A: Annual frequency

B: Quarterly frequency

FIGURE 1.—The probability a loan application is granted (left-hand scale) by a bank with low versus high capital (by median) to an otherwise average firm with non-performing loans outstanding in the previous 4 years (HR) versus a firm without (LR), and the change in the overnight interest rate (right-hand scale).

A: Annual frequency

B: Quarterly frequency

FIGURE 2.—The logarithm of the committed amount of granted loans (left-hand scale) by a bank with low versus high capital (by median) to an otherwise average firm with non-performing loans outstanding in the previous 4 years (HR) versus a firm without (LR), and the change in the overnight interest rate (right-hand scale).

TABLE I

SUMMARY STATISTICS OF ALL VARIABLES USED IN THE ESTIMATIONS ON THE SAMPLE SELECTION MODEL USING LOAN APPLICATIONS [a]

Variable Name	Mean	Minimum	Q1	Median	Q3	Maximum	Standard Deviation
Dependent Variables							
I(LOAN APPLICATION IS APPROVED BY A BANK AND THE LOAN IS GRANTED TO A FIRM THAT IS NEW TO THE BANK$_{tbi}$)	0.36	0	0	0	1	1	0.48
COMMITTED AMOUNT OF GRANTED LOANS$_{tbi}$	287	2	30	69	180	77,704	1,315
LN(COMMITTED AMOUNT OF GRANTED LOANS$_{tbi}$)	4.41	0.69	3.40	4.23	5.19	11.26	1.32
I(FUTURE DEFAULT WITH THE BANK$_{tbi}$)	0.35	0	0	0	1	1	0.48
I(WITHOUT COLLATERAL$_{tbi}$)	0.89	0	1	1	1	1	0.31
Independent Variables							
Macro Variables							
ΔOVERNIGHT INTEREST RATE$_{t-1}$	0.26	-1.52	-0.08	0.23	0.74	1.48	0.71
ΔGDP$_{t-1}$	3.19	-0.27	3.00	3.46	3.83	3.98	0.88
ΔCPI$_{t-1}$	3.41	2.14	2.67	3.47	4.03	5.27	0.80
Bank Variables							
Bank Risk-taking Variable							
BANK CAPITAL RATIO$_{t-1b}$	5.51	3.18	4.20	4.94	6.09	63.10	1.96
LN(BANK CAPITAL RATIO$_{t-1b}$)	1.66	1.16	1.44	1.60	1.81	4.14	0.30
Bank Controls							
LN(TOTAL ASSET$_{t-1b}$)	17.33	9.94	16.34	17.37	18.50	19.91	1.45
LIQUIDITY RATIO$_{t-1b}$	14.96	0.03	9.59	13.94	18.87	91.21	7.52
ROA$_{t-1b}$	0.98	-8.93	0.68	0.92	1.17	10.84	0.53
NPL RATIO$_{t-1b}$	0.90	0.00	0.36	0.62	1.03	16.08	0.89
I(COMMERCIAL BANK$_b$)	0.39	0	0	0	1	1	0.49
I(SAVINGS BANK$_b$)	0.54	0	0	1	1	1	0.50
Firm Credit Risk Variables							
Firm Credit Risk Variable with 4 Years Horizon							
I(FIRM CREDIT RISK$_{ti}$)	0.03	0	0	0	0	1	0.17
Firm Credit Risk Variables with Other Horizons							
I(FIRM CREDIT RISK 5 YEARS$_{ti}$)	0.03	0	0	0	0	1	0.17
I(FIRM CREDIT RISK 3 YEARS$_{ti}$)	0.03	0	0	0	0	1	0.16
I(FIRM CREDIT RISK 2 YEARS$_{ti}$)	0.02	0	0	0	0	1	0.14
I(FIRM CREDIT RISK 1 YEAR$_{ti}$)	0.02	0	0	0	0	1	0.12

[a] This table reports summary statistics for the sample with 241,052 observations from the 2002:02 - 2008:12 period.

TABLE II

MAIN RESULTS[a]

	(1)	(2)	(3)	(4)	(5) BENCHMARK	(6) TIME*BANK FE
FIRST STEP						
Dependent Variable : I(LOAN APPLICATION IS APPROVED BY A BANK AND THE LOAN IS GRANTED TO A FIRM THAT IS NEW TO THE BANK $_{tbi}$)						
LN(BANK CAPITAL RATIO$_{t-1b}$)	-0.05 **	-0.03	-0.02	-0.02	0.06	
	(0.02)	(0.04)	(0.04)	(0.04)	(0.06)	
I(FIRM CREDIT RISK$_{ti}$)	-0.07 ***	-0.25				
	(0.02)	(0.25)				
ΔOVERNIGHT INTEREST RATE$_{t-1}$*LN(BANK CAPITAL RATIO$_{t-1b}$)		1.50	1.61	2.03 *	0.31	
		(1.20)	(1.09)	(1.18)	(1.56)	
ΔOVERNIGHT INTEREST RATE$_{t-1}$*I(FIRM CREDIT RISK$_{ti}$)		-9.44 *				
		(4.91)				
ΔOVERNIGHT INTEREST RATE$_{t-1}$*LN(BANK CAPITAL RATIO$_{t-1b}$)*I(FIRM CREDIT RISK$_{ti}$)		7.03 ***	9.32 ***	9.84 **	9.89 **	9.73 *
		(2.73)	(3.26)	(4.24)	(4.72)	(5.59)

SECOND STEP

Dependent Variable : LN(COMMITTED AMOUNT OF GRANTED LOANS$_{tbi}$)						
LN(BANK CAPITAL RATIO$_{t-1b}$)	-0.04	-0.01	-0.08	-0.15	0.08	
	(0.06)	(0.21)	(0.17)	(0.18)	(0.29)	
I(FIRM CREDIT RISK$_{ti}$)	0.27	-7.61 *				
	(0.25)	(4.08)				
ΔOVERNIGHT INTEREST RATE$_{t-1}$*LN(BANK CAPITAL RATIO$_{t-1b}$)		-2.43	-1.78	1.77	-1.96	
		(4.92)	(4.16)	(4.35)	(5.85)	
ΔOVERNIGHT INTEREST RATE$_{t-1}$*I(FIRM CREDIT RISK$_{ti}$)		-161.83 **				
		(66.28)				
ΔOVERNIGHT INTEREST RATE$_{t-1}$*LN(BANK CAPITAL RATIO$_{t-1b}$)*I(FIRM CREDIT RISK$_{ti}$)		69.36 ***	69.96 ***	68.40 ***	58.94 **	53.49 +
		(25.12)	(21.67)	(22.27)	(24.96)	(32.62)
(Year-Month) Fixed Effects	Yes	Yes	-	-	-	-
Bank Fixed Effects	No	No	No	No	Yes	-
Firm Fixed Effects	Yes	Yes	-	-	-	-
[(Year-Month)*Bank] Fixed Effects	No	No	No	No	No	Yes
[(Year-Month)*Firm] Fixed Effects	No	No	Yes	Yes	Yes	Yes
Bank Controls	Yes	Yes	Yes	Yes	Yes	-
{ΔGDP $_{t-1}$, ΔCPI $_{t-1}$ } *LN(BANK CAPITAL RATIO$_{t-1b}$)*I(FIRM CREDIT RISK$_{ti}$)	No	Yes	Yes	Yes	Yes	Yes
ΔOVERNIGHT INTEREST RATE$_{t-1}$**{Bank Controls $_{t-1b}$ }* *I(FIRM CREDIT RISK$_{ti}$)	No	No	No	Yes	Yes	Yes

[a] This table reports estimates from type-2 Tobit sample selection models which explain the probability that a loan application is approved by a bank and the loan is granted to a firm that is new to the bank (extensive margin of new lending) and the committed amount of granted loans by the bank to a firm given its loan application was succesfull (intensive margin of new lending). The estimates of the first step in this table come from linear probability models using ordinary least squares and 241,052 observations from the 2002:02 - 2008:12 period. The estimates of the second step for Models (1) and (2) in this table come from a standard two-step selection model, whereas the estimates for Models (3) to (5) come from the second stage of a two-step estimation procedure for panel data sample selection models outlined by Kyriazidou (1997) using kernel least squares. Both use 38,334 observations. The dependent variables are I(LOAN APPLICATION IS APPROVED BY A BANK AND THE LOAN IS GRANTED TO A FIRM THAT IS NEW TO THE BANK$_{tbi}$) which equals one if the loan application made in month t to bank b by firm i is successful and the loan is granted in t to t+3, and equals zero otherwise; and LN(COMMITTED AMOUNT OF GRANTED LOANS$_{tbi}$) which following a succesful application filed in month t to bank b by firm i is the logarithm of the committed loan amount granted by bank b to firm i in t to t+3. The definition of the independent variables can be found in the Appendix. Where possible a constant is included but its coefficient is left unreported. Where possible all macro, bank and firm variables in triple interactions are included in levels and in double interactions but their coefficients are left unreported. Fixed effects are either included ("Yes"), not included ("No") or spanned by another set of effects ("-"). For each variable the first row lists the coefficient, the second row lists the robust standard error that is corrected for multi-clustering at the year-month, bank and firm level; the corresponding significance levels are adjacent to the coefficient in the second column. [+] The coeffient has a p-value that equals 10.1 percent. * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

TABLE III

VARIOUS ROBUSTNESS[a]

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	BENCHMARK: TABLE II MODEL (5)	BENCHMARK & ΔCPI_{t-1} IN ALL INTERACTIONS	BENCHMARK & **CONTROL**$_{t-1}$ = ΔSPANISH LONG-TERM INTEREST RATE	BENCHMARK & **CONTROL**$_{t-1}$ = ΔSPANISH LONG-TERM INTEREST RATE	BENCHMARK & **CONTROL**$_{t-1}$ = ΔUS LONG-TERM INTEREST RATE	BENCHMARK & **CONTROL**$_{t-1}$ = ΔUS SHORT-TERM INTEREST RATE	BENCHMARK & **CONTROL**$_{t-1}$ = ΔUS SHORT-(LONG-)TERM INTEREST RATE	BENCHMARK & **CONTROL**$_{t-1}$ = ΔSPANISH SECURITIZED ASSETS / TOT. ASSETS	BENCHMARK & **CONTROL**$_{t-1}$ = ΔSPANISH CURRENT ACCOUNT DEFICIT / GDP	TIME*BANK FE & CONTROLS OF (6), (8) & (9)
FIRST STEP										
Dependent Variable : I(LOAN APPLICATION IS APPROVED BY A BANK AND THE LOAN IS GRANTED TO A FIRM THAT IS NEW TO THE BANK$_{tbi}$)										
LN(BANK CAPITAL RATIO$_{t-1b}$)	0.06	0.00	0.06	0.08	0.05	0.02	0.02	0.18 ***	0.09	
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.07)	(0.07)	(0.07)	(0.06)	
ΔOVERNIGHT INTEREST RATE$_{t-1}$*LN(BANK CAPITAL RATIO$_{t-1b}$)	0.31	0.28	0.28		0.27	0.50 **	0.00	0.02	0.23	
	(1.56)	(19.22)	(1.60)		(1.58)	(19.95)	(1.58)	(1.52)	(1.53)	
CONTROL$_{t-1}$*LN(BANK CAPITAL RATIO$_{t-1b}$)			0.05	0.77	-0.61	-0.01	-0.01	-4.41 ***	-1.01	
			(1.37)	(1.58)	(1.36)	(0.82)	(0.81)	(1.36)	(0.80)	
ΔOVERNIGHT INTEREST RATE$_{t-1}$*LN(BANK CAPITAL RATIO$_{t-1b}$)*I(FIRM CREDIT RISK$_{ti}$)	9.89 **	9.34 **	10.70 *		10.10 **	10.91 **	10.86 **	10.05 **	10.04 **	10.82 *
	(4.72)	(4.68)	(5.64)		(4.70)	(4.59)	(4.58)	(4.64)	(4.83)	(5.75)
CONTROL$_{t-1}$*LN(BANK CAPITAL RATIO$_{t-1b}$)*I(FIRM CREDIT RISK$_{ti}$)			-1.66	3.41	2.12	4.46 *	4.67 *	0.85	1.95	
			(5.71)	(6.04)	(5.73)	(2.52)	(2.73)	(5.95)	(4.28)	
Economic Significance (Semi-elasticity) of ΔOVERNIGHT INTEREST RATE $_{t-1}$	*8.4%*	*7.9%*	*9.1%*		*8.5%*	*9.2%*	*9.2%*	*8.5%*	*8.5%*	*9.2%*
Economic Significance (Semi-elasticity) of ***CONTROL*** $_{t-1}$			*-1.4%*	*2.9%*	*1.8%*	*3.8%*	*4.0%*	*0.7%*	*1.6%*	

SECOND STEP										
Dependent Variable : LN(COMMITTED AMOUNT OF GRANTED LOANS$_{tbi}$)										
LN(BANK CAPITAL RATIO$_{t-1b}$)	0.08	-0.13	-0.03	0.18	0.14	0.18	0.16	-0.19	0.17	
	(0.29)	(0.28)	(0.23)	(0.26)	(0.25)	(0.22)	(0.22)	(0.26)	(0.31)	
ΔOVERNIGHT INTEREST RATE$_{t-1}$*LN(BANK CAPITAL RATIO$_{t-1b}$)	-1.96	60.78	-2.47		-1.62	-1.31	-1.30	-0.34	-2.18	
	(5.85)	(202.20)	(5.65)		(5.64)	(5.46)	(5.47)	(5.26)	(5.92)	
CONTROL$_{t-1}$*LN(BANK CAPITAL RATIO$_{t-1b}$)			3.31	2.88	3.65	1.49	0.55	9.87 *	-2.02	
			(5.56)	(6.99)	(4.63)	(2.91)	(3.20)	(5.20)	(4.01)	
ΔOVERNIGHT INTEREST RATE$_{t-1}$*LN(BANK CAPITAL RATIO$_{t-1b}$)*I(FIRM CREDIT RISK$_{ti}$)	58.94 **	82.88 ***	78.35 **		61.49 **	86.76 ***	86.96 ***	55.62 *	81.69 ***	86.88 **
	(24.96)	(23.18)	(31.05)		(27.17)	(30.38)	(30.27)	(30.29)	(28.64)	(41.74)
CONTROL$_{t-1}$*LN(BANK CAPITAL RATIO$_{t-1b}$)*I(FIRM CREDIT RISK$_{ti}$)			-50.00	10.08	14.38	44.54 **	49.10 **	-15.26	-63.40 **	
			(44.27)	(29.37)	(36.26)	(21.79)	(24.11)	(42.78)	(30.97)	
Economic Significance (Semi-elasticity) of ΔOVERNIGHT INTEREST RATE $_{t-1}$	*19.4%*	*28.4%*	*26.6%*		*20.4%*	*29.9%*	*30.0%*	*18.3%*	*27.9%*	*29.9%*
Economic Significance (Semi-elasticity) of ***CONTROL $_{t-1}$***			*-42.3%*	*4.0%*	*4.4%*	*14.4%*	*16.0%*	*-4.5%*	*-17.4%*	
[(Year-Month)*Firm] Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	-
[(Year-Month)*Bank] Fixed Effects	No	No	No	No	No	No	No	No	No	Yes
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
{ΔGDP $_{t-1}$, ΔCPI $_{t-1}$ } *LN(BANK CAPITAL RATIO$_{t-1b}$)*I(FIRM CREDIT RISK$_{ti}$)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ΔOVERNIGHT INTEREST RATE$_{t-1}$**{Bank Controls $_{t-1b}$ }* *I(FIRM CREDIT RISK$_{ti}$)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

[a] This table reports estimates from type-2 Tobit sample selection models which explain the probability that a loan application is approved by a bank and the loan is granted to a firm that is new to the bank (extensive margin of new lending) and the committed amount of granted loans by the bank to a firm given its loan application was succesfull (intensive margin of new lending). The estimates of the first step in this table come from linear probability models using ordinary least squares and 241,052 observations from the 2002:02 - 2008:12 period. The estimates of the second step come from the second stage of a two-step estimation procedure for panel data sample selection models outlined by Kyriazidou (1997) using kernel least squares. It uses 38,334 observations. The dependent variables are I(LOAN APPLICATION IS APPROVED BY A BANK AND THE LOAN IS GRANTED TO A FIRM THAT IS NEW TO THE BANK$_{tbi}$) which equals one if the loan application made in month t to bank b by firm i is successful and the loan is granted in t to t+3, and equals zero otherwise; and LN(COMMITTED AMOUNT OF GRANTED LOANS$_{tbi}$) which following a succesful application filed in month t to bank b by firm i is the logarithm of the committed loan amount granted in t to t+3 by bank b to firm i. The definition of the independent variables can be found in the Appendix. Where possible a constant is included but its coefficient is left unreported. Where possible all macro,bank and firm variables in triple interactions are included in levels and in double interactions but their coefficients are left unreported. Fixed effects are either included ("Yes"), not included ("No") or spanned by another set of effects ("-"). For each variable the first row lists the coefficient, the second row lists the robust standard error that is corrected for multi-clustering at the year-month, bank and firm level; the corresponding significance levels are adjacent to the coefficient in the second column. The assessment of economic relevancy (in italics below the estimates for each stage) is based on a one percentage point decrease in the overnight interest rate or a comparable change in the indicated variable for a lowly versus highly capitalized bank (that differ by one standard deviation in capitalization) lending to firms with doubtful loans in the previous four years. * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

TABLE IV

ROBUSTNESS WITH RESPECT TO THE TIME HORIZON ON NON-PERFORMING LOANS TO MEASURE FIRM CREDIT RISK[a]

	(1)	(2)	(3)	(4)	(5)
FIRM CREDIT RISK Time Horizon:	5 YEARS	BENCHMARK: 4 YEARS	3 YEARS	2 YEARS	1 YEAR
FIRST STEP					
Dependent Variable : I(LOAN APPLICATION IS APPROVED BY A BANK AND THE LOAN IS GRANTED TO A FIRM THAT IS NEW TO THE BANK$_{tbi}$)					
LN(BANK CAPITAL RATIO$_{t-1b}$)	0.06	0.06	0.06	0.05	0.05
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
ΔOVERNIGHT INTEREST RATE$_{t-1}$*LN(BANK CAPITAL RATIO$_{t-1b}$)	0.31	0.31	0.32	0.30	0.45
	(1.56)	(1.56)	(1.56)	(1.55)	(1.56)
ΔOVERNIGHT INTEREST RATE$_{t-1}$*LN(BANK CAPITAL RATIO$_{t-1b}$)*I(FIRM CREDIT RISK$_{ti}$)	9.05 *	9.89 **	10.93 **	13.49 ***	8.49
	(4.87)	(4.72)	(5.27)	(5.22)	(6.43)
Economic Significance (Semi-elasticity) of ΔOVERNIGHT INTEREST RATE $_{t-1}$	*7.7%*	*8.4%*	*9.2%*	*11.7%*	*7.2%*
SECOND STEP					
Dependent Variable : LN(COMMITTED AMOUNT OF GRANTED LOANS$_{tbi}$)					
LN(BANK CAPITAL RATIO$_{t-1b}$)	0.00	0.08	0.02	0.01	-0.01
	(0.23)	(0.29)	(0.24)	(0.24)	(0.24)
ΔOVERNIGHT INTEREST RATE$_{t-1}$*LN(BANK CAPITAL RATIO$_{t-1b}$)	-1.07	-1.96	-0.92	0.39	-0.49
	(4.97)	(5.85)	(5.04)	(4.93)	(4.89)
ΔOVERNIGHT INTEREST RATE$_{t-1}$*LN(BANK CAPITAL RATIO$_{t-1b}$)*I(FIRM CREDIT RISK$_{ti}$)	58.31 ***	58.94 **	45.34 **	42.95 *	88.02 ***
	(17.91)	(24.96)	(22.67)	(22.38)	(31.38)
Economic Significance (Semi-elasticity) of ΔOVERNIGHT INTEREST RATE $_{t-1}$	*19.2%*	*19.4%*	*14.6%*	*14.0%*	*30.4%*
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes
[(Year-Month)*Firm] Fixed Effects	Yes	Yes	Yes	Yes	Yes
Bank Controls	Yes	Yes	Yes	Yes	Yes
{ΔGDP $_{t-1}$, ΔCPI $_{t-1}$ } *LN(BANK CAPITAL RATIO$_{t-1b}$)*I(FIRM CREDIT RISK$_{ti}$)	Yes	Yes	Yes	Yes	Yes
ΔOVERNIGHT INTEREST RATE$_{t-1}$**{Bank Controls $_{t-1b}$ }* *I(FIRM CREDIT RISK$_{ti}$)	Yes	Yes	Yes	Yes	Yes

[a] This table reports estimates from type-2 Tobit sample selection models which explain the probability that a loan application is approved by a bank and the loan is granted to a firm that is new to the bank (extensive margin of new lending) and the committed amount of granted loans by the bank to a firm given its loan application was succesfull (intensive margin of new lending). The estimates of the first step in this table come from linear probability models using ordinary least squares and 241,052 observations from the 2002:02 - 2008:12 period. The estimates of the second step come from the second stage of a two-step estimation procedure for panel data sample selection models outlined by Kyriazidou (1997) using kernel least squares. It uses 38,334 observations. The dependent variables are I(LOAN APPLICATION IS APPROVED BY A BANK AND THE LOAN IS GRANTED TO A FIRM THAT IS NEW TO THE BANK$_{tbi}$) which equals one if the loan application made in month t to bank b by firm i is successful and the loan is granted in t to t+3, and equals zero otherwise; and LN(COMMITTED AMOUNT OF GRANTED LOANS$_{tbi}$) which following a succesful application filed in month t to bank b by firm i is the logarithm of the committed loan amount granted in t to t+3 by bank b to firm i. The definition of the independent variables can be found in the Appendix. Where possible a constant is included but its coefficient is left unreported. Where possible all macro, bank and firm variables in triple interactions are included in levels and in double interactions but their coefficients are left unreported. Fixed effects are either included ("Yes"), not included ("No") or spanned by another set of effects ("-"). For each variable the first row lists the coefficient, the second row lists the robust standard error that is corrected for multi-clustering at the year-month, bank and firm level; the corresponding significance levels are adjacent to the coefficient in the second column. The assessment of economic relevancy (in italics below the estimates for each stage) is based on a one percentage point decrease in the overnight interest rate for a lowly versus highly capitalized bank (that differ by one standard deviation in capitalization) lending to firms with doubtful loans in the indicated number of previous years. * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

TABLE V

THE PROBABILITY THAT A FIRM BECOMES DELINQUENT WITH THE BANK IN THE FUTURE[a]

	(1)	(2)	(3)	(4)	(5)	(6)
FIRST STEP						
Dependent Variable : I(LOAN APPLICATION IS APPROVED BY A BANK AND THE LOAN IS GRANTED TO A FIRM THAT IS NEW TO THE BANK$_{tbi}$)						
ΔOVERNIGHT INTEREST RATE$_{t-1}$	-4.91 ***	-8.14	-8.50 *			
	(0.67)	(5.11)	(4.58)			
ΔGDP$_{t-1}$	6.26 ***	8.87 ***	7.02 ***			
	(0.55)	(1.35)	(1.63)			
ΔCPI$_{t-1}$	-1.58 ***	-2.52	-1.58			
	(0.51)	(1.55)	(1.58)			
LN(BANK CAPITAL RATIO$_{t-1b}$)	-0.05 **	-0.02	0.04	0.05	0.06	0.28 ***
	(0.02)	(0.04)	(0.05)	(0.05)	(0.06)	(0.08)
ΔOVERNIGHT INTEREST RATE$_{t-1}$*LN(BANK CAPITAL RATIO$_{t-1b}$)		2.37 *	1.07	0.84	0.58	0.10
		(1.23)	(1.33)	(1.34)	(1.54)	(1.51)
SECOND STEP						
Dependent Variable : I(FUTURE DEFAULT WITH THE BANK$_{tbi}$)						
ΔOVERNIGHT INTEREST RATE$_{t-1}$	3.34	-11.86	-32.91 ***			
	(2.42)	(10.30)	(9.13)			
ΔGDP$_{t-1}$	2.08	2.54	7.57 *			
	(3.93)	(3.61)	(3.97)			
ΔCPI$_{t-1}$	3.62 **	-5.80 **	-4.64			
	(1.53)	(2.46)	(3.32)			
LN(BANK CAPITAL RATIO$_{t-1b}$)	-0.03	-0.13 *	0.00	-0.02	-0.05	-0.14
	(0.03)	(0.07)	(0.12)	(0.11)	(0.12)	(0.19)
ΔOVERNIGHT INTEREST RATE$_{t-1}$*LN(BANK CAPITAL RATIO$_{t-1b}$)		4.79 **	4.46 **	3.59 *	6.17 ***	6.27 ***
		(2.14)	(2.16)	(2.12)	(2.39)	(2.42)
Economic Significance (Semi-elasticity) of ΔOVERNIGHT INTEREST RATE $_{t-1}$		*4.1%*	*3.8%*	*3.1%*	*5.3%*	*5.3%*
(Year-Month) Fixed Effects	No	No	No	Yes	-	-
Bank Fixed Effects	No	No	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes	-	-
[(Year-Month)*Firm] Fixed Effects	No	No	No	No	Yes	Yes
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes
{ΔGDP $_{t-1}$, ΔCPI $_{t-1}$} *LN(CAPITAL RATIO$_{t-1b}$)	No	Yes	Yes	Yes	Yes	Yes
*{ΔUS Short-Term IR $_{t-1}$, ΔSecurit./TA $_{t-1}$, ΔCurr. Acc./GDP $_{t-1}$}*LN(BANK CAPITAL RATIO $_{t-1b}$)*	No	No	No	No	No	Yes
ΔOVERNIGHT INTEREST RATE$_{t-1}$**{Bank Controls}*	No	Yes	Yes	Yes	Yes	Yes

[a] This table reports estimates from type-2 Tobit sample selection models which explain the probability that a loan application is approved by a bank and the loan is granted to a firm that is new to the bank (extensive margin of new lending) and subsequently the firm defaults (risk-taking margin of new lending). The estimates of the first step in this table come from linear probability models using ordinary least squares and 241,052 observations from the 2002:02 - 2008:12 period. The estimates of the second step come from the second stage of a two-step estimation procedure for panel data sample selection models outlined by Kyriazidou (1997) using kernel least squares. It uses 38,334 observations. The dependent variables are I(LOAN APPLICATION IS APPROVED BY A BANK AND THE LOAN IS GRANTED TO A FIRM THAT IS NEW TO THE BANK$_{tbi}$) which equals one if the loan application made in month t to bank b by firm i is successful and the loan is granted in t to t+3, and equals zero otherwise; and I(FUTURE DEFAULT WITH THE BANK$_{tbi}$) which equals one when the loan that is granted at time t by bank b to firm i defaults. The definition of the independent variables can be found in the Appendix. Where possible a constant is included but its coefficient is left unreported. Where possible all macro and bank level variables in double interactions and the double interactions reported in the Table are included in levels but their coefficients are left unreported. Fixed effects are either included ("Yes"), not included ("No") or spanned by another set of effects ("-"). For each variable the first row lists the coefficient, the second row lists the robust standard error that is corrected for multiclustering at the year-month, bank and firm level; the corresponding significance levels are adjacent to the coefficient in the second column. The assessment of economic relevancy (in italics below the estimates) is based on a one percentage point decrease in the overnight interest rate for a lowly versus highly capitalized bank (that differ by one standard deviation in capitalization). * p < 0.10; ** p < 0.05; *** p < 0.01.

TABLE VI

LOANS GRANTED WITHOUT COLLATERAL[a]

	(1)	(2)	(3)
	TABLE II MODEL (2)	TABLE II MODEL (5)	TABLE III MODEL (10)
FIRST STEP			
Dependent Variable : I(LOAN APPLICATION IS APPROVED BY A BANK AND THE LOAN IS GRANTED TO A FIRM THAT IS NEW TO THE BANK $_{tbi}$)			
LN(BANK CAPITAL RATIO$_{t-1b}$)	-0.03	0.06	
	(0.04)	(0.06)	
I(FIRM CREDIT RISK$_{it}$)	-0.25		
	(0.25)		
ΔOVERNIGHT INTEREST RATE$_{t-1}$*LN(BANK CAPITAL RATIO$_{t-1b}$)	1.50	0.31	
	(1.20)	(1.56)	
ΔOVERNIGHT INTEREST RATE$_{t-1}$*I(FIRM CREDIT RISK$_{ti}$)	-9.44 *		
	(4.91)		
ΔOVERNIGHT INTEREST RATE$_{t-1}$*LN(BANK CAPITAL RATIO$_{t-1b}$)*I(FIRM CREDIT RISK$_{ti}$)	7.03 ***	9.89 **	10.82 *
	(2.73)	(4.72)	(5.75)
SECOND STEP			
Dependent Variable : I(LOAN GRANTED WITHOUT COLLATERAL$_{tbi}$)			
LN(BANK CAPITAL RATIO$_{t-1b}$)	-0.07	-0.11	
	(0.09)	(0.09)	
I(FIRM CREDIT RISK$_{it}$)	-1.61		
	(1.31)		
ΔOVERNIGHT INTEREST RATE$_{t-1}$*LN(BANK CAPITAL RATIO$_{t-1b}$)	0.31	0.45	
	-1.33	-1.43	
ΔOVERNIGHT INTEREST RATE$_{t-1}$*I(FIRM CREDIT RISK$_{ti}$)	-0.38		
	(24.53)		
ΔOVERNIGHT INTEREST RATE$_{t-1}$*LN(BANK CAPITAL RATIO$_{t-1b}$)*I(FIRM CREDIT RISK$_{ti}$)	15.22 *	7.94	19.60 *
	(9.07)	(9.80)	(11.69)
Economic Significance (Semi-elasticity) of ΔOVERNIGHT INTEREST RATE $_{t-1}$	*5.2%*	*2.8%*	*6.6%*
(Year-Month) Fixed Effects	Yes	-	-
Bank Fixed Effects	No	Yes	-
Firm Fixed Effects	Yes	-	-
[(Year-Month)*Bank] Fixed Effects	No	No	Yes
[(Year-Month)*Firm] Fixed Effects	No	Yes	Yes
ΔOVERNIGHT INTEREST RATE$_{t-1}$**{Bank Controls $_{t-1b}$}* *I(FIRM CREDIT RISK$_{ti}$)	No	Yes	Yes

[a] This table reports estimates from type-2 Tobit sample selection models which explain the probability that a loan application is approved by a bank and the loan is granted to a firm that is new to the bank (extensive margin of new lending) and the lack of collateralization of the loan granted by the bank to a firm given its loan application was succesfull (risk-taking margin of new lending). The estimates of the first step in this table come from linear probability models using ordinary least squares and 241,052 observations from the 2002:02 - 2008:12 period. The estimates of the second step come from the second stage of a two-step estimation procedure for panel data sample selection models outlined by Kyriazidou (1997) using kernel least squares. It uses 38,334 observations. The dependent variables are I(LOAN APPLICATION IS APPROVED BY A BANK AND THE LOAN IS GRANTED TO A FIRM THAT IS NEW TO THE BANK$_{tbi}$) which equals one if the loan application made in month t to bank b by firm i is successful and the loan is granted in t to t+3, and equals zero otherwise; and I(LOAN GRANTED WITHOUT COLLATERAL$_{tbi}$) which equals one if the loan granted in month t by bank b by firm i is uncollateralized, and equals zero otherwise. The definition of the independent variables can be found in the Appendix. Where possible a constant is included but its coefficient is left unreported. Where possible all macro and bank level variables in double interactions and the double interactions reported in the Table are included in levels but their coefficients are left unreported. Fixed effects are either included ("Yes"), not included ("No") or spanned by another set of effects ("-"). For each variable the first row lists the coefficient, the second row lists the robust standard error that is corrected for multi-clustering at the year-month, bank and firm level; the corresponding significance levels are adjacent to the coefficient in the second column. The assessment of economic relevancy (in italics below the estimates) is based on a one percentage point decrease in the overnight interest rate for a lowly versus highly capitalized bank (that differ by one standard deviation in capitalization) lending to firms with doubtful loans in the previous four years. * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

TABLE VII

ONE-STEP MODELS WITHOUT CORRECTING FOR SAMPLE SELECTION[a]

	(1)	(2)	(3)	(4)
	2nd STAGE OF BENCHMARK: TABLE II MODEL (5)	2nd STAGE OF TIME*BANK FE: TABLE II MODEL (6)	TABLE V MODEL (5)	TABLE VI MODEL (3)
Dependent Variable:	LN(COMMITTED AMOUNT OF GRANTED $LOANS_{tbi}$)	LN(COMMITTED AMOUNT OF GRANTED $LOANS_{tbi}$)	I(FUTURE DEFAULT WITH THE $BANK_{tbi}$)	I(LOAN GRANTED WITHOUT $COLLATERAL_{tbi}$)
LN(BANK CAPITAL $RATIO_{t-1b}$)	-0.04			
	(0.19)			
ΔOVERNIGHT INTEREST $RATE_{t-1}$*LN(BANK CAPITAL $RATIO_{t-1b}$)	0.05		3.20 *	12.25
	(4.73)		(1.84)	(9.77)
ΔOVERNIGHT INTEREST $RATE_{t-1}$*LN(BANK CAPITAL $RATIO_{t-1b}$)*I(FIRM CREDIT $RISK_{ti}$)	43.87 **	31.39		
	(22.43)	(28.11)		
Reduction of the Main Interaction Coefficient When Not Controlling for Selection	*-26%*	*-41%*	*-48%*	*-37%*
Bank Fixed Effects	Yes	-	Yes	-
[(Year-Month)*Bank] Fixed Effects	No	Yes	No	Yes
[(Year-Month)*Firm] Fixed Effects	Yes	Yes	Yes	Yes
{ΔGDP $_{t-1}$, ΔCPI $_{t-1}$} *LN(BANK CAPITAL $RATIO_{t-1b}$)*I(FIRM CREDIT $RISK_{ti}$)	Yes	Yes	Yes	Yes
ΔOVERNIGHT INTEREST $RATE_{t-1}$**{Bank Controls $_{t-1b}$}* *I(FIRM CREDIT $RISK_{ti}$)	Yes	Yes	Yes	Yes

[a] This table reports estimates from linear regression models which explain the committed amount of a granted loan by the bank to a firm, whether or not the firm that received the loan will default and the collateralization of the granted loan. It uses 38,334 observations from the 2002:02 - 2008:12 period. The dependent variables are: LN(COMMITTED AMOUNT OF GRANTED $LOANS_{tbi}$) which following a succesful application filed in month t to bank b by firm i is the logarithm of the committed loan amount granted in t to t+3 by bank b to firm i; I(FUTURE DEFAULT WITH THE $BANK_{tbi}$) which equals one when the loan granted in month t by bank b to firm defaults; and, I(LOAN GRANTED WITHOUT $COLLATERAL_{tbi}$) which equals one if the loan granted in month t by bank b by firm i is uncollateralized, and equals zero otherwise. The definition of the independent variables can be found in the Appendix. Where possible a constant is included but its coefficient is left unreported. Where possible all macro, bank and firm variables in triple interactions are included in levels and in double interactions but their coefficients are left unreported. Fixed effects are either included ("Yes"), not included ("No") or spanned by another set of effects ("-"). For each variable the first row lists the coefficient, the second row lists the robust standard error that is corrected for multi-clustering at the year-month, bank and firm level; the corresponding significance levels are adjacent to the coefficient in the second column. * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

TABLE VIII

SUMMARY STATISTICS OF ALL VARIABLES USED IN THE ESTIMATIONS ON THE INTENSIVE MARGIN OF THE CHANGE IN THE COMMITTED AMOUNT OF GRANTED LOANS[a]

Variable Name	Mean	Minimum	Q1	Median	Q3	Maximum	Standard Deviation
Dependent Variables							
ΔLN(COMMITTED AMOUNT OF GRANTED LOANS$_{tbi}$)	-0.02	-12.08	-0.10	0.00	0.02	12.08	0.47
Independent Variables							
ΔOVERNIGHT INTEREST RATE$_{t-1}$	-0.30	-7.27	-1.22	0.03	0.76	4.59	1.61
BANK CAPITAL RATIO$_{t-1b}$	6.14	3.18	4.56	5.45	7.17	92.56	2.38
LN(BANK CAPITAL RATIO$_{t-1b}$)	1.75	1.16	1.52	1.70	1.97	4.53	0.34
I(FIRM CREDIT RISK$_{ti}$)	0.11	0	0	0	0	1	0.32

[a] This table reports summary statistics for the sample with 6,564,964 observations from the 1988:II - 2008:IV period.

APPENDIX

DEFINITIONS OF ALL VARIABLES USED IN THE ESTIMATIONS

Variable Name	Unit	Definition
Dependent Variables		
I(LOAN APPLICATION IS APPROVED BY A BANK AND THE LOAN IS GRANTED TO A FIRM THAT IS NEW TO THE BANK$_{tbi}$)	0/1	A dummy variable which equals one if the loan application made in month t to bank b by firm i is successful and the loan is granted in t to t+3, and equals zero otherwise
LN(COMMITTED AMOUNT OF GRANTED LOANS$_{tbi}$)	ln(000 Euros)	The logarithm of the committed loan amount granted in months t to t+3 by bank b to firm i following a succesful application filed in month t to bank b by firm i
I(FUTURE DEFAULT WITH THE BANK$_{tbi}$)	0/1	A dummy variable which equals one when the loan that is granted in month t by bank b to firm i defaults at some point in the future, and equals zero otherwise
I(WITHOUT COLLATERAL$_{tbi}$)	0/1	A dummy variable which equals one if the loan granted in month t by bank b by firm i is uncollateralized, and equals zero otherwise
ΔLN(COMMITTED AMOUNT OF GRANTED LOANS$_{tbi}$)	ln(000 Euros)	The quarterly change in the logarithm of committed credit granted during quarter t by bank b to firm i
Independent Variables		
Macro-level Variables		
ΔOVERNIGHT INTEREST RATE$_{t-1}$	%	The annual change in the Euro overnight index average rate (EONIA) which is the target interest rate for monetary policy in the Eurosystem, and before 1998 the change in the Spanish overnight interest rate at t-1
ΔGDP$_{t-1}$	%	Annual change of Spanish gross domestic product in real terms at t-1
ΔCPI$_{t-1}$	%	Annual change of Spanish Consumer Price Index at t-1
Additional Macro-level Controls		
ΔSPANISH LONG-TERM INTEREST RATE$_{t-1}$	%	The annual change in the ten-year Spanish government bond rate at t-1
ΔUS SHORT-TERM INTEREST RATE$_{t-1}$	%	The annual change in the U.S. Federal funds rate at t-1
ΔUS LONG-TERM INTEREST RATE$_{t-1}$	%	The annual change in the ten-year U.S. government bond rate at t-1
ΔSPANISH SECURITIZED ASSETS / TOT. ASSETS$_{t-1}$	%	The annual change in assets that were securitized bay Spanish banks at t-1
ΔSPANISH CURRENT ACCOUNT DEFICIT / GDP$_{t-1}$	%	The annual change in the Spanish current account deficit over GDP at t-1
Bank-level Variables		
Bank Risk-taking Variable		
LN(BANK CAPITAL RATIO$_{t-1b}$)	-	The logarithm of the ratio of bank equity over total assets of the bank at t-1
Bank Controls		
LN(TOTAL ASSETS$_{t-1b}$)	ln (000 Euros)	The logarithm of the total assets of the bank
LIQUIDITY RATIO$_{t-1b}$	%	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
ROA$_{t-1b}$	%	The total net income over assets of the bank
NPL RATIO$_{t-1b}$	%	The non-performing loan ratio of the bank
I(COMMERCIAL BANK$_b$)	0/1	A dummy variable which equals one if the bank is a commercial bank and equals zero otherwise
I(SAVINGS BANK$_b$)	0/1	A dummy variable which equals one if the bank is a savings bank and equals zero otherwise
Firm-level Credit Risk Variables		
I(FIRM CREDIT RISK$_{ti}$)	0/1	A dummy variable which equals one if in month t the firm had non-performing loans outstanding 4 years prior to the loan application , and equals zero otherwise