Universitat Pompeu Fabra Barcelona
Department of Economics and Business

Economics Working Paper Series

Working Paper No. 1699

"In the short run blasé, in the long run risqué" On the effects of monetary policy on bank credit risk taking in the short versus long run"

Gabriel Jiménez, Steven Ongena, José-Luis Peydró, and Jesús Saurina

March 2017

"In the Short Run Blasé, In the Long Run Risqué" On the Effects of Monetary Policy on Bank Credit Risk-Taking in the Short Versus Long Run

Gabriel Jiménez †

Steven Ongena ‡

José-Luis Peydró ҕ

Jesús Saurina §

Abstract

We identify the impact of short-term interest rates on credit risk-taking in the short and long run by analyzing a comprehensive credit register from Spain, a country where for the last twenty years monetary policy was mostly decided abroad. Duration analyses show that lower overnight rates prior to loan origination lead banks to lend more to borrowers with a worse credit history and to grant more loans with a higher per-period probability of default. Lower overnight rates during the life of the loan reduce this probability. Bank, borrower and market characteristics determine the impact of overnight rates on credit risk-taking.

JEL Codes: E44; E5; G21

Keywords: Monetary Policy · Low Interest Rates · Financial Stability · Lending Stardards · Credit Risk-Taking · Credit Composition · Business Cycle · Liquidity Risk

This version: March 2017

† Banco de España, Madrid, Spain, gabriel.jimenez@bde.es.

‡ University of Zurich, Zurich, Switzerland. Swiss Finance Institute, Zurich, Switzerland. KU Leuven, Leuven, Belgium. CEPR, London, UK, steven.ongena@bf.uzh.ch.

ҕ ICREA-Universitat Pompeu Fabra, Barcelona, Spain. CREI, Barcelona, Spain. Barcelona GSE, Barcelona, Spain, jose.peydro@upf.edu.

§ Banco de España, Madrid, Spain, jsaurina@bde.es.

1 Introduction

Do low short-term interest rates spur credit risk-taking by banks and can subsequent increases in interest rates exacerbate an ensuing crisis? While the first part of this question has been thoroughly answered, and mostly positively so in our earlier paper (Jiménez et al. 2014b),[1] the second part has received much less attention.[2] In this paper we therefore study how short-term interest rates influence credit risk-taking by banks in the short *and* long run using the combination of a duration analysis methodology and a unique and comprehensive dataset containing bank loan contract information from Spain.

Theory suggests lower interest rates – by improving borrowers' net worth –may result in banks to lend to borrowers that were deemed in the past to be too risky (Bernanke et al. 1996) or to lend to borrowers with fewer pledgeable assets (Matsuyama 2007). In the "balance sheet channel" lenders embrace borrowers that were deemed too risky *in the past* but have become in effect less risky due to the lower interest rates (e. g., Jiménez et al. 2014b). Yet, lower interest rates may push financiers beyond this category of "redeemed borrowers" to finance firms and projects that are actually riskier *in the present*, i.e., to grant loans with a longer maturity (and more liquidity risk) and even a higher per period probability of default (and more *pure* credit risk). This latter effect of low rates has been labeled the "credit risk-taking channel" of monetary policy (following Borio and Zhu 2012),[3] and can be considered part of the credit channel (Bernanke and Blinder 1992; Bernanke and Gertler 1995; Kashyap and Stein 2000; Jiménez et al. 2012). Once more risky credit has been granted subsequent increases in the interest rates may especially deteriorate their subsequent repayment performance.

Comprehensive panel data on individual bank loans is needed to *dynamically* account for changing loan conditions, to adequately assess credit risk,[4] and to disentangle the supply of credit to risky borrowers from its demand. Indeed, as the change in the demand for investment through the interest rate channel may also affect the marginal borrower's riskiness, disentangling demand from supply of credit is one of the key challenges in this literature. A fairly exogenous monetary policy and ample controls for other important macroeconomic factors (the growth in real gross domestic product, the inflation rate and a measure of country risk for example) are also crucial for econometric identification.

The *Credit Register* of the *Banco de España* (CIR) is uniquely suited to fulfill these many requirements.[5] The CIR records detailed monthly information on *all*, new and outstanding, commercial/industrial and financial loans (over 6000 Euros) to non financial firms by *all* credit institutions in Spain during the last twenty-three years – generating almost twenty-three million bank loan records in total. Its comprehensiveness directly averts any concerns about unobserved changes in bank lending. The CIR contains loan conditions and performance variables that are essential to our analysis, and tracks key borrower and bank characteristics, including borrower and bank identity.

Banks continue to play a key role in the Spanish economy and in the financing of the corporate sector. In 2006 for example their deposits (credits) to GDP equaled

132% (164%). Most non-financial firms had no access to bond financing and the securitization of commercial and industrial loans is still very low (4.8% in 2006).

Spain formally joined the European Monetary Mechanism in 1989; it had implicitly been part since 1988, after joining the European Union in 1986. Monetary conditions consequently became fairly exogenous and basically "set in Frankfurt", first through the fixed exchange rate policy with the *Deutsche Mark* and as of January 1, 1999 within the Eurosystem. In addition, GDP growth in Germany and Spain are weakly synchronized. Consequently, we can use the German then Euro overnight interbank rates as an exogenous measure of the stance of monetary policy (alternatively, we instrument the Spanish by the German overnight rate, a strong instrument as our later reported results clearly indicate). In addition to the fairly exogenous monetary conditions and, as both the *Deutsche Bundesbank* and the European Central Bank (ECB) were mandated to principally maintain price stability, controlling for other macroeconomic conditions should allay concerns of reverse causality and omitted variables' bias.

Using duration analyses, we investigate whether short-term interest rates prior to loan origination influence credit risk-taking by banks and whether changes in short-term interest over the life of the loan impacts its subsequent performance. One of our main challenges is to disentangle demand from supply of risky credit and to account for potential changes in credit quality of the marginal borrower: When overnight rates are lower, quality possibly worsens as more – and more risky –projects surpass a zero net present value hurdle for example.

We introduce borrower characteristics, or identity, and loan conditions. The former set of controls absorbs the changes in the pool of borrowers, the latter the adjustments banks make trying to keep their level of risk-taking constant (if banks want to keep their credit risk constant they will tighten lending standards when they face a riskier pool of borrowers or projects).

Our findings are both robust and economically relevant. Lower interest rates prior to the origination of the loans precede more lending with a substantially higher *hazard rate* (which is a default probability normalized per time; a normalization that is desirable as loan maturity may also be affected by overnight rates). In striking contrast, once loans are outstanding lower interest rates imply lower hazard rates conform to standard theoretical predictions.

In sum, when monetary policy is expansive, not only do banks give more loans to borrowers with either a bad or no credit history, but also the new loans themselves are more hazardous. Consequently, better borrowers' net worth and a higher appetite for liquidity risk are not the only motives for the banks' new engagements. Following a monetary expansion banks also want to take more credit risk. These main findings are robust to many alterations in the functional form of the specification, the variables that are included, and the sub-samples that are investigated. Results are similar when – in addition to many key bank, borrower, loan and macro controls – we include measures of bank efficiency, credit growth, house prices, GDP forecasts, and bond yields for example. Results are further robust across maturity classes and in the *Bundesbank* and ECB sub-periods (i.e., before and after 1999).

We also find robust evidence, confirming theoretical predictions, that smaller banks' incentives and ability for risk-taking are more affected by the stance of monetary policy than larger banks' incentives. The effect of the stance of monetary policy on credit risk-taking further depends on bank liquidity and ownership type, and on the level of banking competition and new borrower entry in the local area. All in all, our results suggest that the stance of monetary policy influences banks' appetite for credit risk.

Higher GDP growth lowers credit risk on new *and* outstanding loans. We note that both lower short-term interest rates and higher GDP growth imply higher borrower net worth and, therefore, fewer agency problems between lenders and borrowers. However, the effect of GDP growth on credit risk-taking is different from the effect of short-term interest rates. This implies that there may be other financial inefficiencies (Rajan 2006; Diamond and Rajan 2006) that explain the results of this paper. In addition, higher inflation during the life of the loan reduces credit risk, maybe because it cuts the real value of debt (Allen and Gale 2004; Diamond and Rajan 2006). In contrast higher inflation before loan origination implies higher risk taking. Finally, long-term interest rates have a weaker impact on credit risk-taking than short-term rates, possible because banks themselves rely mainly on short-term debt (Diamond and Rajan 2006).

Consequently these results have important policy implications regarding the link between monetary policy and financial stability. The moment of highest credit risk, our results suggest, is when short-term rates that were very low for a long time period suddenly increase steeply: At that moment, the net worth of an already risky pool of borrowers is suddenly eroded possibly leading to non-performance and defaults. Our results also suggest a way forward: Reducing interest rates again lowers the credit risk of all outstanding loans, making banks more willing to again accept credit risk thereby reducing the tensions in the credit markets.

The rest of the paper proceeds as follows. Section II details and explains the testable predictions derived from theory. Section III reviews our empirical strategy and introduces the data and the variables employed in our empirical specifications. Section IV discusses the results on borrower selection, within borrower comparison, and time to default of bank loans. Section V summarizes the results, discusses policy implications and concludes.

2 Literature Review and Testable Implications

2.1 Credit Channel of Monetary Policy

Does the stance of monetary policy, short-term interest rates in particular,[6] affect the appetite for credit risk of financial intermediaries? In addressing this question, that is key to our investigation, one needs to recognize a large literature in economics that has investigated whether and exactly how the conduct of monetary policy has effects for the real economy.

Short-term interest rates may affect investment and hence firms' demand for credit (the classical interest rate channel), while at the same time short-term interest rates may affect credit markets and the banking system in particular (for the credit channel of monetary policy transmission, see Bernanke and Gertler 1995).[7] Because of credit market imperfections – asymmetries of information and incompleteness of contracts – contractive monetary policy may reduce the ability and incentive of banks to supply loans (Bernanke and Blinder 1988; Bernanke and Gertler 1989; Lang and Nakamura 1995; Gertler and Gilchrist 1994; among others). Bernanke and Blinder (1992) indeed find that significant movements in bank aggregate lending volume follow changes in the stance of monetary policy.[8] To control for loan demand, Kashyap and Stein (2000) analyze whether there are also important cross-sectional differences in the way that banks respond to monetary policy shocks. They find that illiquid banks respond most and that this variation can be attributed to bank size.

Higher levels of interest rates directly and/or indirectly reduce borrowers' net worth (Bernanke and Gertler 1995). This reduction in net worth worsens the agency problems between banks and their borrowers in turn making banks fly to quality (Bernanke et al. 1996, 1999). In Matsuyama (2007) borrowers are heterogeneous in productivity and asset pledgeability, and banks change their optimal *credit composition* among borrowers according to the business cycle – in fact, there is a change in credit composition without a change in bank volume. Lower short-term rates for example increase borrowers' net worth making banks more willing to lend to borrowers with fewer pledgeable assets.

2.2 Credit Risk-Taking Channel of Monetary Policy

All theories discussed so far show that expansive monetary policy may increase the volume of loan supply, in particular to borrowers that in the past looked too risky (borrowers with a bad credit history for example that due to an improvement in their net worth are not so risky anymore). However, none of these theories necessarily imply higher risk-taking by the banks, i.e., granting loans with a higher default probability.

In Diamond and Rajan (2006) banks take more risk when monetary policy is expansive. In their model, which provides "a liquidity version of the lending channel" of the monetary policy transmission mechanism, banks finance illiquid long-term projects with liquid demand deposits. This mismatch makes banks reluctant to grant risky loans in times of liquidity shortages. Depending on the aggregate liquidity conditions, monetary intervention can play a useful role by limiting the depositors' incentives to withdraw. Banks will respond by continuing, rather than curtailing, risky credit. Consequently, the stance of monetary policy may affect the banks' appetite for risk.[9]

In Dell'Ariccia and Marquez (2006) banks' incentives to screen depend on their cost of financing, which in turn is determined by short-term interest rates. When there is a monetary tightening, to recover their losses on the "loans to lemons" when not screening, banks have to increase the average loan rate more than the observed increase in the policy rate. This pass-through is clearly larger than if banks were screening. Consequently, if interest rates decrease, the banks' incentives to screen borrowers and to fly to quality (with a lower default probability) wane. Banks also lower their screening standards when there are many loan applicants that are new to *all* banks.[10]

In general, because of information, contract and competition imperfections, banks may act risk aversely, and the degree of their risk aversion may depend not only on their borrowers' but also on their own net worth (Stiglitz and Greenwald 2003). 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 (also Stiglitz 2001).[11]

Rajan (2006) discusses whether and how the stance of monetary policy may affect the risk-appetite of financial intermediaries.[12] Because of incentives, contractual and informational imperfections, managers of financial intermediaries may take excessive risk when interest rates are low. Financial intermediaries may increase their exposure to liquidity risk for example by exploiting their duration mismatch and by lending more to risky long-term projects. This enhanced risk-taking yields extra returns during normal times. However the extra risk becomes problematic when monetary policy tightens and liquidity evaporates.[13]

All in all, lower short-term interest rates may increase the banks' incentives to take both more liquidity risk (i.e., more loans with a longer maturity) and credit risk (i.e., loans with a higher probability of default). To analyze credit risk-taking controlling for liquidity risk therefore requires investigating the probability of loan default normalized per time period.

2.3 Three Testable Hypotheses

To summarize, there are three testable predictions arising from the theory discussed so far:

(H1) Lower interest rates increase the credit risk-taking by banks, i.e., banks engage borrowers with a higher probability of default per time period.

(H2) Default rates are at their highest level when a period of low interest rates, which boosted credit risk-taking, is followed by a significant monetary tightening, which devalues the net worth of the outstanding risky borrowers for example.

(H3) Not all types of banks are equally affected. Smaller banks for example – because of their lower net worth, lack of diversification and difficulties accessing liquidity during tighter times – increase more their appetite for, or ability to take on, risk in response to an expansionary monetary policy.

Yet, it is important to note that not all banking theory implies that higher short-term rates go hand-in-hand with decreased credit risk-taking. Higher interest rates increase the opportunity costs for banks to hold cash (held as an insurance against high deposit withdrawals), making risky alternatives more attractive (Smith 2002). Higher interest rates may also reduce banks' net worth or charter value, driving banks towards a "gambling for resurrection" strategy (Kane 1989; Hellman et al. 2000). These conflicting theoretical predictions –though not formally embedded in our hypotheses to keep them parsimonious– make determining the impact of monetary policy on bank risk-taking ultimately a non-trivial, but salient empirical question.

3 Empirical Strategy

Essential ingredients to econometrically identify the impact of monetary policy stance on credit risk-taking are: (1) A disaggregated and comprehensive dataset on bank loans; (2) a measure of bank credit risk-taking that reflects the loan default risk per period of time; (3) a number of steps to disentangle supply of risky credit from its demand (employing loan and borrower characteristics/identity and interactions with bank characteristics); and (4) an exogenous stance of monetary policy. Spain delivers all of them as the *Credit Register* of the *Banco de España* (CIR) contains comprehensive information on Spanish bank lending over the last twenty-three years, a period during which Spain had a reasonably exogenous monetary policy.

3.1 Disaggregated and Comprehensive Dataset on Bank Loans

We aim to study the impact of the stance of monetary policy on the credit risk-taking of banks. We are therefore in the first place not interested in the impact of monetary policy on the risk of total outstanding loan portfolios, but want to focus on the credit risk of new loans being granted.

The CIR contains confidential and very detailed information at the loan level on (almost) *all* loans granted by *all* credit institutions operating in Spain during a twenty-three year period. The CIR is *almost* comprehensive, as the reporting threshold for a loan is only 6000 Euros. This low threshold alleviates any concerns about unobservable changes in bank credit to small and medium sized enterprises, which may be influenced by changes in monetary policy.[14] We have borrower, bank and loan information. For the *borrower* we know its identity, province, industry, bank indebtedness level, credit history and the number of banking relationships; for the *bank* we know its identity, legal status, size, non-performing loan ratio and other bank characteristics; and for the *loan* we know the type of instrument, currency, maturity, degree of collateralization, default status, and amount.

We do not have information on the interest rate of the loan. However, when we control for an individual bank risk premium, the empirical results we report are unaffected.[15] Moreover, Jiménez et al. (2006) show that collateral requirements are softened during expansions, while Delgado et al. (2007) find that average loan size (in real terms) and loan maturity increase in upturns. Therefore, it seems reasonable to expect a decline in the loan risk premium during expansions, given that the other risk control tools present in the loans are also relaxed.

Our sample consists of new business loans, granted to non-financial firms by commercial, savings banks and credit cooperatives (the 95% of all the Spanish financial system), where non-Spanish subsidiaries and branches are excluded. We use quarterly data information from 1984:IV to 2006:IV, which includes at least a complete business cycle in Spain. Every quarter all new loans are selected and tracked over time until they become impaired, repaid or still outstanding at the end of 2006.

We work at the loan level because econometric identification (further discussed below) requires variation in both borrower characteristics and loan conditions.[16] All in all, we have complete records on almost twenty-three million loans. In order to keep estimations manageable, we randomly sample 3% of these new loans in the CIR and work with 674,127 loans or 1,987,967 loan-quarter observations. We select firms on the basis of their tax identification number to obtain a random sample. We use the same set of loans throughout the paper, unless otherwise stated.[17]

3.2 Measuring Credit Risk

As explained in Section II an (almost) ideal measure of credit risk is the probability of default of individual loans that is normalized per time period. Indeed, lower short-term rates may lead to more lending to non-prime borrowers and/or a lengthening of average loan maturity. However, neither action needs to imply higher credit risk-taking *per se*, as the net worth of non-prime borrowers also improved because of the lower short term rates and longer loan maturity entails more liquidity risk but not necessarily more credit risk.

Therefore, to isolate the changes in credit risk-taking, we employ duration models and analyze the impact of short-term interest rates prior to loan origination on the loan hazard rate, which is a loan default probability that is normalized per unit of time. This is possible as our dataset includes unique loan repayment information, i.e., not only *whether* but also *when* the loan defaults.

We use the observed realizations of the time to default as our main measure of bank risk-taking *ex ante*.[18] However, we do observe all new and outstanding loans over a very long time period and can control in our estimations for multiple bank characteristics and time-varying macroeconomic conditions, assuaging any concerns that the realizations of the time to default would systematically differ from the officers' expectations.

In addition, employing duration models, we can not only dynamically control for macroeconomic factors that influence credit risk, but also analyze at each point in time during the life of the loan what impact monetary policy has on its default probability. This possibility further helps in our econometric identification. Indeed, a testable prediction from theory implies that higher interest rates may lead to lower credit risk-taking at origination (as banks' net worth is lower), but results in higher credit risk once the loan is outstanding (as the borrowers' net worth is lower). We can actually test this prediction using duration models – i.e., on a loan-by-loan basis we can analyze how overnight rates before loan origination and how the path of overnight rates after loan origination affect the loan hazard rate.

Other potential measures that one could use as proxies for credit risk-taking are loan rates or collateral requirements. However, it is not clear what the expected impact of the short-term interest rates on loan rates or collateral requirements is.[19] Contractive monetary policy for example would imply higher loan spreads and collateral requirements if the banks' risk-appetite decreases. On the other hand, lower risk-appetite implies banks fleeing to quality, and consequently lower loan spreads and collateral requirements for the better average borrower.

3.3 Disentangling Supply of Credit to Risky Borrowers from its Demand

Detailed information in the CIR database allows us to disentangle the supply of credit to risky borrowers from its demand. The identification problem we face is that, when short-term interest rates change, the loan demand by the risky borrowers (or for risky projects) could be affected differently than the loan demand by the not-so-risky (henceforth, "safe") borrowers. Fortunately for our investigation, this identification problem may not be as severe as in the bank lending literature at large because four different steps assure us a proper identification.

First, lower short-term interest rates in general result in a higher loan demand (Kashyap and Stein 2000), but not necessarily only from risky borrowers. Moreover, if their demand for loans would increase more (than the demand from the safe borrowers) and if the banks' appetite for risk would remain unaffected, we actually would expect observable lending standards to tighten and not to loosen. Therefore, controlling for lending standards such as collateral, maturity and loan amount therefore mitigates the identification challenge.

Second, we rely on a wide set of borrower characteristics, including borrower identity, to absorb the variation in the risk of the pool of the borrowers over the monetary policy cycle.

Third, as in Kashyap and Stein (2000), we exploit the cross-sectional implications of the sensitivity of bank risk-taking to monetary policy according to the strength of banks' balance sheet and moral hazard problems (proxied by bank size for example). At each point in time there are more than two hundred banks operational in Spain providing ample cross-sectional variation.

To conclude, given the nature of the identification problem we face, the range of borrower and bank characteristics we have access to, and the econometric strategies we mobilize, we surmise that making inferences on whether the stance of monetary policy affects the banks' appetite for credit risk is possible.

3.4 Exogenous Monetary Policy

If the level or variations of short-term interest rates were completely exogenous, the coefficient of the regression of credit risk-taking on short-term interest rates would indicate its causal impact. When monetary policy is not exogenous, there are two problems with econometric identification: (i) Reverse causality (e.g., future higher risk may imply current monetary expansion), and (ii) omitted variables (variables correlated with the stance of monetary policy that can also influence risk-taking). We can deal with these two problems relying on two key features of our empirical setting.

First, for the whole period analyzed, short-term interest rates in Spain were decided mostly in Frankfurt, not in Madrid. Implicitly from mid-1988 and explicitly from mid-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).[20] From 1999 onwards, Spain joined the Eurosystem as one of twelve countries, representing less than 15% of the total economic activity in this group.

Second, the mandate given to the *Bundesbank* and the ECB was primarily to preserve price stability, not to stimulate economic activity. Nevertheless, we control in the specifications for many macroeconomic variables such as Spanish (and German/Euro Area) GDP growth and their forecasts, inflation, country risk, yield curve measures and other variables. In addition, we also track bank lending to borrowers with bad or no credit history. Indeed, if risk is expected to increase in the future and monetary policy reacts by being expansive today, low interest rates could still correspond to higher loan hazard rates even if banks flee to quality because of the looming crisis. However, observing that banks continue to grant loans to risky borrowers (for instance borrowers with no credit history) implies it is not monetary policy simply reacting to future risk but banks actually seeking it.

Our sample period spans more than a complete domestic business cycle as we extract quarterly loan records running from 1984:IV to 2006:IV to study the impact of monetary policy on bank credit risk-taking starting in 1988:II. We use the German and Euro overnight rates as a measure of the stance of monetary policy. While monetary policy was fairly exogenous, as we argued, and hence this measure is therefore appropriate, we also employ either the Spanish overnight interest rate directly or instrumented by the German rate. In addition, we also run all specifications for the pre-1999 period and for the euro period.

To conclude, given the degree of exogeneity of monetary policy in Spain, the macroeconomic controls and the combination of econometric strategies we employ, we are confident that making inferences on whether the stance of monetary policy affects the banks' appetite for credit risk is possible.

4 Results

4.1 Main Elements

Fig. 1 summarizes the elements of the duration models we will now discuss, including the indexing and timing of the variables. We say a loan l by bank b is granted to borrower j in quarter τ. Let T denote the time to maturity or the time to default; hence, repayment or default would occur in quarter $\tau + T$. The duration models differentiate between monetary policy conditions prior to origination ($\tau - 1$) and policy conditions prevailing during the life of the loan, either in the quarter prior to loan repayment or default ($\tau + T - 1$) or, in all the periods between the loan origination and the loan repayment or default (τ + t, where $t = 0, 1, \ldots, T-1$).

Table 1 defines the main dependent (Panel A) and independent (Panel B) variables that are employed in the empirical specifications (including those that are used in the tabulated robustness exercises) as well as their descriptive statistics. As independent variables in the models we include measures of monetary policy conditions and an array of bank, borrower, loan, macroeconomic and provincial characteristics and controls. We measure monetary policy conditions using the quarterly average of nominal German and, from 1999:I onwards, Euro overnight interbank interest rates. We label the monetary policy measure prior to loan origination as INTEREST RATE.

Credit risk-taking and, in general, lending behavior may vary across banks. To control for differences in lending by the banks we introduce bank characteristics (coming from the CIR as well as from the banks' balance sheets). We include LN(TOTAL ASSETS) which equals the logarithm of the total assets of the bank, LIQUIDITY RATIO is the amount of liquid assets held by the bank over total assets, and OWN FUNDS/TOTAL ASSETS is the amount of bank equity over total bank assets.[21] We also control for the level of bank risk (i.e., an indicator of the bank's relative risk appetite and/or ability), measured by BANK NPL_b-NPL, which is the difference between the bank and the other banks' non-performing loan ratios. All bank characteristics are measured prior to the loan origination quarter. We further include the type of bank ownership using dummies that equal one if the bank is a commercial bank LISTED, a SAVINGS BANK, or a CREDIT COOPERATIVE and equal zero otherwise.[22] As savings banks and credit cooperatives are not listed, the benchmark category is the non-listed commercial bank.

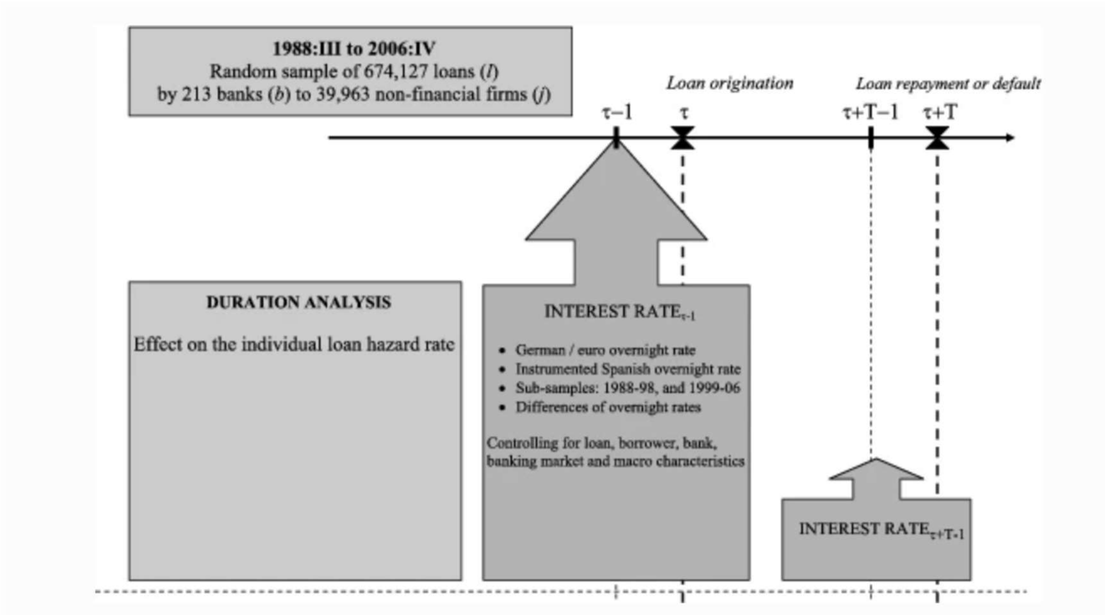

Fig. 1 The empirical strategy we follow

[Insert Figure 1 about here]

We include borrower and loan characteristics as the composition of the pool of borrowers and loans may change over time and to disentangle supply from demand effects (we also employ borrower identity in the duration analysis of individual loans). We define LN(1+BORROWER BANK DEBT) to equal the logarithm of one plus the total amount of borrower bank debt and LN(1+NUMBER OF BANK RELATIONSHIPS) as the logarithm of one plus the number of bank relationships of the borrower. We do not have direct access to the actual date of registration of the firm, but we know when the firm borrowed for the first time since 1984:IV. The variable LN(2+AGE AS BORROWER) measures the age of the borrower in the CIR and for most firms will be highly correlated with actual age.[23] In addition to these borrower characteristics, our specifications include ten Industry dummies and fifty Province dummies.

As loan characteristics we include the log of the total loan amount, LN(SIZE OF THE LOAN) and time-invariant loan dummies that equal one if the loan requires COLLATERAL or is a FINANCIAL CREDIT and equal zero otherwise. Four MATURITY dummies stand for the 0 to 3 month, 3 month to 1 year, 1 to 3 year, and 3 to 5 year maturity classes, the benchmark being long-term loans over 5 years. All borrower characteristics are dated in the quarter prior to the origination of the loan and all loan characteristics are naturally dated in the quarter of the origination itself.

To capture general economic and market developments related to business cycle conditions and country risk, we include the growth in real gross domestic product, GGDP, in the quarter prior to the origination of the loan, and at origination itself the Spanish INFLATION rate, a COUNTRY RISK measure (the spread between the ten year Spanish and German government bond rate), and a TIME TREND and TIME TREND^2 (as in Kashyap and Stein 2000).[24]

4.2 Methodology

We analyze the time to default of the individual bank loan, or "loan spell", as a measure of risk.[25] We define default to occur if three months after the date of maturity or the date of an interest payment, the debt balance remains unpaid.[26]

The hazard function in duration analysis provides us with a suitable method for summarizing the relationship between the time to default and the likelihood of default. The hazard rate effectively is a per-period measure of credit risk-taking and has an intuitive interpretation as the per-period probability of loan default provided the loan "survives" up to that period. We rely on a parametric Weibull specification to determine the shape of the hazard function with respect to time. The Weibull distribution allows for monotonically positive or negative duration dependence, i.e., loans may be more or less likely to default as the time since their origination increases. As almost 80% of the loans in the sample are four quarters or shorter in maturity, we focus on the results for the standard Weibull parameterization with non-time varying covariates.[27]

Repayment of a loan may prevent us from ever observing a default on this loan. Such a loan spell can be considered right censored. Not knowing when the default would occur means we are unable to observe the "true" time to default for these loan spells. With no adjustment to account for censoring, maximum likelihood estimation of the proportional hazard models produces biased and inconsistent estimates of model parameters. Accounting for right-censored observations will be accomplished in duration analysis by expressing the log-likelihood function as a weighted average of the sample density of completed loan spells and the survivor function of uncompleted spells. We return to the independence of the censoring scheme itself in the robustness subsection. As our sample consists out of *new* loans granted from 1988:II onwards, there is no left censoring problem.

4.3 First Results

The estimates in Table 2 are based on the maximum likelihood estimation of a duration model with a Weibull distribution. A positive coefficient indicates that an increase in the independent variable increases the hazard rate. All estimates are adjusted for right censoring and standard errors are clustered at the borrower level.[28]

Model I controls for key macroeconomic conditions (specifically for the growth in real gross domestic product, the inflation rate, a measure of country risk, and two time trends, in level and squared), and also includes bank random effects to control for unobservable heterogeneity related to different bank lending behavior ("frailty model"). The estimated coefficient on INTEREST RATE$_{\tau-1}$ in Model I equals –0.099***.[29] Hence, a lower short-term interest rate prior to loan origination implies that banks grant loans with a *higher* hazard rate, i.e., with a higher probability of default per quarter. Therefore, we find support for Hypothesis 1 that lower interest rates increase the credit risk-taking by banks. On the other hand, the coefficient on INTEREST RATE$_{\tau+T-1}$ equals 0.344*** indicating that a lower shortterm rate during the life of the loan implies a *lower* loan hazard rate.

While lower short-term interest rates in the economy increase the hazard rate on new loans but decrease the hazard rate on the outstanding loans, higher GDP growth decreases the hazard rate on both new and outstanding loans (the coefficients on GDP growth are –0.201*** and –0.045***, respectively). These estimated coefficients also benchmark the effects of monetary policy on credit risk: A one percentage point change in the interest rate for example has similar sized effects as one percentage point change in GDP growth, though its standard deviation is almost double the size of the standard deviation of GDP growth one (more on economic relevancy later). All in all, these results suggest that expansive monetary policy, in contrast to economic growth, whets the appetite for credit risk.

[Insert Figure 2 about here]

Both higher inflation and country risk at origination entail as expected a higher loan hazard rate, while the positive coefficients on both time trends indicates a secular increase in Spanish bank risk-taking. The latter finding clearly demonstrates that more risk-taking need not be excessive *per se* and that only intertemporal variation in risk-taking across borrowers and banks can provide evidence in this regard.

Finally, the estimate of ln(α), which is the logarithm of the parameter of duration dependence in the Weibull distribution, equals 0.620***. As α equals 1.859 and is larger than one, the positive duration dependence we find implies that default becomes conditionally more likely over the life of the loan.

4.4 Bank, Borrower and Loan Characteristics

Bank characteristics have significantly changed during the entire sample period.
We therefore add time variant bank characteristics in Model II. The key results we already discussed are basically unchanged. The coefficients on most bank characteristics are statistically significant, except the coefficient on total assets. The coefficients on the own funds and liquidity ratio for example are negative, indicating that banks with more own funds at stake or with more liquidity grant loans with lower hazard rates. More own funds at stake may lower the incentive to take risk as in Keeley (1990) for example and, banks may hoard liquidity and therefore not grant risky loans as in Diamond and Rajan (2006). The coefficient on the bank's non-performing loan ratio (compared to the sector's average) is positive suggesting that banks seemingly persist in hazardous lending. Listed commercial banks, and more intensely savings banks and cooperatives grant more risky loans (0.154***; 0.422*** and 0.371***, respectively).

We further add borrower and loan characteristics inModel III of Table 2 to control for changes over time in the borrowers and loans and to disentangle supply from demand effects. A higher demand from risky borrowers or a deterioration in the quality of the marginal new borrower and/or project for example may lead banks with a constant risk-appetite to lower the amount of credit, to demand more collateral and/or to shorten maturity. Including these proxies for lending standards, and the borrower characteristics, leaves the main results basically unchanged.

With regard to the borrower characteristics, we observe that the coefficient on the proxy of the size of the firm is insignificant, whereas as the borrower ages the likelihood to default decreases. The risk profile of a firm, measured by its credit history, shows that firms with bad credit records in the past are more likely to default in the future. Finally, we observe that borrowers with a large number of bank relationships are more risky. Loan characteristics play also an important role explaining the time to default of a loan. Model III shows that smaller, more collateralized and short-term loans are riskier than the other (as in Jiménez et al. 2006).

Controlling also for unobservable borrower heterogeneity employing random effects (corresponding to 39,963 individual firms) in Model IV again does not alter our findings. All these results suggest that banks do *adjust* their credit risk-taking in response to changes in short-term rates. The coefficients on most borrower and loan characteristics are statistically significant in Model IV, except the coefficient on collateral.[30] Younger firms with more bank relationships are more likely to default and so are smaller loans with a shorter maturity. Once we control for unobservable firm heterogeneity the coefficient on the size of the borrower turns negative, showing that loans to smaller firms are riskier. Banks seem to adjust loan amount and maturity when the demand from risky borrowers is higher (again not including loan characteristics leaves the results unaffected).[31]

[Insert Figure 3 about here]

Finally, in Model V we introduce interactions between the interest-rate-at-origination variable and a borrower bad credit history dummy and borrower age. Remember that one of our two main motivations to employ duration analysis was that more lending to borrowers with a bad or no credit history not necessarily implied more bank credit risk-taking if lower interest rates significantly bolstered borrowers' net worth for example. However, the estimates reported in Model V suggest that borrowers with a bad or shorter credit history fail even more when monetary policy is expansive. This is a key finding providing our results on borrower selection in Table 2 and 3 with a clearer interpretation: When interest rates are lower, there is more credit risk-taking. Therefore, we find support for H2.

4.5 Economic Relevancy

In this section we investigate how the stance and dynamic path of monetary policy affect credit risk. We employ the coefficients of the Model IV in Table 2 to calculate a quarterly probability of default for a loan with a mean maturity of five quarters,[32] and other mean characteristics, for different combinations of $\text{INTEREST RATE}_{\tau-1}$ and $\text{INTEREST RATE}_{\tau+T-1}$. Fig. 2 displays these combinations.

For example, if the short-term interest rate in the economy is equal to 4.1% (the sample mean) at loan origination and maturity, the quarterly probability of loan default is estimated to equal 0.56% (which equals the sample quarterly probability of loan default). If the interest rate at origination is set equal to 2.0% (the sample mean minus one standard deviation), while the interest rate at maturity remains at 4.1%, the default rate is 0.18 percentage points higher and equal to 0.74%. On the other hand, if the interest rate at maturity is set at 2.0%, while the interest rate at origination remains at 4.1%, the default rate is 0.26 percentage points lower and is equal to 0.30%. Hence changes in both interest rates taken separately have opposite but almost similarly sized and economically relevant effects. Of all macro variables only the country risk variable is equally economically relevant. GDP growth (smaller standard deviation) and inflation (smaller and insignificant coefficient) seem less relevant.

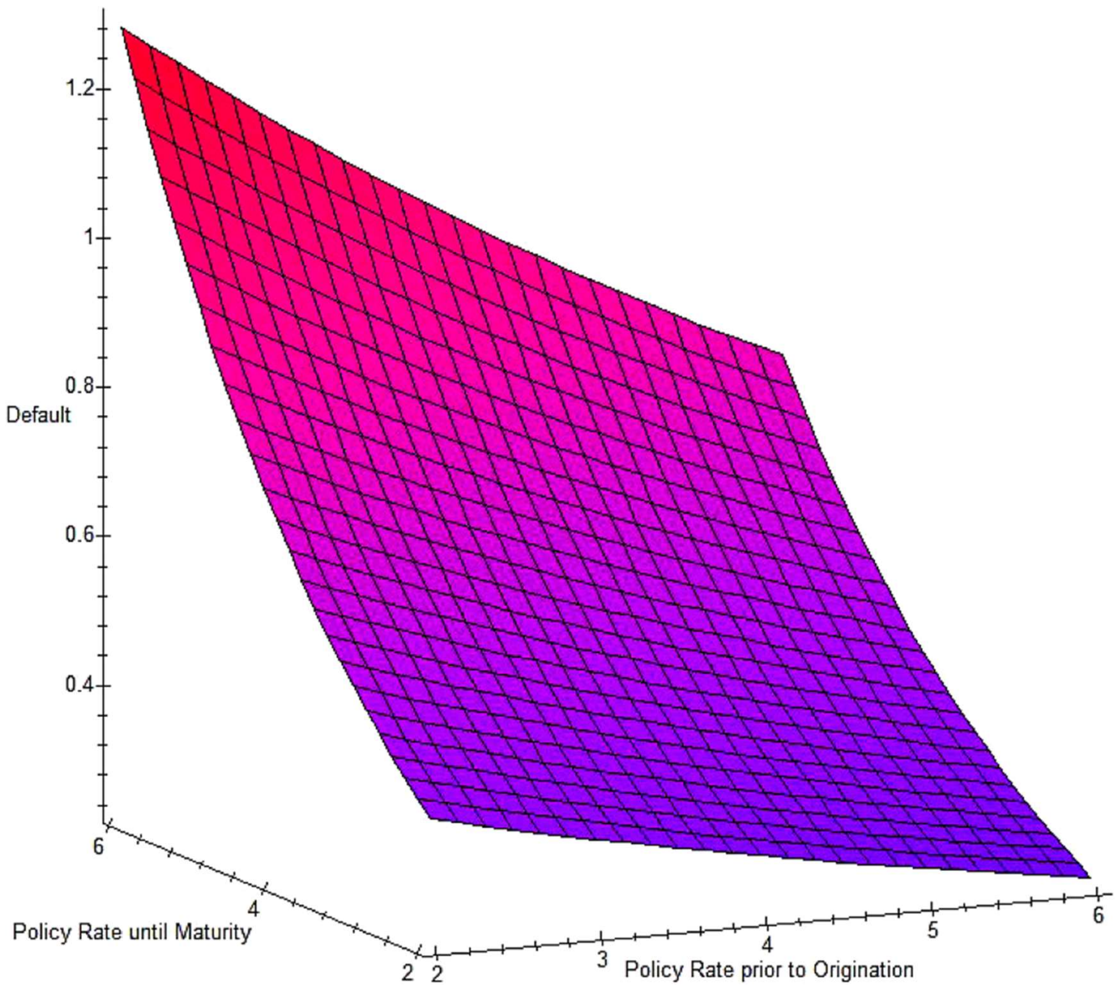

Fig. 2 Monetary policy paths and the loan hazard rate. The figure displays on the vertical axis the quarterly probability of *Default* (in percent) calculated for a loan with a mean maturity of five quarters, and other mean characteristics, based on the coefficients of Model IV in Table 4. On the horizontal axes are the *Policy Rate prior to Origination* (INTEREST RATE$_{\tau-1}$) and *the Policy Rate until Maturity* (INTEREST RATE$_{\tau+T-1}$)

To further assess the impact of the interest rate at origination independently from the interest rate at maturity we replace the latter independent variable with 18 year dummies in Model VI – i.e., we analyze the impact of policy rates on hazard rates for loans with the same year of maturity. The estimated coefficient on the interest rate at origination now equals –0.327*** and the economic effect is commensurately larger. Not including year dummies or splitting the sample at one year in short- and long-term loans leave results unaffected. We therefore take the economic relevancy reported so far as conservative. Later robustness tests show that the interest rate at origination also has a larger effect during the 1999–2006 ECB period for example.

The effects of interest rates at origination and maturity combined have a very large and noteworthy impact on the default rate. For example, if the interest rate at origination equals 2.0%, and the interest rate at maturity increases from 2.0 to 6.2% (the sample mean plus one standard deviation), the loan default rate more than triples from 0.39 to 1.36%. But the effect is more muted when rates are already high at origination. For example if the interest rate at origination equals 4.1% and the interest rate at maturity increases from 4.1 to 6.2%, the loan default rate increases only from

0.56 to 1.03%.

To conclude, these estimates suggest that during long periods of low interest rates banks may take on more credit risk and relax lending standards. Exposing the "hazardous" cohort of loans, granted when rates were low, to swiftly increasing policy rates dramatically exacerbates their risk.[33] Therefore, we also find support for Hypothesis 2 that default rates are at their highest level after a period of low interest rates followed by a significant monetary tightening.

4.6 Asymmetry and Dynamics

To test for the asymmetric impact of the interest rate on risk-taking, we replace the interest rate at origination with two interactive terms, i.e., the interactions of the interest rate at origination with (1) a dummy variable that equals one if the change in the interest rate during the previous quarter was larger than or equal to zero (and equals zero otherwise) and (2) a dummy variable that equals one if the change in the interest rate during the previous quarter was smaller than zero (and equals zero otherwise).[34] The estimated coefficients on both terms are virtually the same. Replacing the interest rate at maturity with 18 year dummies for example yields similar results. To conserve space we choose not to report these specifications.

Next, and to assess the dynamics of credit risk-taking, we first-difference the interest rate and GDP growth variables and include additional lags of the interest rate in Model VII of Table 2. The effect of a change in the interest rate on the hazard rate is immediate. Coefficients on the quarterly change in the interest rate one and two quarters prior to origination are equal to –0.601*** and –0.152**, respectively, while the coefficient on its third lag is small and not significant. The coefficient on the change in the interest rate over the life of a loan equals +0.201***.
These estimates again vividly illustrate the conundrum central banks may face when changing policy rates: On the one hand, lowering rates reduces on the short-run the credit risk of outstanding loans and increases the credit risk-taking of banks; on the other hand, there will be more defaults in the medium term.

Finally, we report the results for a duration model that allows the short-term interest rate, GDP growth rate, country risk and inflation to vary over the life of the loan (indexed $\tau + t-1$, with t: $1 \rightarrow T$). We focus on the time variation in only these variables as a number of bank and borrower characteristics do not vary much over time (bank ownership, number of borrower relationships, and bad credit history for example) or are deterministically "defined" with respect to the duration of the loan (age for example). In addition, the loan characteristics if allowed to vary may *not* be longer "ancillary" (or exogenous) with respect to loan duration![35]

Models VIII and IX report the estimates employing 1,989,170 loan-quarter observations. The coefficient on the interest rate prior to origination remains negative and significant, but the coefficient on the newly introduced time-varying interest rate covariate is small in Model VIII. However, also the two trend variables strikingly loose significance in that model thus suggesting multicollinearity. Therefore, we drop the two-time trend variables in Model IX and the coefficient on the time-varying interest rate as expected returns to a value closer to previous specifications (i.e., non-time-varying).

Note also in Model IX that when we allow inflation to vary over the life of the loan, higher inflation implies lower hazard rate. Higher inflation reduces the real value of the debt thus reducing default risk (see Allen and Gale 2004; Diamond and Rajan 2006). However, higher inflation at origination implied more risk in Model I for instance.[36]

4.7 Interactions with Bank Characteristics

Next we introduce interactions of the overnight rates with bank characteristics. Theory suggests banks' propensity to adjust credit risk-taking in response to monetary policy conditions may depend upon bank size, liquidity, type of ownership, and local market characteristics. Interactions can further assist us in addressing identification problems. We report the estimates in Table 3. To focus and conserve space, the coefficients on borrower and loan characteristics and the macro controls are no longer reported. These coefficients remain virtually unaffected from Table 2.

Smaller banks not only take more credit risk but also change their credit risk-taking more in response to changes in the stance of monetary policy (Model I in Table 3). Their lower net worth, lack of diversification, and more difficulties in accessing liquidity may provide an explanation (Diamond and Rajan 2006). On the other hand, banks with more liquidity take more risks and respond more to a lowering of interest rates in their risk-taking than other banks (Model II).[37] Banks may hoard liquidity (possibly because they take higher risk). Hence when short-term interest rates are lower, banks with high levels of liquidity may finance more risky long-term projects (Diamond and Rajan 2006), as they no longer need this level of liquidity since their cost/access to liquidity improves. Liquid bank assets may also worsen the moral hazard problem as these assets can be easily directed towards risky ventures (Myers and Rajan 1998). When monetary policy is expansive and bank return on assets is low, the banks that can increase credit risk-taking more are those with many liquid assets at hand.[38]

Banks with a relatively higher ratio of non-performing loans seem to continue in their ways by granting loans with a higher hazard rate (Model III). However monetary policy does not affect their credit risk-taking in a statistically significant way.[39] While credit cooperatives grant loans with a higher hazard rate than private commercial banks, their risk-taking is not significantly affected by monetary policy (Model IV). Savings banks increase less their risk-taking when rates are lower, which suggests that bank managers seem to be more cautious. That might be the result of a more limited upside potential in their pay packages since savings banks have no shares. Alternatively, they might try to rein more on credit risk since their portfolios are, *ceteris paribus*, always more risky (the SAVINGS BANK parameter is always positive, significant and the largest one among type of ownership dummy variables in specifications without interaction terms).

Having more new borrowers in the province increases the hazard rate on new loans (Model V), as the adverse selection problem among banks stemming from bank relationships with old borrowers is alleviated thereby weakening the bank incentives to screen. When monetary policy is more expansionary, the relative cost of screening versus non-screening increases, providing incentives to banks to soften their lending standards (Dell'Ariccia and Marquez 2006). We find that the presence of more new borrowers in the province reinforces the impact of short-term rates on credit risk-taking.

Finally, with more banking competition (proxied by a lower Herfindahl-Hirschman Index), banks have more incentives to take risk because the franchise value of the bank is lower (as in Keeley 1990). Thus, with easy access to liquidity during monetary expansions, a very competitive environment for banks may enhance risk taking (Dell'Ariccia and Marquez 2006).

Overall, we find that the impact of the stance of monetary policy on credit risk-taking depends on bank size, liquidity, and ownership. Local banking conditions, at the province level, like the percentage of new borrowers and the banking market concentration also matter. Therefore, the evidence is consistent with Hypothesis 3 that not all types of banks are equally affected.

4.8 Robustness

Finally, in Table 4 we run through a number of additional robustness checks. To conserve space we now also suppress the coefficients on the bank characteristics. These coefficients remain virtually unaffected from Table 3.

4.8.1 Censoring Scheme Independence: Loan Maturity and Multiplicity

Banks may not only change loan risk, but also alter other loan terms according to monetary conditions. For instance, expansive monetary policy could make banks more willing to bear liquidity risk (Diamond and Rajan 2006). Changes in observed loan maturity in particular are a fundamental reason to rely on duration models when assessing loan risk on the basis of observed loan default. But even if the loan maturity (at origination) would be directly affected by monetary policy (the conditional correlation coefficient of –0.08 actually suggests it is *not*),[40] or borrowers would repay early to benefit from a lower interest rate on a new loan, the censoring scheme would remain independent and the basic methods of survival analysis would remain valid.[41]

However, schemes in which the failure times of loans are censored because of an unusually high (or low) risk of failure are not independent and the basic methods of survival analysis are then not valid. Early repayments of individual loans for example that would follow from their lower failure rates do not constitute an independent censoring mechanism. However, this problem should be limited as most loans have a short maturity and do not have early repayment clauses, nor adjustable rates.

Nevertheless, we conservatively remove all loans with maturity longer than one year in Model I in Table 4. Despite losing more than 20% of all observations (with

536,571 observations remaining), results are mostly unaffected. For selected specifications we also check the results for loans with maturity shorter than three months. Again results are unaltered. Note again that these loans with short maturities do not have adjustable interest rates. Therefore, our findings related to the effect of overnight rates on credit risk seem not driven by the higher direct financing costs resulting from the adjustable loan rates. We also remove all loans with maturity shorter than one year. Results (unreported) do not change qualitatively despite working again with a much smaller number of loans (137,556 observations). In sum, overnight rates influence the hazard rate across the maturity spectrum.

Repayments by the same borrower may also not be independent *across* loans. If successful in servicing other loans, borrowers may strive to avoid defaulting on the "last" loan for example. Alternatively, a default on one loan may increase the probability of default on the other loans. Our earlier borrower random effects model and clustering at the borrower level throughout all other exercises should have accounted for this dependence. Nevertheless, next we also remove all the loans from borrowers that have multiple loans outstanding. Only 234,338 "single" loans remain. This rather drastic loan selection, however, does not alter the results (Model II of Table 4). Hence, H1 seems again supported, irrespective of the maturity and multiplicity of the loans.

[Insert Figure 4 about here]

4.8.2 Exogeneity of Monetary Policy

Model III in Table 4 focuses on the 1988–1998 period during which the Spanish peseta was pegged to the German mark. In this earlier period most sample borrowers also had no access to bond financing while securitization of loans was almost inexistent. In fact, if we consider all the loans that were securitized (and most of them were mortgages, not business loans), securitized loans represented less than 1% of the total number of loans in 1998 (but already 15.3% of all loans in 2006). In consequence, borrowers in Spain in this earlier period were almost entirely dependent on bank credit and banks did not transfer the credit risk. While the number of loan observations drops to 292,346 once we consider the 88–98 period, the results are mostly unaffected however.

Next, we replace again both interest rate variables by the interest rate in Spain, instrumented by the German interest rate, but do not detrend. In an unreported first stage we regress the INTEREST RATE in SPAIN on all predetermined variables including the German overnight interest rates.[42] The estimated coefficients on the instrumented INTEREST RATE SPAIN are similar to the estimates in the duration models using the INTEREST RATE variables.[43] All in all, Model IV in Table 4 shows that using the (instrumented) Spanish interest rate does not alter the results.

In Model V we report the equivalent results for the 1999–2006 Euro period (381,781 loans). Results for both periods are strikingly similar. It is interesting to notice that nominal rates were in some sub-periods very low compared to a Taylor

rule, since in these sub-periods the three largest Euro area economies had significant lower levels of GDP growth and inflation than Spain. In addition, this period of time is more homogenous: Inside this period the Spanish economy in general, and the banking system in particular, did not experience any significant structural change.
Therefore, H1 seems supported either for the whole period or for each of the two subperiods separated by the inception of the Euro, which further helps in giving the results a causal interpretation.

4.8.3 Definitions of Independent Variables and Omitted Variables

The time trends we included so far may capture improvements in the efficiency in the Spanish banking sector during the last 20 years. The efficiency of the banking sector has dramatically improved in Spain, potentially biasing our results if we would not control for this effect. Consequently, we also replace the trend variables once with the variables EFFICIENCY RATIO and FINANCIAL INCOME/ATA, respectively. The EFFICIENCY RATIO, a direct measure of efficiency, is defined as expenses over gross operating margin of all banks. FINANCIAL INCOME/ATA equals the interest income plus dividends received over average total assets of all banks (i.e., asset profitability), thus, reflecting a more indirect measure of efficiency. Alternatively, it controls for the risk profile of the bank (on average, riskier banks should have a higher FINANCIAL INCOME/ATA ratio). Results are virtually unaffected and we choose not to report them. Time trends may also capture the volatility of GDP growth. Replacing the time trends with these variables again does not affect our findings.

Changes in credit composition (with respect to risk for example) not necessarily affect the volume of credit (Matsuyama 2007). However, in the banking lending channel, monetary policy stance affects the volume of lending, maybe implying more credit-risk if the marginal borrowers were of a lower quality. In Table 4, Model VI we control for the annual growth rate in business loans for each individual bank at the time of the origination of the loans.[44] We find that results are very similar suggesting that the stance of monetary policy may imply a change in credit risk-taking and an optimal change in credit composition in addition to changing the credit volume (which has a positive and significant parameter, as expected).

Note that this regression is also related to the demand *versus* supply identification issue. If banks would want to keep their level of credit risk constant, then more credit volume would imply (if the marginal projects were riskier) a tightening of lending standards or maybe a different pool of borrowers. In Table 2, 3 and 4 we control for loan characteristics such as collateral, maturity and loan amount, and we also control for some borrower characteristics including identity. Hence, our results suggest that the stance of monetary policy in general and in particular the level of overnight rates also influence the appetite of banks for credit risk.

Lower interest rates may increase real estate prices and the value of collateral. This may imply more lending as in Kiyotaki and Moore (1997), but defaults may occur once liquidity evaporates.[45]Model VII controls for the changes in house prices. The results suggest the other mechanisms we identified so far are at work besides this channel.[46]

Monetary policy may further react to lower expected GDP growth, even if determined by central banks in which price stability is the main objective of monetary policy. Lower forecasted GDP growth (that is, potentially higher risk in the future) would result in lower central bank policy rates in this case – a reverse causality problem. We introduce expected GDP growth in Model VIII to further deal with this problem. We focus on the Euro period for two reasons: (1) we have access to the ECB's own quarterly predictions and the predictions by the Organization for Economic Co-operation and Development (OECD) for the entire period only come at a semiannual frequency; and (2) the business cycle conditions in the Euro area are more relevant (than the German conditions in the earlier period) as the now opened Spanish economy is more connected to the larger Euro area. In addition, by including expected GDP growth in the Euro Area, we control as well for the possibility that the results were driven by changes in Euro Area GDP growth rather than by ECB rates. However we find very similar results.[47]

Finally, in Model IX we introduce Spanish long-term interest rates prior to loan origination, in particular the interest rate on the SPANISH TEN YEAR BOND, which is the most liquid one. Long-term rates may also matter for credit risk-taking. However, results are again unaffected, maybe because banks finance themselves more through short maturity debt that is more affected by short-term rates.

5 Conclusions and Policy Implications

This paper empirically investigates three questions that tie overnight rates and the stance of monetary policy to credit risk-taking and that are relevant for both academics and policy makers (central bankers and supervisors alike). Do lower interest rates increase the credit risk-taking by banks? Are default rates the highest when a period of low interest rates, which boosted credit risk-taking, is followed by a significant monetary tightening? Do the answers to the former questions vary across types of banks, borrowers and banking markets?

We employ the Spanish Credit Register, a unique and comprehensive dataset that contains almost all business loan contracts from the last twenty-three years, and rely on the short-term interest rates set by the *Bundesbank* and then the ECB as the proper, yet fairly exogenous, measure of the stance of monetary policy. Therefore we can identify the effect of short-term interest rates on credit risk-taking. We are able to tackle the pernicious endogeneity problem that arises if monetary policy is determined domestically, disentangle demand of risky credit from supply and control for alternative hypotheses.

Controlling for macroeconomic conditions and for bank, loan, and borrower characteristics, we find robust evidence that suggests that prior to loan origination lower short-term interest rates motivate banks to soften their lending standards and grant loans with a higher hazard rate (default probability normalized per time, a desirable normalization since monetary policy may also affect liquidity risks and hence maturity). In consequence, these results suggest that following a monetary expansion better borrowers' net worth and a higher appetite for liquidity risk are not the only motives for the banks' new engagements (see Bernanke et al. 1996; Diamond and Rajan 2006; Matsuyama 2007). Following a monetary expansion banks want to take more credit risk as well (see Smith 2002; Stiglitz and Greenwald 2003; Diamond and Rajan 2006; Dell'Ariccia and Marquez 2006; Rajan 2006; Borio and Zhu 2012).

Conditioning on the loan being granted, lower interest rates imply lower credit risk – i.e., lower interest rates reduce the credit risk of outstanding loans. This is possibly the case because refinancing costs are lower and borrower net worth is higher and, therefore, credit risk is lower. Consequently there is a completely different impact of lower interest rates on the credit risk of new *vis-à-vis* outstanding loans.

In sum, in the short-run lower interest rates reduce total credit risk of banks since the volume of outstanding loans is larger than the volume of new loans. In the medium term, lower interest rates, however, may increase credit risk in the economy. In particular, a period of low interest rates followed by a severe monetary contraction maximizes credit risk, as the already "hazardous" cohort of new loans gets exposed to higher interest rates as outstanding loans. On the other hand, steep declines in interest rates minimize total credit risk thus possibly reducing a credit crunch.

The impact of monetary policy on risk-taking is not equal for all banks: Small banks, banks that are flush with liquidity and commercial banks take on more extra risk when interest rates are low. Therefore, balance-sheet strength, investment opportunities, moral hazard and type of bank ownership shape the impact of monetary policy on bank credit risk-taking. In addition, more new firms and fiercer competition in the market enhance the impact of interest rates on bank credit risk-taking (see Dell'Ariccia and Marquez 2006; Keeley 1990).

We also find that higher GDP growth reduces credit risk for new and outstanding loans alike and for loans to borrowers with bad credit history. Higher GDP growth or lower short-term interest rates imply higher borrower net worth and, therefore, fewer agency problems between lenders and borrowers. However, the effect of GDP growth on credit risk-taking is different from the effect of short-term interest rates. This implies that there may be other financial inefficiencies (Rajan 2006; Diamond and Rajan 2006) that explain the results of this paper. Finally, higher inflation during the life of the loan reduces credit risk, maybe because it reduces the real value of debt (Allen and Gale 2004; Diamond and Rajan 2006). In contrast higher inflation before loan origination implies higher risk taking. Finally, we find that long-term interest rates have a weaker effect on credit risk-taking than short-term rates. Short-term rates possibly affect bank risk-taking more because banks finance themselves mainly through short-term debt (Diamond and Rajan 2006).

There are a number of natural extensions to our study. First, we currently focus on the impact of monetary policy on the hazard rate of individual bank loans but overlook the correlations between loan default and the impact on each individual bank's portfolio or the correlations between all the banks' portfolios and the resulting systemic impact of monetary policy. Second, given the cohorts of loans and initial and ending policy rates for a time period, one can calculate on the basis of the estimated coefficients the path of monetary policy rates that would minimize the total amount of credit risk. It would be interesting to compare this path to the actual path that was followed. Third, we have studied the effects of monetary policy on the composition of credit in only one dimension, i.e., risk. Industry affiliation or portfolio distribution between mortgages, consumer loans and commercial and industrial loans for example may also change. Fourth, we focus on one of the possible causes of the current credit crisis, but we were silent on whether the risk-taking we observe was excessive. In credit channel models banks are usually too conservative due to agency problems with their borrowers and expansive monetary policy can therefore not result in excessive risk-taking. However, in Rajan (2006) or in banking models with agency problems between shareholders and debtholders and/or banking regulators (Freixas and Rochet 2008), banks will take excessive risk. The structure of bank deposits, debt, ownership and control – in particular, for listed banks, *board independence* and *ownership dispersion* and, for non-listed commercial banks, savings banks and credit cooperatives, *stakeholders' relationships* – may therefore determine the impact of monetary policy on credit risk-taking. And independent of its pricing credit risk-taking directly impacts financial stability and economic growth. Finally, the impact of monetary policy on credit risk-taking by banks may be amplified by certain types of financial innovation, for example, loan securitization. Given space constraints we leave these extensions for future work.

Footnotes

1 In that paper we employ a two-stage model that analyzes the granting of loan applications in the first stage and loan outcomes for the applications granted in the second stage. This setup makes it harder to draw the inferences derived in this paper. On the risk-taking channel of monetary policy see e.g. for the U.S. (Delis et al. 2011; Paligorova and Santos 2013; Altunbas et al. 2014; Buch et al. 2014a, 2014b; Dell'Ariccia et al. 2016), Austria (Gaggl and Valderrama 2010), Colombia (López et al. 2011, 2012), the Czech Republic (Geršl et al. 2015), and Sweden (Apel and Claussen 2012). Lower real interest rates preceded banking crises in 47 countries (von Hagen and Ho 2007).

2 An exception is Ioannidou et al. (2015) who analyze the risk-pricing by banks in Bolivia during the period 1999 to 2003. They find that when the U.S. federal funds rate decreases, bank credit risk increases while loan spreads drop and that increases of the funds rate during the life of the loan has the opposite effect. Expansionary monetary policy and credit risk-taking followed by restrictive monetary policy possibly led to the financial crisis during the 1990s in Japan (see Allen and Gale 2004 for example).

3 Lower interest rates may reduce the threat of deposit withdrawals (Diamond and Rajan 2006), abate adverse selection problems in credit markets (Dell'Ariccia and Marquez 2006) or improve banks' net worth (Stiglitz and Greenwald 2003), for example, allowing banks to relax their lending standards and to increase their credit risk-taking. Low levels of short-term interest rates may further make riskless assets less attractive for financial institutions and lead to a search-for-yield (Rajan 2006; Blanchard 2008). On the other hand, higher interest rates increase the opportunity costs for banks to hold cash thus making risky alternatives more attractive (Smith 2002), or may reduce the banks' net worth or charter value enough to make a "gambling for resurrection" strategy attractive (Kane 1989; Hellman et al. 2000), thus making the impact of short-term interest rates on credit risk-taking ultimately a critical empirical question.

4 Banks may not only arise to overcome key informational and contractual problems (as in Diamond 1984) to lend to a potentially wide range of intermediately opaque firms in modern theoretical work (as in Diamond 1991; Bolton and Freixas 2000), but banks also haven been and still are the main providers of credit in most economies (Source: International Finance Statistics of the International Monetary Fund). Credit risk may be the most important risk type banks face (Kuritzkes and Schuermann 2010).

5 The Credit Register has been employed in, e.g., Jiménez and Saurina (2004) and Jiménez et al. (2006, 2012, 2014b, 2016).

6 In Bernanke and Blinder (1992) and Christiano et al. (1996), among others, the overnight interest rate is an indicator for the stance of monetary policy. The ECB targets the overnight rate as a measure of the stance of its monetary policy.

7 The credit channel comprises both a balance sheet and a bank-lending channel. The latter channel can also be viewed as a balance sheet channel for banks (see Bernanke 2007 for a recent review of this literature).

8 Den Haan et al. (2007) find that monetary policy differently affects consumer, real estate, and business lending by banks. In fact, contractive monetary policy does not decrease the volume of business loans for example. Their findings may be caused by a decline in bank risk-taking when short-term interest rates are high.

9 In Diamond and Rajan (2006) an entrepreneur gets either an early or a late payoff that is fixed (and known). Introducing uncertainty about the payoff level will influence the amount lent to the entrepreneur, we conjecture, without altering the main results of the model. In consequence, monetary policy may affect both the level of liquidity and credit risk taken by the banks.

10 A decline in the cost of funds in Sengupta (2014) likewise facilitates entry of outside banks into "highrisk" credit markets, as inclusion of non-credit worthy borrowers in their loan portfolio becomes possible. And in Ruckes (2004) improvements in economic outlook and declines in the average default probability of the borrowers lowers the lenders' screening activity, intensifies price competition and boosts lending to low quality borrowers.

11 Because of equity rationing, the shocks to the banks' net worth may not be immediately reversible, explaining their potentially large adverse macro-economic consequences. Lower interest rates may also reduce moral hazard and adverse selection problems in credit markets, thereby lessening credit rationing (Stiglitz and Weiss 1981; see Berger and Udell 1992 for empirical evidence).

12 Lower policy rates may for example reduce the loan-deposit rate spread, shrink the financial intermediation margin and whet bankers' incentive to take risk to meet some profitability target (European Central Bank Financial Stability Review, December 2007). See also Caballero (2006).

13 Ahrend et al. (2008), Taylor (2007) and Shiller (2007) discuss excess risk-taking in general. Borio (2003) and Borio and Lowe (2002) assert that monetary policy narrowly focused on controlling shortrun goods price inflation is less likely to exert control over credit expansions and asset price inflation (followed by subsequent busts). The increase in the number of booms and busts in recent years is thus, in part, a corollary to "the death of inflation". Borio and Zhu (2012) maintain that recent changes in banking regulation and the financial system may have amplified the impact of monetary policy on the risk-taking by financial intermediaries. Adalid and Detken (2007) find a correspondence between liquidity shocks and aggregate asset prices during asset price boom or bust episodes for 18 OECD countries since the 1970s. Kiyotaki and Moore (1997) show how falling interest rates and rising asset prices cause a lending boom by increasing collateral values. As asset prices and collateral values decrease, loan defaults occur. Finally, Allen and Gale (2004) point out that while monetary policy may influence risk taking and hasten the creation of a bubble, it may also help solve credit problems once the bubble bursts.

14 See Gertler and Gilchrist (1993, 1994), Bernanke and Gertler (1995) and Bernanke et al. (1996) for example. Incomplete coverage of the widely used U.S. (National) Survey of Small Business Finances or the more recent Loan Pricing Corporation datasets (e.g., Petersen and Rajan 1994; Berger and Udell 1995; Bharath et al. 2007; Calomiris and Pornrojnangkool 2009) may therefore complicate any analysis of bank risk-taking.

15 As in Martin-Oliver et al. (2006) we calculate a risk premium for each individual bank and subtract the average risk premium of all banks in that quarter.

16 Den Haan et al. (2007) document that contractive monetary policy does not necessarily reduce the volume of business lending, while Hernando and Martínez-Pagés (2003) find no bank lending channel operative in Spain. Both findings suggest that focusing on new business loans allows us to determine the changes in loan composition without overlooking the concurrent changes in loan volume across loan categories (despite these priors we control for the growth in total and individual bank loan volume in the robustness subsection).

17 The entire database contains more than 32,000,000 loans. We focus on the 22,470,900 commercial and financial loans (80% of total loans), excluding leasing, factoring and other specialized loans, granted by commercial banks, savings banks or credit cooperatives (95% of total credit market). Given the way in which tax identification numbers are assigned, all firms with the same last digit for example would comprise a 10% random sample. We randomly re-sample another 3% of the loans and re-run all specifications. We also sample 6% of the loans and run selected specifications. Results (available upon request) are virtually unchanged and illustrate the robustness of our results to the sampling procedure.

18 Internal or external credit ratings of loans or borrowers are not available. However, these measures are often criticized as coarse and unreliable. Internal credit ratings of banks in the U.S., Germany and Argentina for example are partly based on subjective, non-financial factors (Treacy and Carey 2000; Grunert et al. 2005; Liberti 2004). Loan officers can therefore manipulate the ratings (Hertzberg et al. 2010) and give better ratings when interest rates are low. External ratings provided by credit rating agencies were widely blamed during the financial crisis of 2007 as having been uninformative, even deceptive, in the years prior to the crisis.

19 The loan rate as a proxy for risk may additionally suffer from the variation over time in the price of risk. Evidence from equity prices (Bernanke and Kuttner 2005), bond yields (Manganelli and Wolswijk 2007), buyout pricing (Axelson et al. 2013) and loan rates (Ioannidou et al. 2015) suggest this time variation is common across many financial assets.

20 In 1986 Spain joined the European Union. Consequently, monetary policy started to pay more attention to the exchange rate and, in particular, to the Peseta/Deutsche Mark exchange rate. 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. As of mid-1988, Spanish monetary policy was no longer independent from the German monetary policy according to the textbook "Mundell-Fleming trilemma" (see Blanchard 2006 or Krugman and Obstfeld 2006 for example). Spain did devalue its currency three times between 1992 and 1993 and also had temporary credit controls the second half of 1989 and during 1990. In non-reported robustness regressions, we include time dummies for the quarters involved and results do not change significantly.

21 Very few banks in certain periods record negative equity values. Removing these observations does not alter our results and, for consistency reasons, we decided to retain them.

22 Delgado et al. (2007) explain the main features of the Spanish banking system, focusing in particular on the differences in characteristics and behavior of commercial banks (both listed and non-listed), savings banks and credit cooperatives. All of them compete under the same rules although savings banks do not have shareholders.

23 This variable is therefore by construction left censored but removing it or limiting its backward looking horizon does not alter our results.

24 Replacing the spread with the time-varying International Country Risk Guide index does not alter results. We also include measures of banking system efficiency or credit growth, individual bank credit growth, German/Euro inflation and GDP growth, GDP growth forecasts, the volatility of GDP, yield curve measures and house prices. Results are unaffected and we opted to report the more parsimonious models. We revisit the inclusion of these variables in our duration analysis.

25 As in McDonald and Van de Gucht (1999) for example. Loans to small firms typically carry a relatively short maturity, often without early repayment possibilities; hence, we choose to ignore early repayment behavior captured in their competing risk model. Cameron and Trivedi (2005), Heckman and Singer (1984), Kiefer (1988), Kalbfleisch and Prentice (2002) and Greene (2003) provide comprehensive treatments of duration analysis. Shumway (2001), Chava and Jarrow (2004) and Duffie, Saita and Wang (2007) discuss and employ empirical bankruptcy models.

26 We use "default" in the common sense of "a failure to pay financial debts" (Merriam-Webster Dictionary). We classify loans that are ninety days overdue as "in default". Ninety days overdue is a standard period to classify a loan as non-performing but some countries use different overdue dates depending on the credit product (see for example Beattie et al. 1995).

27 Our main results are unaffected either if we use a log-logistic specification which allows for a nonmonotonic duration dependence or a Cox (1972) proportional hazard model for which the baseline hazard is a loan-specific constant. We find weak evidence for non-monotonicity at longer maturities. We return to estimation with time-varying covariates in the robustness subsection.

28 We alternatively cluster at the loan vintage (quarter) level. Results are unaffected.

29 ***Significant at 1%, **significant at 5%, and *significant at 10%. For convenience we also indicate the significance levels of the coefficients in the text.

30 The coefficient on collateral turns statistically significant when we do not control for unobservable borrower heterogeneity (as in Model III for example). Collateral may be set for the borrower in beginning of the relationship and may be only infrequently adjusted.

31 For credit lines we take the total amount that is made available to the borrower. Dropping credit lines that are not drawn or dropping all credit lines does not alter the results. Some loans are also flagged as renewals. Dropping renewals does not change the results.

32 The choice of maturity matters also because the estimated parameter of duration dependence is significantly larger than one: In Model IV it equals e0.816 = 2.261. The hazard rate will therefore increase over the life of the loan. Integrating the hazard rate over the life of the loan yields the probability of default of the loan.

33 While suggestive of the impact of changes in monetary policy on the loan hazard rates, the estimates are calculated for one loan cohort only. To obtain a correct assessment of a monetary policy path on the aggregate hazard rate, cohort size and timing needs to be properly accounted for (loans granted during the period of the increase in the policy interest rate will have a lower and lower hazard rate for example). We leave such an exercise for future work.

34 Our methodology is similar to Thoma (1994). Weise (1999) for example also finds no asymmetric effects of U.S. monetary shocks on prices or output.

35 To obtain interpretable estimates it is required that the variables be either "defined" or "ancillary" with respect to the duration of the loan. A defined variable follows a deterministic path. Age is an example of a defined variable because its path is set in advance of the loan and varies deterministically with loan duration. An ancillary variable has a stochastic path but the path cannot be influenced by the duration of the loan. Collateralization for example is probably not ancillary as banks may eventually tighten collateral requirements when hazard rates increase.

36 Higher inflation may amplify the standard deviation of the spread between bank loan and deposit rates, yet cut bank profitability and lead to banking instability (Boyd and Champ 2003). The evidence seems sometimes mixed (Beck et al. 2003; Demirgüc-Kunt and Detragiache 1998, 2002).

37 Similarly more profitable banks also respond more (not tabulated), possibly by virtue of their higher retained earnings.

38 The measure for bank liquidity we employ is often used in the literature that investigates the credit channel of monetary policy (see Kashyap and Stein 2000 for example). In non-reported regressions we explore other measures of liquidity such as the ratios of loans to deposits and interbank deposits (a measure for the importance of wholesale depositors). We find that the impact of interest rates on credit risk-taking also depends on the structure of the deposits.

39 The insignificant coefficient on the interaction term is positive, possibly because banking supervisors face a capacity constraint (when low interest rates spur risk-taking by many banks) and focus on curtailing risk-taking by banks with high NPL ratios.

40 The correlation is even weaker when we consider the Euro period (i.e., it equals 0.01).

41 A censoring scheme is said to be independent if the probability of censoring at each time t depends only on random processes that are independent of the failure times in the trial, the observed pattern of failures and censoring up to time t in the trial, or (as in our case) on a covariate (Kalbfleisch and Prentice 2002, p. 13).

42 The estimates show that controlling for Spanish macro conditions the German rate is a strong instrument (Staiger and Stock 1997), with a t-statistic on its coefficient that is larger than eight. Jointly the variables explain 97% of the variation in the Spanish interest rate. Notice that the correlation between the two countries' GDP growth rates is only 36%! These results are consistent with Boivin et al. (2008) who finds that German interest-rate shocks triggered stronger responses to interest rates and consumption in Spain than in Germany itself.

43 The required adjustment of the standard errors on the estimated coefficients is not immediately available. The difference in fit of the models estimated with the actual and the projected Spanish interest rate, however, suggests that the adjustment factor is likely to be close to one. We further calculate the adjustment factor for a model estimated using ordinary least squares for which the dependent variable equals the logarithm of the time to default (censored observations are set equal to their maximum, i.e., 48 months). Again the adjustment factor is close to one and the estimated coefficients themselves in this linear model are very similar to those of the duration model.

44 For comparability reasons we use the annual growth rate. Using the more noisy quarterly growth leaves results virtually unaffected.

45 While we cannot control for loss given default, empirical evidence actually shows a negative correlation between default probabilities and average recovery rates (Altman et al. 2005; Acharya et al. 2007). In addition to house prices, industry, province and borrower effects may have absorbed differences in recovery rates.

46 We control at the firm level for the level of debt. Lower interest rates make debt cheaper, which may increase debt levels and make firm defaults more likely. However, comparing the results in Models I and II in Table 2 (no debt level variable) with all subsequent models suggest that the level of debt is not the only channel through which the stance of monetary policy influences the hazard rate.

47 In a non-reported regression we also use OECD forecasts for the whole period and control for German GDP growth. Results are virtually the same.

References

Acharya, Viral V., Sreedhar T. Bharath, and Anand Srinivasan. 2007. Does industry-wide distress affect defaulted firms? Evidence from creditor recoveries. *Journal of Financial Economics* 85:787–821.

Adalid, Ramón, and Carsten Detken. 2007. *Liquidity shocks and asset price boom/bust cycles*. Working Paper 732. Frankfurt: European Central Bank.

Ahrend, Rudiger, Boris Cournède, and Robert Price. 2008. *Monetary policy, market excesses and financial turmoil*. Economics Department Working Paper 597. Paris: Organisation for Economic Co-operation and Development.

Allen, Franklin, and Douglas Gale. 2004. Asset price bubbles and monetary policy. In *Global governance and financial crises*, ed. Meghnad Desai, Yahia Said, 19–42. London: Routledge.

Altman, Edward I., Brooks Brady, Andrea Resti, and Andrea Sironi. 2005. The link between default and recovery rates: Theory, empirical evidence, and implications. *Journal of Business* 78:2203–2228.

Altunbas, Yener, Leonardo Gambacorta, and David Marquez-Ibañez. 2014. Does monetary policy affect bank risk-taking? *International Journal of Central Banking* 10:95–135.

Apel, Mikael, and Carl Andreas Claussen. 2012. Monetary policy, interest rates and risk-taking. *Sveriges Riksbank Economic Review* 2:68–83.

Axelson, Ulf, Tim Jenkinson, Per Strömberg, and Michael S. Weisbach. 2013. Borrow cheap, buy high? Determinants of leverage and pricing in buyouts. *Journal of Finance* 68:2223–2267.

Banco de España. 1997. *La política monetaria y la inflación en España (Monetary policy and inflation in Spain)*. Madrid: Alianza Editorial.

Beattie, Vivien A., Peter D. Casson, Richard S. Dale, George W. McKenzie, Charles M.S. Sutcliffe, and Michael J. Turner. 1995. *Banks and bad debts: Accounting for international losses in international banking*. London: John Wiley & Sons.

Beck, Thorsten, Asli Demirgüc-Kunt, and Ross Levine. 2003. *Bank supervision and corporate finance*. Working Paper 9620. Cambridge: National Bureau of Economic Research.

Berger, Allen N., and Gregory F. Udell. 1992. Some evidence on the empirical significance of credit rationing. *Journal of Political Economy* 100:1047–1077.

Berger, Allen N., and Gregory F. Udell. 1995. Relationship lending and lines of credit in small firm finance. *Journal of Business* 68:351–381.

Bernanke, Ben S. 2007. *The financial accelerator and the credit channel*. Washington, D.C.: Board of Governors of the US Federal Reserve System. Remarks – Credit Channel of Monetary Policy in the Twenty-first Century.

Bernanke, Ben S., and Alan S. Blinder. 1988. Money, credit and aggregate demand. *American Economic Review* 82:901–921.

Bernanke, Ben S., and Alan S. Blinder. 1992. The federal funds rate and the channels of monetary transmission. *American Economic Review* 82:901–921.

Bernanke, Ben S., and Mark Gertler. 1989. Agency costs, net worth, and business fluctuations. *American Economic Review* 79:14–31.

Bernanke, Ben S., and Mark Gertler. 1995. Inside the black box: The credit channel of monetary policy transmission. *Journal of Economic Perspectives* 9:27–48.

Bernanke, Ben S., and Kenneth N. Kuttner. 2005. What explains the stock market's reaction to federal reserve policy? *Journal of Finance* 60:1221–1258.

Bernanke, Ben S., Mark Gertler, and Simon Gilchrist. 1996. The financial accelerator and the flight to quality. *Review of Economics and Statistics* 78:1–15.

Bernanke, Ben S., Mark Gertler, and Simon Gilchrist. 1999. The financial accelerator in a quantitative business cycle framework. In *Handbook of macroeconomics*, ed. John Taylor, Michael Woodford, 1341–1393. Amsterdam: Elsevier.

Bharath, Sreedhar T., Sandeep Dahiya, Anthony Saunders, and Anand Srinivasan. 2007. So what do i get: A bank's view of lending relationships. *Journal of Financial Economics* 85:368–419.

Blanchard, Olivier. 2006. *Macroeconomics*. New York: Prentice Hall.

Blanchard, Olivier. 2008. *The state of macro*. Working Paper 14259. Cambridge: National Bureau for Economic Research.

Boivin, Jean, Benoît Mojon, and Marc P. Giannoni. 2008. How has the euro changed the monetary transmission? In *NBER macroeconomics annual*, ed. Daron Acemoglu, Kenneth Rogoff, and Michael Woodford, 77–125. Cambridge: MIT Press.

Bolton, Patrick, and Xavier Freixas. 2000. Equity, bonds, and bank debt: Capital structure and financial market equilibrium under asymmetric information. *Journal of Political Economy* 108:324–351.

Borio, Claudio. 2003. Towards a macroprudential framework for financial supervision and regulation. *CESifo Economic Studies* 49:181–215.

Borio, Claudio, and Philip Lowe. 2002. *Asset prices, financial and monetary stability: Exploring the nexus*. BIS Paper 114. Basel: Bank of International Settlements.

Borio, Claudio, and Haibin Zhu. 2012. Capital regulation, risk-taking and monetary policy: A missing link in the transmission mechanism. *Journal of Financial Stability* 8:236–251.

Boyd, John H., and Bruce Champ. 2003. *Inflation and financial market performance: What have we learned in the last ten years?* Working Paper 17. Cleveland: Federal Reserve Bank of Cleveland.

Buch, Claudia M., Sandra Eickmeier, and Esteban Prieto. 2014a. In search for yield? Survey-based evidence on bank risk taking. *Journal of Economic Dynamics and Control* 43:12–30.

Buch, Claudia M., Sandra Eickmeier, and Esteban Prieto. 2014b. Macroeconomic factors and microlevel bank behavior. *Journal of Money, Credit and Banking* 46:715–751.

Caballero, Ricardo. 2006. On the macroeconomics of asset shortages. In *The role of money: Money and monetary policy in the twenty-first century*, ed. Andreas Beyer, Lucrezia Reichlin, 272–283. Frankfurt: European Central Bank.

Calomiris, Charles W., and Thanavut Pornrojnangkool. 2009. Relationship banking and the pricing of financial services. *Journal of Financial Services Research* 35:189–224.

Cameron, A. Colin, and Pravin K. Trivedi. 2005. *Microeconometrics: Methods and applications*. New York: Cambridge University Press.

Chava, Sudheer, and Robert A. Jarrow. 2004. Bankruptcy prediction with industry effects. *Review of Finance* 8:537–569.

Christiano, Lawrence J., Martin Eichenbaum, and Charles Evans. 1996. The effects of monetary policy shocks: Evidence from the flow of funds. *Review of Economics and Statistics* 78:16–34.

Cox, David R. 1972. Regression models and life tables. *Journal of the Royal Statistical Society* 24:187–201.

Delgado, Javier, Vicente Salas, and Jesús Saurina. 2007. Joint size and ownership specialization in bank lending. *Journal on Banking and Finance* 31:3563–3583.

Delis, Manthos D., Hasan Iftekhar, and Nikolaos Mylonidis. 2011. *The risk-taking channel of monetary policy in the USA: Evidence from micro-level data*. London: Cass Business School. Mimeo.

Dell'Ariccia, Giovanni, and Robert Marquez. 2006. Lending booms and lending standards. *Journal of Finance* 61:2511–2546.

Dell'Ariccia, Giovanni, Luc Laeven, and Gustavo A. Suarez. 2016. *Bank leverage and monetary policy's risk-taking channel: Evidence from the United States*. Working Paper 1903. Frankfurt: European Central Bank.

Demirgüc-Kunt, Asli, and Enrica Detragiache. 1998. *The determinants of banking crises in developing and developed countries*. Staff Paper 45. Washington, D.C.: International Monetary Fund.

Demirgüc-Kunt, Asli, and Enrica Detragiache. 2002. Does deposit insurance increase banking system stability: An empirical investigation. *Journal of Monetary Economics* 49:1373–1406.

Diamond, DouglasW. 1984. Financial intermediation and delegated monitoring. *Review of Economic Studies* 51:393–414.

Diamond, Douglas W. 1991. Monitoring and reputation: The choice between bank loans and privately placed debt. *Journal of Political Economy* 99:689–721.

Diamond, Douglas W., and Raghuram G. Rajan. 2006. Money in a theory of banking. *American Economic Review* 96:30–53.

Duffie, Darrell, Leandro Saita, and KeWang. 2007. Multi-period corporate default prediction with stochastic covariates. *Journal of Financial Economics* 83:635–665.

Freixas, Xavier, and Jean Charles Rochet. 2008. *Microeconomics of banking*. Cambridge: MIT Press.

Gaggl, Paul, and Maria Teresa Valderrama. 2010. Does a low interest rate environment affect risk taking in Austria? *Monetary Policy and the Economy of the Oesterreichische Nationalbank* 2010(4):32–48.

Gertler, Mark, and Simon Gilchrist. 1993. The role of credit market imperfections in the monetary transmission mechanism: Arguments and evidence. *Scandinavian Journal of Economics* 95:43–64.

Gertler, Mark, and Simon Gilchrist. 1994. Monetary policy, business cycles, and the behavior of small manufacturing firms. *Quarterly Journal of Economics* 109:309–340.

Geršl, Adam, Petr Jakubík, Dorota Kowalczyk, Steven Ongena, and José-Luis Peydró. 2015. Monetary conditions and banks' behaviour in the Czech Republic. *Open Economies Review* 26(3):407–446.

Greene, William H. 2003. *Econometric analysis*. Upper Saddle River: Prentice Hall.

Grunert, Jens, Lars Norden, and Martin Weber. 2005. The role of non-financial factors in internal credit ratings. *Journal of Banking and Finance* 29:509–531.

Den Haan, Wouter J., Steven Sumner, and Guy Yamashiro. 2007. Bank loan portfolios and the monetary transmission mechanism. *Journal of Monetary Economics* 54:904–924.

von Hagen, Jürgen, and Tai-Kuang Ho. 2007. Money market pressure and the determinants of banking crises. *Journal of Money, Credit and Banking* 39:1037–1066.

Heckman, James J., and Burton Singer. 1984. Econometric duration analysis. *Journal of Econometrics* 24:63–132.

Hellman, Thomas F., Kevin C. Murdock, and Joseph E. Stiglitz. 2000. Liberalization, moral hazard in banking and prudential regulation: Are capital controls enough? *American Economic Review* 90:147–165.

Hernando, Ignacio, and Jorge Martínez-Pagés. 2003. Is there a bank lending channel of monetary policy in Spain? In *Monetary policy transmission in the euro area*, ed. Ignazio Angeloni, Anil K. Kashyap, and Benoit Mojon, 284–296. New York: Cambridge University Press.

Hertzberg, Andrew, Jose Maria Liberti, and Daniel Paravisini. 2010. Information and incentives inside the firm: Evidence from loan officer rotation. *Journal of Finance* 65:795–828.

Ioannidou, Vasso P., Steven Ongena, and José-Luis Peydró. 2015. Monetary policy, risk-taking and pricing: Evidence from a quasi-natural experiment. *Review of Finance* 19:95–144.

Jiménez, Gabriel, and Jesús Saurina. 2004. Collateral, type of lender and relationship banking as determinants of credit risk. *Journal of Banking and Finance* 28:2191–2212.

Jiménez, Gabriel, Vicente Salas, and Jesús Saurina. 2006. Determinants of collateral. *Journal of Financial Economics* 81:255–281.

Jiménez, Gabriel, Steven Ongena, José-Luis Peydró, and Jesús Saurina. 2012. Credit supply and monetary policy: Identifying the bank balance-sheet channel with loan applications. *American Economic Review* 102:2301–2326.

Jiménez, Gabriel, Steven Ongena, José-Luis Peydró, and Jesús Saurina. 2014a. *'Credit demand forever?' On the strengths of bank and firm balance-sheet channels in good and crisis times*. Madrid: Banco de España. Mimeo.

Jiménez, Gabriel, Steven Ongena, José-Luis Peydró, and Jesús Saurina. 2014b. Hazardous times for monetary policy: What do twenty-three million bank loans say about the effects of monetary policy on credit risk-taking? *Econometrica* 82:463–505.

Jiménez, Gabriel, Steven Ongena, José-Luis Peydró, and Jesús Saurina. 2016. Macroprudential policy, countercyclical bank capital buffers and credit supply: Evidence from the Spanish dynamic provisioning experiments. *Journal of Political Economy*. Forthcoming.

Kalbfleisch, John D., and Ross L. Prentice. 2002. *The statistical analysis of failure time data*. New York: Wiley.

Kane, Edward J. 1989. *The S&L insurance mess: How did it happen?* Cambridge: MIT Press.

Kashyap, Anil K., and Jeremy C. Stein. 2000. What do a million observations on banks say about the transmission of monetary policy? *American Economic Review* 90:407–428.

Keeley, Michael C. 1990. Deposit insurance risk and market power in banking. *American Economic Review* 80:1183–1200.

Kiefer, Nicholas M. 1988. Economic duration data and hazard functions. *Journal of Economic Literature* 26:646–679.

Kiyotaki, Nobuhiro, and John Moore. 1997. Credit cycles. *Journal of Political Economy* 105:211–248.

Krugman, Paul R., and Maurice Obstfeld. 2006. *International economics: Theory and policy*. New York: Addison-Wesley.

Kuritzkes, Andrew, and Til Schuermann. 2010. What we know, don't know, and can't know about bank risk: A view from the trenches. In *The known, the unknown and the unknowable in financial risk management*, ed. Francis X. Diebold, Neil A. Doherty, and Richard J. Herring, 103–144. Princeton: Princeton University Press.

Lang, William W., and Leonard I. Nakamura. 1995. 'Flight to quality' in banking and economic activity. *Journal of Monetary Economics* 36:145–164.

Liberti, Jose M. 2004. *Initiative, incentives and soft information: How does delegation impact the role of bank relationship managers?* Chicago: Kellogg School of Management Northwestern. Mimeo.

López, Martha, Fernando Tenjo, and Hector Zárate. 2011. The risk-taking channel and monetary transmission mechanism in Colombia. *Ensayos sobre Política Económica* 29:212–287.

López, Martha, Fernando Tenjo, and Hector Zárate. 2012. The risk-taking channel in colombia revisited. *Ensayos sobre Política Económica* 30:274–295.

Manganelli, Simone, and Guido Wolswijk. 2007. Market discipline, financial integration and fiscal rules: What drives spreads in the euro area government bond market? Working Paper 745. Frankfurt: European Central Bank.

Martin-Oliver, Alfredo, Vicente Salas, and Jesús Saurina. 2006. Risk premium and market power in credit markets. *Economics Letters* 93:450–456.

Matsuyama, Kiminori. 2007. Credit traps and credit cycles. *American Economic Review* 97:503–516.

McDonald, Cynthia G., and Linda M. Van de Gucht. 1999. High-yield bond default and call risks. *Review of Economics and Statistics* 81:409–419.

Myers, Stewart, and Raghuram G. Rajan. 1998. The paradox of liquidity. *Quarterly Journal of Economics* 113:733–771.

Paligorova, Teodora, and Joao A.C. Santos. 2013. Monetary policy and bank risk-taking: Evidence from the corporate loan market. Ottawa: Bank of Canada. Mimeo.

Petersen, Mitchell A., and Raghuram G. Rajan. 1994. The benefits of lending relationships: Evidence from small business data. *Journal of Finance* 49:3–37.

Rajan, Raghuram G. 2006. Has finance made the world riskier? *European Financial Management* 12:499–533.

Ruckes, Martin. 2004. Bank competition and credit standards. *Review of Financial Studies* 17:1073–1102.

Sengupta, Rajdeep. 2014. Lending to uncreditworthy borrowers. *Journal of Financial Intermediation* 23:101–128.

Shiller, Robert J. 2007. Low interest rates and high asset prices: An interpretation in terms of changing popular economic models. *Brookings Papers on Economic Activity* 2:111–132.

Shumway, Tyler. 2001. Forecasting bankruptcy more accurately: A simple hazard model. *Journal of Business* 74:101–124.

Smith, Bruce D. 2002. Monetary policy, banking crises, and the Friedman rule. *American Economic Review* 92:128–134.

Staiger, Douglas, and James H. Stock. 1997. Instrumental variables regression with weak instruments. *Econometrica* 65:557–586.

Stiglitz, Joseph E. 2001. *Information and the change in the paradigm in economics*. Stockholm: Nobel Foundation. Prize Lecture.

Stiglitz, Joseph E., and Bruce Greenwald. 2003. *Towards a new paradigm in monetary economics*. Cambridge: Cambridge University Press.

Stiglitz, Joseph E., and Andrew Weiss. 1981. Credit rationing in markets with imperfect information. *American Economic Review* 71:393–410.

Taylor, John B. 2007. Housing and monetary policy. Paper Presented at a Symposium Sponsored by the Federal Reserve Bank of Kansas City, Jackson Hole. Jackson Hole: Federal Reserve Bank of Kansas City.

Thoma, Mark A. 1994. Subsample instability and asymmetries in money-income causality. *Journal of Econometrics* 64:279–306.

Treacy, William F., and Mark S. Carey. 2000. Credit risk-rating systems at large U.S. Banks. *Journal of Banking and Finance* 24:167–201.

Weise, Charles L. 1999. The asymmetric effects of monetary policy: A nonlinear vector autoregression approach. *Journal of Money, Credit and Banking* 31:85–108.

Table 1 Descriptive Statistics

Variables	Definition	Unit	Mean	St. Dev.	Min.	Max.
Deependent Variables						
DEFAULT (0/1)	=1 if there is default, i.e, if three months after the date of maturity or the date of an interest payment, the debt balance remains unpaid; =0 otherwise	–	0.006	0.080	0	1
TIME TO DEFAULT	The number of quarters to default	QRT	4.371	3.815	1	48
Independent Variables						
Monetary Policy Rates						
INTEREST RATE	Quarterly averages of German and Euro overnight interest rates (the Euro interest rate starts in 1999:I), dated in the quarter prior to loan origination	%	4.135	2.166	2.023	9.619
Δ INTEREST RATE	The change in the INTEREST RATE	%	–0.037	0.702	–7.540	6.390
INTEREST RATE SPAIN	Quarterly average of Spanish overnight interest rate	%	6.086	4.330	2.023	15.512
Bank Characteristics	*Including bank identity (213 banks)*					
LN(TOTAL ASSETS)	The logarithm of the total assets of the bank	EUR	16.859	1.626	8.595	19.484
LIQUIDITY RATIO	The amount of liquid assets (cash and balances with central banks, loans and advances to credit institutions, and loans and advances to general government) held by the bank over total assets	%	29.270	12.422	0.222	95.902
BANK NPL_b-NPL	The difference between the bank and the average bank's level of non performing loans over total assets	%	–0.013	1.793	–4.784	68.969
OWN FUNDS/ TOTAL ASSETS	The amount of bank equity over total bank assets	%	6.324	2.470	–11.226	80.945
LISTED (0/1)	=1 if the commercial bank is publicly listed; =0 otherwise	–	0.456	0.498	0	1
SAVINGS BANK (0/1)	=1 if the bank is a saving bank; =0 otherwise	–	0.319	0.466	0	1
CREDIT COOPERATIVE (0/1)	=1 if the bank is a credit cooperative; =0 otherwise	–	0.050	0.218	0	1
Borrower Characteristics	*Including borrower identity (39,963 borrowers)*					
LN(1+BORROWER BANK DEBT)	The logarithm of one plus the total amount of borrower bank debt	EUR	5.609	2.380	0	14.401
LN(1+NUMBER OF BANK RELATIONSHIPS)	The logarithm of one plus the number of bank relationships of the borrower	–	1.385	0.710	0	4.369

Table 1 Descriptive Statistics (Continued)

Variables	Definition	Unit	Mean	St. Dev.	Min.	Max.
BAD CREDIT HISTORY (0/1)	=1 if the borrower was overdue any time before on another loan; =0 otherwise	–	0.111	0.314	0	1
LN(2+AGE AS BORROWER)	The logarithm of two plus the age of the borrower. Age is the number of quarters from the first time the firm borrowed from a bank	QRT	2.874	1.102	0.693	4.477
Loan Characteristics	*Including a loan identifier (674,127 loans)*					
LN(SIZE OF THE LOAN)	The logarithm of the total loan amount granted	–	4.175	1.376	1.792	15.061
COLLATERAL (0/1)	=1 if the loan is collateralized; =0 otherwise	–	0.077	0.267	0	1
FINANCIAL CREDIT (0/1)	=1 if the loan is a financial credit; =0 otherwise. Financial credit includes all loans that are not used to finance either the production of commercialization of goods or services	–	0.457	0.498	0	1
MATURITY 0 m.–3 m. (0/1)	=1 if the loan matures before 3 months; =0 otherwise	–	0.421	0.494	0	1
MATURITY 3 m.–1 y. (0/1)	=1 if the loan matures between 3 months and 1 year; =0 otherwise	–	0.375	0.484	0	1
MATURITY 1 y.–3 y. (0/1)	=1 if the loan matures between 1 year and 3 years; =0 otherwise	–	0.099	0.298	0	1
MATURITY 3 y.–5 y. (0/1)	=1 if the loan matures between 3 year and 5 years; =0 otherwise	–	0.035	0.185	0	1
Macro Controls						
GGDP	Growth in real gross domestic product	%	3.032	1.312	–1.833	6.193
INFLATION	CPI Inflation rate	%	3.755	1.368	1.490	7.100
COUNTRY RISK	The spread between the ten year Spanish and German government bond rate	%	1.526	2.064	0.010	6.700
Province Characteristics						
NEW FIRMS/ TOTAL FIRMS	The number of new firms over the total number of firms in the province	%	4.551	1.530	1.148	21.781
HERFINDAHL-HIRSCHMAN INDEX	The Herfindahl Hirschman Index is hundred times the sum of squared bank market shares in total bank loans in each province (0 to 100)	–	6.950	3.001	2.578	39.420

Table 1 Descriptive Statistics (Continued)

Variables	Definition	Unit	Mean	St. Dev.	Min.	Max.
Robustness						
CREDIT GROWTH	Growth of loans to firms at bank level	%	1.922	30.636	–77.839	43.679
HOUSE PRICE GROWTH	The growth in house prices	%	11.449	7.370	–7.415	27.335
FORECAST EURO AREA GDPG	ECB forecast for 1 year ahead euro area GDP growth	%	2.210	0.526	1.200	3.400
SPANISH TEN YEAR BOND	The interest rate on a Spanish ten year Governement bond	%	6.877	3.483	3.180	14.750

The table defines the variables employed in the empirical specifications, including their unit, and provides their mean, standard deviation, minimum and maximum. All variables are measured in the quarter before the loan was granted, except the loan characteristics and the first three robust variables that are measured in the quarter the loan was granted. All country specific variables pertain to Spain unless otherwise indicated. *EUR* amount in Euros, *QTR* number of quarters, % in percent. The number of observations equals 674,127 for all variables (based on a 3% random sample), except for D SMALL – LARGE BANK where it equals 13,265,830 (based on the full sample of firms with multiple loans)

Table 2 Duration Models

Independent Variables	Model I Weibull Bank Heterogeneity			II Weibull Bank Characteristics			III Weibull Borrower/Loan Characteristics			IV Weibull Borrower Heterogeneity		
	Coeff.	Sig.	*(S.E.)*	Coeff.	Sig.	*(S.E.)*	Coeff.	Sig.	*(S.E.)*	Coeff.	Sig.	*(S.E.)*
Monetary Policy Rates												
INTEREST $RATE_{t-1}$	–0.099	***	*(0.019)*	–0.084	***	*(0.021)*	–0.072	***	*(0.021)*	–0.127	***	*(0.023)*
INTEREST $RATE_{t+T-1}$	0.344	***	*(0.014)*	0.350	***	*(0.015)*	0.323	***	*(0.016)*	0.293	***	*(0.017)*
INTEREST $RATE_{t-1}$ * BAD CREDIT $HISTORY_{jt-1}$ (0/1)	–			–			–			–		
INTEREST $RATE_{t-1}$ * LN(2+AGE AS $BORROWER_{jt-1}$)	–			–			–			–		
ΔINTEREST $RATE_{t-1}$	–			–			–			–		
ΔINTEREST $RATE_{t-2}$	–			–			–			–		
Δ INTEREST $RATE_{t-3}$	–			–			–			–		
INTEREST $RATE_{t+T-1}$ – INTEREST $RATE_{t-1}$	–			–			–			–		
Bank Characteristics												
LN(TOTAL $ASSETS_{bt-1}$)	–			0.018	–	*(0.014)*	0.022	–	*(0.015)*	0.017	–	*(0.015)*
LIQUIDITY $RATIO_{bt-1}$	–			–0.573	***	*(0.215)*	–0.358	–	*(0.230)*	–0.182	–	*(0.218)*
BANK NPL_{bt-1}-NPL_{t-1}	–			0.061	***	*(0.005)*	0.055	***	*(0.006)*	0.069	***	*(0.007)*
OWN FUNDS/TOTAL $ASSETS_{bt-1}$	–			–5.042	***	*(0.922)*	–5.360	***	*(0.953)*	–5.996	***	*(0.922)*
$LISTED_{bt-1}$ (0/1)	–			0.154	***	*(0.059)*	0.146	**	*(0.060)*	0.079	–	*(0.060)*
SAVINGS $BANK_{bt-1}$ (0/1)	–			0.422	***	*(0.058)*	0.469	***	*(0.059)*	0.479	***	*(0.059)*
CREDIT $COOPERATIVE_{bt-1}$ (0/1)	–			0.371	***	*(0.099)*	0.521	***	*(0.103)*	0.417	***	*(0.105)*
Borrower Characteristics												
LN(1+BORROWER BANK $DEBT_{jt-1}$)	–			–			0.025	–	*(0.018)*	–0.043	**	*(0.018)*

Table 2 Duration Models (Continued)

Independent Variables	Model I Weibull Bank Heterogeneity			II Weibull Bank Characteristics			III Weibull Borrower/Loan Characteristics			IV Weibull Borrower Heterogeneity		
	Coeff.	Sig.	*(S.E.)*	Coeff.	Sig.	*(S.E.)*	Coeff.	Sig.	*(S.E.)*	Coeff.	Sig.	*(S.E.)*
LN(1+NUMBER OF BANK RELATIONSHIPS$_{jt-1}$)	–			–			0.529	***	*(0.070)*	1.013	***	*(0.065)*
BAD CREDIT HISTORY$_{jt-1}$ (0/1)	–			–			1.110	***	*(0.063)*	0.777	***	*(0.061)*
LN(2+AGE AS BORROWER$_{jt-1}$)	–			–			–0.406	***	*(0.026)*	–0.264	***	*(0.027)*
Loan Characteristics												
LN(SIZE OF THE LOAN$_{lt}$)	–			–			–0.231	***	*(0.016)*	–0.104	***	*(0.018)*
COLLATERAL$_{lt}$ (0/1)	–			–			0.225	***	*(0.061)*	0.076	–	*(0.064)*
FINANCIAL CREDIT$_{lt}$ (0/1)	–			–			0.665	***	*(0.056)*	0.834	***	*(0.055)*
MATURITY$_{lt}$ 0 m.–3 m. (0/1)	–			–			0.906	***	*(0.082)*	1.182	***	*(0.086)*
MATURITY$_{lt}$ 3 m.–1 y. (0/1)	–			–			0.886	***	*(0.068)*	0.987	***	*(0.071)*
MATURITY$_{lt}$ 1 y.–3 y. (0/1)	–			–			0.527	***	*(0.070)*	0.495	***	*(0.073)*
MATURITY$_{lt}$ 3 y.–5 y. (0/1)	–			–			0.158	**	*(0.075)*	0.111	–	*(0.080)*
Macro Controls												
GGDP$_{t-1}$	–0.201	***	*(0.014)*	–0.202	***	*(0.016)*	–0.199	***	*(0.017)*	–0.240	***	*(0.016)*
GGDP$_{t+T-1}$	–0.045	***	*(0.016)*	–0.048	***	*(0.018)*	–0.052	***	*(0.018)*	–0.057	***	*(0.019)*
ΔGGDP$_{t-1}$	–			–			–			–		
GGDP$_{t+T-1}$ – GGDP$_{t-1}$	–			–			–			–		
INFLATION$_t$	0.067	**	*(0.027)*	0.055	*	*(0.031)*	0.050	–	*(0.031)*	0.088	***	*(0.030)*
COUNTRY RISK$_t$	0.090	***	*(0.021)*	0.107	***	*(0.023)*	0.108	***	*(0.023)*	0.139	***	*(0.023)*
TIME TREND	0.133	***	*(0.021)*	0.173	***	*(0.028)*	0.159	***	*(0.028)*	0.211	***	*(0.026)*
TIME TREND^2	0.000	***	*(0.000)*	–0.001	***	*(0.000)*	0.000	***	*(0.000)*	–0.001	***	*(0.000)*

Table 2 Duration Models (Continued)

Independent Variables	Model											
	I Weibull Bank Heterogeneity			II Weibull Bank Characteristics			III Weibull Borrower/Loan Characteristics			IV Weibull Borrower Heterogeneity		
	Coeff.	Sig.	*(S.E.)*	Coeff.	Sig.	*(S.E.)*	Coeff.	Sig.	*(S.E.)*	Coeff.	Sig.	*(S.E.)*
Other	1.859											
CONSTANT	–19.04	***	*(1.770)*	–22.13	***	*(2.276)*	–21.89	***	*(2.336)*	–26.43	***	*(2.158)*
ln(α) (duration dependence)	0.620	***	*(0.008)*	0.619	***	*(0.008)*	0.671	***	*(0.008)*	0.816	***	*(0.009)*
Industry dummies (9)	No			No			Yes			Yes		
Province dummies (49)	No			No			Yes			Yes		
Year dummies (18)	No			No			No			Yes		
Bank Random Effects (213 Banks)	Yes			No			No			No		
Borrower Random Effects (39,963 Borrowers)	No			No			No			Yes		
No. of Observations (Loans or Loan Quarters)	674,127			674,127			674,127			674,127		
Log pseudolikelihood	–21,895			–21,682			–20,598			–19,199		
c^2 (p-value)	0.000			0.000			0.000			0.000		

Table 2 Duration Models

Independent Variables	Model V Weibull Borrower Risk Interactions			VI Weibull Year Dummies			VII Weibull Differences			VIII Weibull Time-Varying			IX Weibull Time-Varying Without Trends		
	Coeff.	Sig.	*(S.E.)*	Coeff.	Sig.	*(S.E.)*	Coeff.	Sig.	*(S.E.)*	Coeff.	Sig.	*(S.E.)*	Coeff.	Sig.	*(S.E.)*
Monetary Policy Rates															
INTEREST RATE$_{t-1}$	–0.100	***	*(0.025)*	–0.327	***	*(0.019)*	–			–0.114	***	*(0.014)*	–0.052	***	*(0.014)*
INTEREST RATE$_{t+T-1}$	0.324	***	*(0.016)*	–			–			0.044	**	*(0.021)*	0.191	***	*(0.019)*
INTEREST RATE$_{t-1}$ * BAD CREDIT HISTORY$_{jt-1}$ (0/1)	–0.093	***	*(0.021)*	–			–			–			–		
INTEREST RATE$_{t-1}$ * LN(2+AGE AS BORROWER$_{jt-1}$)	0.021	***	*(0.006)*	–			–			–			–		
ΔINTEREST RATE$_{t-1}$	–			–			–0.601	***	*(0.067)*	–			–		
ΔINTEREST RATE$_{t-2}$	–			–			–0.152	***	*(0.058)*	–			–		
Δ INTEREST RATE$_{t-3}$	–			–			0.011	–	*(0.063)*	–			–		
INTEREST RATE$_{t+T-1}$ – INTEREST RATE$_{t-1}$	–			–			0.201	***	*(0.012)*	–			–		
Bank Characteristics															
LN(TOTAL ASSETS$_{bt-1}$)	0.022	–	*(0.015)*	0.119	***	*(0.015)*	0.032	**	*(0.015)*	0.073	***	*(0.015)*	0.033	**	*(0.014)*
LIQUIDITY RATIO$_{bt-1}$	–0.362	–	*(0.230)*	–2.834	***	*(0.218)*	–0.671	***	*(0.233)*	–1.804	***	*(0.234)*	–0.594	***	*(0.198)*
BANK NPL$_{bt-1}$-NPL$_{t-1}$	0.055	***	*(0.006)*	0.038	***	*(0.006)*	0.053	***	*(0.006)*	0.051	***	*(0.006)*	0.055	***	*(0.006)*
OWN FUNDS/TOTAL ASSETS$_{bt-1}$	–5.449	***	*(0.954)*	–4.591	***	*(0.889)*	–5.026	***	*(0.948)*	–5.543	***	*(0.938)*	–5.028	***	*(0.928)*
LISTED$_{bt-1}$ (0/1)	0.148	**	*(0.060)*	0.232	***	*(0.061)*	0.184	***	*(0.060)*	0.215	***	*(0.062)*	0.154	**	*(0.060)*
SAVINGS BANK$_{bt-1}$ (0/1)	0.471	***	*(0.059)*	0.606	***	*(0.059)*	0.495	***	*(0.059)*	0.505	***	*(0.061)*	0.455	***	*(0.059)*
CREDIT COOPERATIVE$_{bt-1}$ (0/1)	0.524	***	*(0.103)*	0.925	***	*(0.104)*	0.564	***	*(0.103)*	0.742	***	*(0.104)*	0.547	***	*(0.101)*

Table 2 Duration Models (Continued)

Independent Variables	Model														
	V Weibull Borrower Risk Interactions			VI Weibull Year Dummies			VII Weibull Differences			VIII Weibull Time-Varying			IX Weibull Time-Varying Without Trends		
	Coeff.	Sig.	*(S.E.)*	Coeff.	Sig.	*(S.E.)*	Coeff.	Sig.	*(S.E.)*	Coeff.	Sig.	*(S.E.)*	Coeff.	Sig.	*(S.E.)*
Borrower Characteristics															
LN(1+BORROWER BANK $DEBT_{jt-1}$)	0.023	–	*(0.018)*	0.002	–	*(0.018)*	0.027	–	*(0.018)*	0.014	–	*(0.019)*	0.019	–	*(0.018)*
LN(1+NUMBER OF BANK $RELATIONSHIPS_{jt-1}$)	0.538	***	*(0.070)*	0.526	***	*(0.071)*	0.540	***	*(0.071)*	0.540	***	*(0.072)*	0.537	***	*(0.071)*
BAD CREDIT $HISTORY_{jt-1}$ (0/1)	1.608	***	*(0.136)*	1.021	***	*(0.064)*	1.132	***	*(0.064)*	1.093	***	*(0.064)*	1.118	***	*(0.064)*
LN(2+AGE AS $BORROWER_{jt-1}$)	–0.512	***	*(0.039)*	–0.333	***	*(0.028)*	–0.411	***	*(0.026)*	–0.367	***	*(0.028)*	–0.392	***	*(0.027)*
Loan Characteristics															
LN(SIZE OF THE $LOAN_{lt}$)	–0.235	***	*(0.016)*	–0.226	***	*(0.016)*	–0.234	***	*(0.016)*	–0.238	***	*(0.016)*	–0.239	***	*(0.016)*
$COLLATERAL_{lt}$ (0/1)	0.227	***	*(0.061)*	0.366	***	*(0.058)*	0.240	***	*(0.062)*	0.237	***	*(0.061)*	0.227	***	*(0.061)*
FINANCIAL $CREDIT_{lt}$ (0/1)	0.672	***	*(0.056)*	0.717	***	*(0.057)*	0.660	***	*(0.056)*	0.650	***	*(0.057)*	0.637	***	*(0.057)*
$MATURITY_{lt}$ 0 m.–3 m. (0/1)	0.912	***	*(0.082)*	0.637	***	*(0.078)*	0.976	***	*(0.082)*	0.950	***	*(0.081)*	0.947	***	*(0.081)*
$MATURITY_{lt}$ 3 m.–1 y. (0/1)	0.890	***	*(0.068)*	0.553	***	*(0.065)*	0.945	***	*(0.069)*	0.915	***	*(0.068)*	0.923	***	*(0.068)*
$MATURITY_{lt}$ 1 y.–3 y. (0/1)	0.530	***	*(0.070)*	0.135	**	*(0.068)*	0.565	***	*(0.071)*	0.520	***	*(0.070)*	0.549	***	*(0.069)*
$MATURITY_{lt}$ 3 y.–5 y. (0/1)	0.159	**	*(0.075)*	–0.098	–	*(0.075)*	0.173	**	*(0.076)*	0.139	*	*(0.076)*	0.164	**	*(0.075)*
Macro Controls															
$GGDP_{t-1}$	–0.201	***	*(0.017)*	–0.289	***	*(0.015)*	–			–0.162	***	*(0.014)*	–0.154	***	*(0.014)*
$GGDP_{t+T-1}$	0.227	***	*(0.061)*	–			–			–0.121	***	0.017	–0.040	**	*(0.016)*
$\Delta GGDP_{t-1}$	–			–			–0.296	***	*(0.047)*	–			–		
$GGDP_{t+T-1} - GGDP_{t-1}$	–			–			0.026	*	*(0.015)*	–			–		
$INFLATION_t$	0.049	–	*(0.031)*	0.050	*	*(0.029)*	0.412	***	*(0.033)*	0.036	–	*(0.029)*	–0.094	***	*(0.027)*
COUNTRY $RISK_t$	0.109	***	*(0.023)*	–0.508	***	*(0.024)*	–0.058	**	*(0.022)*	0.033	–	*(0.023)*	0.222	***	*(0.018)*

Table 2 Duration Models (Continued)

Independent Variables	Model V Weibull Borrower Risk Interactions			VI Weibull Year Dummies			VII Weibull Differences			VIII Weibull Time-Varying			IX Weibull Time-Varying Without Trends		
	Coeff.	Sig.	*(S.E.)*	Coeff.	Sig.	*(S.E.)*	Coeff.	Sig.	*(S.E.)*	Coeff.	Sig.	*(S.E.)*	Coeff.	Sig.	*(S.E.)*
TIME TREND	0.155	***	*(0.028)*	–			0.181	***	*(0.023)*	0.007	–	*(0.024)*	–		
TIME TREND^2	0.000	***	*(0.000)*	–			–0.001	***	*(0.000)*	0.000	*	*(0.000)*	–		
Other	1.859														
CONSTANT	–21.48	***	*(2.351)*	–9.08	***	*(0.434)*	–22.55	***	*(1.839)*	–5.684	***	*(1.981)*	–8.649	***	*(0.430)*
ln(α) (duration dependence)	0.672	***	*(0.008)*	0.671	***	*(0.008)*	0.624	***	*(0.008)*	0.705	***	*(0.009)*	0.671	***	*(0.008)*
Industry dummies (9)	Yes			Yes			Yes			Yes			Yes		
Province dummies (49)	Yes			Yes			Yes			Yes			Yes		
Year dummies (18)	No			Yes			No			No			No		
Bank Random Effects (213 Banks)	No			No			No			No			No		
Borrower Random Effects (39,963 Borrowers)	No			No			No			No			No		
No. of Observations (Loans or Loan Quarters)	674,127			674,127			674,127			1,989,170			1,989,170		
Log pseudolikelihood	–20,580			–19,325			–20,842			–20,599			–20,719		
c^2 (p-value)	0.000			0.000			0.000			0.000			0.000		

The estimates in this table are based on maximum likelihood estimation of the proportional hazard model using the Weibull distribution as baseline hazard rate. The parameter ln(α) measures the degree of duration dependence. The dependent variable is the hazard rate. The definition of the other variables can be found in Table 1. Subscripts indicate the time of measurement of each variable. τ is the quarter the loan was granted. T is the time to repayment or default of the loan. t which indexes the time over the life of the loan, replaces T in Models VII and VIII in the subscripts of INTEREST RATE, GDPG, INLATION and COUNTRY RISK. All estimates are adjusted for right censoring. Coefficients are listed in the first column, significance levels in the second column, and robust standard errors that are corrected for clustering at the borrower level are reported in italics between parentheses in the third column

***Significant at 1%, **significant at 5%, *significant at 10%

Table 3 Duration Models Including Interactions with Bank Characteristics

Independent Variables	Model I Weibull Size			II Weibull Liquidity			III Weibull NPL			IV Weibull Type of Ownership			V Weibull Local Markets		
	Coeff.	Sig.	*(S.E.)*	Coeff.	Sig.	*(S.E.)*	Coeff.	Sig.	*(S.E.)*	Coeff.	Sig.	*(S.E.)*	Coeff.	Sig.	*(S.E.)*
Monetary Policy Rates															
INTEREST RATE$_{t-1}$	–0.482	***	*(0.077)*	–0.456	***	*(0.078)*	–0.462	***	*(0.079)*	–0.563	***	*(0.090)*	–0.412	***	*(0.082)*
INTEREST RATE$_{t+T-1}$	0.322	***	*(0.016)*	0.325	***	*(0.016)*	0.324	***	*(0.016)*	0.332	***	*(0.016)*	0.328	***	*(0.016)*
Monetary Policy Rate and Bank or Province Characteristics															
INTEREST RATE$_{t-1}$ * LN(TOTAL ASSETS$_{bt-1}$)	0.025	***	*(0.005)*	0.031	***	*(0.005)*	0.031	***	*(0.005)*	0.032	***	*(0.006)*	0.030	***	*(0.005)*
INTEREST RATE$_{t-1}$ * LIQUIDITY RATIO$_{bt-1}$	–			–0.304	***	*(0.078)*	–0.302	***	*(0.078)*	–0.271	***	*(0.078)*	–0.311	***	*(0.078)*
INTEREST RATE$_{t-1}$ * BANK NPL$_{bt-1}$-NPL$_{t-1}$	–			–			0.119	–	*(0.295)*	–			–		
INTEREST RATE$_{t-1}$ * LISTED$_{bt-1}$ (0/1)	–			–			–			0.037	–	*(0.025)*	–		
INTEREST RATE$_{t-1}$ * SAVINGS BANK$_{bt-1}$ (0/1)	–			–			–			0.090	***	*(0.024)*	–		
INTEREST RATE$_{t-1}$ * CREDIT COOPERATIVE$_{bt-1}$ (0/1)	–			–			–			0.024	–	*(0.047)*	–		
INTEREST RATE$_{t-1}$ * NEW FIRMS/TOTAL FIRMS$_{pt-1}$	–			–			–			–			–1.309	***	*(0.451)*
INTEREST RATE$_{t-1}$ * HERFIND-AHL HIRSCHMAN INDEX$_{pt-1}$	–			–			–			–			0.664	*	*(0.343)*

Table 3 Duration Models Including Interactions with Bank Characteristics (Continued)

Independent Variables	Model I Weibull Size			II Weibull Liquidity			III Weibull NPL			IV Weibull Type of Ownership			V Weibull Local Markets		
	Coeff.	Sig.	*(S.E.)*	Coeff.	Sig.	*(S.E.)*	Coeff.	Sig.	*(S.E.)*	Coeff.	Sig.	*(S.E.)*	Coeff.	Sig.	*(S.E.)*
Bank Characteristics															
LN(TOTAL ASSETS$_{bt-1}$)	–0.111	***	*(0.028)*	–0.134	***	*(0.029)*	–0.136	***	*(0.029)*	–0.142	***	*(0.032)*	–0.126	***	*(0.029)*
LIQUIDITY RATIO$_{bt-1}$	–0.357	–	*(0.229)*	1.267	***	*(0.459)*	1.258	***	*(0.458)*	0.992	**	*(0.456)*	1.039	**	*(0.463)*
BANK NPL$_{bt-1}$-NPL$_{t-1}$	0.058	***	*(0.006)*	0.057	***	*(0.006)*	0.050	***	*(0.019)*	0.057	***	*(0.006)*	0.065	***	*(0.006)*
OWN FUNDS/TOTAL ASSETS$_{bt-1}$	–5.819	***	*(0.983)*	–5.760	***	*(0.984)*	–5.745	***	*(0.985)*	–5.601	***	*(0.982)*	–4.956	***	*(0.955)*
LISTED$_{bt-1}$ (0/1)	0.126	**	*(0.060)*	0.125	**	*(0.060)*	0.126	**	*(0.060)*	–0.063	–	*(0.140)*	0.138	**	*(0.059)*
SAVINGS BANK$_{bt-1}$ (0/1)	0.459	***	*(0.059)*	0.477	***	*(0.059)*	0.478	***	*(0.059)*	0.014	–	*(0.133)*	0.468	***	*(0.059)*
CREDIT COOPERATIVE$_{bt-1}$ (0/1)	0.448	***	*(0.103)*	0.462	***	*(0.104)*	0.462	***	*(0.104)*	0.280	–	*(0.223)*	0.434	***	*(0.102)*
Borrower, Loan, and Macro Controls, and Constant	*Yes*			*Yes*			*Yes*			*Yes*			*Yes*		
Province Characteristics															
NEW FIRMS/TOTAL FIRMS$_{pt-1}$	–			–			–			–			0.086	***	*(0.027)*
HERFINDAHL HIRSCHMAN INDEX$_{pt-1}$	–			–			–			–			–0.018	–	*(0.017)*

Table 3 Duration Models Including Interactions with Bank Characteristics (Continued)

Independent Variables	Model														
	I Weibull Size			II Weibull Liquidity			III Weibull NPL			IV Weibull Type of Ownership			V Weibull Local Markets		
	Coeff.	Sig.	*(S.E.)*	Coeff.	Sig.	*(S.E.)*	Coeff.	Sig.	*(S.E.)*	Coeff.	Sig.	*(S.E.)*	Coeff.	Sig.	*(S.E.)*
Other															
ln(a) (duration dependence)	0.671	***	*(0.008)*	0.671	***	*(0.008)*	0.671	***	*(0.008)*	0.673	***	*(0.008)*	0.669	***	*(0.008)*
Industry dummies (9)	Yes			Yes			Yes			Yes			Yes		
Province dummies (49)	Yes			Yes			Yes			Yes			No		
No. of Observations (Loans)	674,127			674,127			674,127			674,127			674,127		
Log pseudolikelihood	–20,580			–20,570			–20,570			–20,558			–20,692		
c^2 (p-value)	0.000			0.000			0.000			0.000			0.000		

The estimates in this table are based on maximum likelihood estimation of the proportional hazard model using the Weibull distribution as baseline hazard rate. The parameter ln(α)measures the degree of duration dependence. The dependent variable is the hazard rate. The definition of the other variables can be found in Table 1. Subscripts indicate the time of measurement of each variable. τ is the quarter the loan was granted. T is the time to repayment or default of the loan. All estimates are adjusted for right censoring. Coefficients are listed in the first column, significance levels in the second column, and robust standard errors that are corrected for clustering at the borrower level are reported in italics between parentheses in the third column

***Significant at 1%, **significant at 5%, *significant at 10%

Table 4 Duration Models: Robustness

Independent Variables	Model											
	I Weibull Maturity ≤1 Yr			II Weibull Single Loans			III Weibull 1988–1998			IV Weibull 1988–1998		
	Coeff.	Sig.	*(S.E.)*	Coeff.	Sig.	*(S.E.)*	Coeff.	Sig.	*(S.E.)*	Coeff.	Sig.	*(S.E.)*
Monetary Policy Rates												
INTEREST RATE$_{t-1}$	–0.104	***	*(0.029)*	–0.081	***	*(0.030)*	–0.111	***	*(0.026)*	–	–	–
INTEREST RATE SPAIN$_{t-1}$	–			–			–			–0.098	***	*(0.019)*
INTEREST RATE$_{t+T-1}$	0.320	***	*(0.022)*	0.307	***	*(0.024)*	0.397	***	*(0.018)*	–		
INTEREST RATE SPAIN$_{t+T-1}$	–			–			–			0.325	***	*(0.010)*
Bank, Borrower, and Loan Controls Macro Controls and Constant	*Yes*			*Yes*			*Yes*			*Yes*		
Additional Variables												
CREDIT GROWTH$_{bt}$	–			–			–			–		
HOUSE PRICE GROWTH$_t$	–			–			–			–		
FORECAST EURO AREA GDPG$_t$	–			–			–			–		
SPANISH TEN YEAR BOND$_{t-1}$	–			–			–			–		
Other												
ln(a) (duration dependence)	0.766	***	*(0.009)*	0.597	***	*(0.012)*	0.645	***	*(0.010)*	0.731	***	*(0.010)*
Industry dummies (9)	Yes			Yes			Yes			Yes		
Province dummies (49)	Yes			Yes			Yes			Yes		
No. of Observations (Loans)	536,571			234,338			292,346			292,346		
Log pseudolikelihood	–8398			–8359			–12,606			–12,319		
c^2 (p-value)	0.000			0.000			0.000			0.000		

Table 4 Duration Models: Robustness

Independent Variables	Model														
	V Weibull 1999–2006			VI Weibull Credit Growth			VII Weibull House Prices			VIII Weibull Forecast GDPG			IX Weibull Ten Yr Bond		
	Coeff.	Sig.	*(S.E.)*	Coeff.	Sig.	*(S.E.)*	Coeff.	Sig.	*(S.E.)*	Coeff.	Sig.	*(S.E.)*	Coeff.	Sig.	*(S.E.)*
Monetary Policy Rates															
INTEREST RATE$_{t-1}$	–0.178	**	*(0.071)*	–0.081	***	*(0.021)*	–0.077	***	*(0.021)*	–0.197	***	*(0.072)*	–0.066	***	*(0.023)*
INTEREST RATE SPAIN$_{t-1}$	–			–			–			–			–		
INTEREST RATE$_{t+T-1}$	0.266	***	*(0.052)*	0.322	***	*(0.016)*	0.324	***	*(0.016)*	0.268	***	*(0.052)*	0.324	***	*(0.016)*
INTEREST RATE SPAIN$_{t+T-1}$	–			–			–			–			–		
Bank, Borrower, and Loan Controls	*Yes*			*Yes*			*Yes*			*Yes*			*Yes*		
Macro Controls and Constant															
Additional Variables															
CREDIT GROWTH$_{bt}$	–			0.399	***	*(0.067)*	–			–			–		
HOUSE PRICE GROWTH$_t$	–			–			–0.009	*	*(0.005)*	–			–		
FORECAST EURO AREA GDPG$_t$	–			–			–			–0.121	–	*(0.085)*	–		
SPANISH TEN YEAR BOND$_{t-1}$	–			–			–			–			–0.029	–	*(0.035)*
Other															
ln(a) (duration dependence)	0.802	***	*(0.017)*	0.670	***	*(0.008)*	0.672	***	*(0.008)*	0.804	***	*(0.017)*	0.671	–	*(0.008)*

Table 4 Duration Models: Robustness (Continued)

Independent Variables	Model														
	V Weibull 1999–2006			VI Weibull Credit Growth			VII Weibull House Prices			VIII Weibull Forecast GDPG			IX Weibull Ten Yr Bond		
	Coeff.	Sig.	*(S.E.)*	Coeff.	Sig.	*(S.E.)*	Coeff.	Sig.	*(S.E.)*	Coeff.	Sig.	*(S.E.)*	Coeff.	Sig.	*(S.E.)*
Industry dummies (9)	Yes			Yes			Yes			Yes			Yes		
Province dummies (49)	Yes			Yes			Yes			Yes			Yes		
No. of Observations (Loans)	381,781			674,127			674,127			381,781			674,127		
Log pseudolikelihood	–7671			–20,575			–20,595			–7574			–20,597		
c^2 (p-value)	0.000			0.000			0.000			0.000			0.000		

The estimates in this table are based on maximum likelihood estimation of the proportional hazard model using the Weibull distribution as baseline hazard rate. The dependent variable is the hazard rate. The definition of the other variables can be found in Table 1. Subscripts indicate the time of measurement of each variable. τ is the quarter the loan was granted. T is the time to repayment or default of the loan. None of the variables vary over time. All estimates are adjusted for right censoring. Coefficients are listed in the first column, significance levels in the second column, and robust standard errors that are corrected for clustering at the borrower level are reported in italics between parentheses in the third column

***Significant at 1%, **significant at 5%, *significant at 10%