How did the 2008-9 Financial Crisis affect Bank Credit Supply and the Real Economy? Bank-Firm-level evidence from Austria*

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– VERY PRELIMINARY, PLEASE DO NOT CITE –

Abstract

We use data from the Austrian Credit Register as well as bank and firm balance sheet data to analyze the effects of the 2008-09 financial crisis on access to credit and the performance of Austrian firms in 2007-2009. We distinguish two important and distinct channels through which the crisis affected bank lending and the real economy: exposure to the interbank market as well as exposure of a bank to the United States via the assets it holds. Controlling for credit demand, we find that firms borrowing from banks that relied more on interbank financing or had more U.S. assets on their balance sheet before the crisis received less bank credit and invested less during the crisis, but did not cut employment by more. Additional results suggest that firms with only one bank relationship before the crisis were more adversely affected by lender health during the crisis in terms of access to credit than firms with multiple banks.

1 Introduction

Several studies have analyzed how and by how much a financial crisis is transmitted to the real economy. A mechanism that has been brought forward is that financial crises lead to a reduction in credit supply, which negatively affects the performance of non-financial firms. However, does credit supply decrease because firms demand less credit during the crisis or because banks decide to cut lending despite unchanged firm credit

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demand and creditworthiness? It has proven difficult to disentangle these factors. Controlling for credit demand using the method of Khwaja and Mian (2008), we first analyze if banks operating in Austria that were relatively highly-exposed to the 2008-09 financial crisis reduced credit supply to their client firms by more than relatively lowly-exposed banks. Second, we assess whether the resulting credit constraints negatively affected the client firms' performance during the crisis. Our main contribution is twofold. First, we compare the effect of two distinct types of crisis exposure on lending and the performance of client firms, namely a bank's exposure to the interbank market and its holdings of U.S. assets. This distinction can shed light on the question whether a bank's liability structure or instead the composition of its assets played a stronger role in transmitting the 2008-9 financial crisis to the real economy. Second, we explore the differential impact of bank crisis exposure on access to bank credit during the financial crisis of firms that borrowed from only one bank – a common practice in Austria and other European countries – versus firms borrowing from multiple banks.

To achieve our goals, we use disaggregated data from the Austrian Credit Register (ZKR) that reveals information on bank-firm-specific credit relationships, as well as bank and firm balance sheet data. Following the previous literature, we use the bank-specific pre-crisis ratio of interbank borrowing to total borrowing as the first proxy of bank exposure to the 2008-09 financial crisis. The motivation for this proxy is the sudden increase in the price of unsecured interbank credit after the Lehman default, which was reflected in Austria by a reduction in interbank borrowing and lending of banks operating in Austria. Second, we study a less explored channel how a financial crisis affects banks and their lending behavior. Crucially, this channel focuses on the asset side of a bank's balance sheet, rather than the liability side. In particular, we use the bank-specific pre-crisis ratio of U.S. assets to total assets as our second proxy for exposure to the financial crisis. Since the financial crisis negatively affected the value of securities and stocks issued by U.S. financial intermediaries, as well as potentially the value of loans to U.S. customers, this variable can give new insights on how a decrease in a bank's net worth affected its credit supply and the performance of its client firms. Furthermore, by exploiting exposure to assets issued in the United States, and thus where the crisis originated, we analyze a very direct transmission channel of the financial crisis to the financial sector and real economy of other countries.

In our main analysis, we work with the sample of firms that borrowed from more than one bank at the onset of the crisis, following Khwaja and Mian (2008). As we will explain in section 4, this allows to control for firm fixed effects and thus for heterogeneity in credit demand and creditworthiness across firms during the crisis. We show that conditional on these firm fixed effects and bank-specific control variables, banks that relied more on interbank financing and/or were more invested in the United States before the crisis significantly reduced credit lines granted to their client firms between December 2006 and December 2009 compared to their counterparts. In particular, a one standard deviation increase in interbank (U.S. asset) exposure lead

to a reduction in the credit line volume to the average client firm by 7.8 (13.4) percent. This result strongly suggests that credit supply did not only decrease due to a reduction in corporate credit demand and/or creditworthiness during the crisis in Austria, and highlights two important but distinct channels through which the crisis affected bank lending. Further, our results suggest that a shock to the value of a bank's assets, and/or perhaps solely their perceived value by other market participants in the midst of a crisis, had an effect on bank lending that was at least as strong as the direct effect of a higher cost of funding due to higher interbank rates.

Importantly, a reduction in credit by a highly exposed pre-crisis bank is unlikely to affect the performance of a firm if the firm manages to substitute "lost credit" by additional credit at similar terms from an existing or new lender which is less or not at all exposed to the crisis. We explore this "firm borrowing channel" and obtain evidence that substitution of credit across banks was difficult during the crisis. Specifically, the weighted average interbank and US asset exposure, respectively, of a firm's pre-crisis banks negatively affected the total credit line volume granted to the firm during the financial crisis. We exploit this result as a "conceptual first stage" for our analysis of the real effects of the crisis: Since the weighted-average crisis exposure of a firm's pre-crisis banks matters for access to credit, we expect it to have real effects in the corporate sector as well. To explore real effects, we thus also regress a firm's investment and change in employment during the crisis on the weighted average interbank and US asset exposure of its banks, as well as a wide range of controls capturing firm heterogeneity in investment opportunities and the ability to absorb shocks to credit access. Our evidence suggests that firms borrowing from highly-exposed banks indeed invested less during the crisis. This suggests that reductions in bank credit during the financial crisis had real effects on Austrian firms. However, we stress that the coefficients are not statistically significant across all specifications with investment as the dependent variable. We do not find evidence that borrowing from highly-exposed banks had an effect on firm employment during the crisis.

In an important extension of our main analysis, we study the access to credit during the crisis of firms that only had one banking relationship in December 2006. While bank credit substitution is most likely more difficult for these firms during crisis times as they would have to establish a new banking relationship in a period of turmoil, the existing banking relationship is likely to be stronger compared to the typical bank relationship of a multi-bank firm. The firm may thus be treated more favorably by its bank in terms of access to credit during the crisis compared to other clients. Since relationship lending is a very common business model in Austria and in line, around half of all firms in the Austrian Credit Register had only one bank in December 2006, Austria is the ideal place to study which of these effects is stronger. To do so, we compare how the crisis exposure of a firm's banks affects the total change in credit between December 2006 and December 2009 for single-bank versus multi-bank firms, and find that single-bank firms experienced a larger decline in credit upon an increase in bank crisis exposure. In section 7, we discuss under which

methodological assumptions this result is credible, and find evidence supporting the verity of this assumption.

The remainder of our study is structured as follows. Section 2 discusses the related literature, section 3 the background and data. Section 4 presents the empirical strategy and results on the effect of high crisis exposure of a firm's banks on the firm's access to credit. In section 5 we present our analysis of the real effects of the crisis, while section 6 discusses robustness checks. In section 7, we present our results on the access to credit and performance of firms that rely more on relationship lending. Section 8 concludes our paper.

2 Literature

Our study adds to a growing literature that analyzes the effects of variation in bank health on credit supply to firms and firm performance. Khwaja and Mian (2008) exploit differential shocks to the liquidity of banks due to unanticipated nuclear tests in Pakistan and find that a bank that experienced a one percent larger fall in liquidity reduces lending by an additional 0.6 percent. The key contribution of this paper is to use panel data at the loan level of firms with multiple banks, and compare the differential growth in credit supply by banks that are differently exposed to the liquidity shock *within the same firm* via firm fixed effects. This technique allows to control for firm-specific changes in credit demand and creditworthiness, and thus plausibly attribute any variation in credit supply to the liquidity shock. Using the same method, Schnabl (2012) shows that the exogenous liquidity shock to international banks due to the Russian default of 1998 reduced lending between banks and lending from banks to firms in Peru. Using Portuguese loan-level data, Iyer et al. (2014) find that banks that financed more heavily through the interbank market before the crisis reduced credit supply by more during the crisis.

The analysis of *real* effects of supply shocks on the corporate sector was initially often carried out as event studies that analyzed the stock market performance of firms that borrowed from a failed bank, using high-frequency data (Slovin et al., 1993; Yamori and Murakami, 1999; Bae et al., 2002; Ongena et al., 2003; Brewer III et al., 2003). A caveat of such event studies is that the performance of borrowers may contribute to the failure of the lender, which would make the latter endogenous. Another set of studies has exploited a shock to the capital or liquidity of a financial institution in economy A to analyze the effect on its borrowers in economy B (Peek and Rosengren, 2000; Van Rijckeghem and Weder, 2001; Chava and Purnanandam, 2011; Chor and Manova, 2012). If local demand and corporate pre-shock performance in economy B is plausibly exogenous to the shock, this is a promising approach. However, these studies have typically used aggregate data, which makes it hard to find out whether only firms that borrow from the affected financial institution or all firms in economy B suffer from the shock. By using the exposure to the United States of banks that lend to Austrian firms, we pick up on this idea, but use disaggregated loan-level data. Almeida et al. (2012) and Duchin et al. (2010) use variation in firm liquidity during the recent financial crisis to analyze the effect

on corporate investment. However, both studies, same as others (Campello et al., 2010; Gan, 2007; Amiti and Weinstein, 2013), only analyze listed firms, which has the caveat of overlooking small and medium-sized firms that may be most affected by the financial crisis.

The most recent studies analyze the effect of lender health on access to credit and real outcomes using matched bank-firm loan data. Amiti and Weinstein (2013) estimate the effect of bank supply shocks on firm investment using Japanese loan data over the period 1990-2010, but their sample only includes listed firms. Chodorow-Reich (2014) uses data from the US syndicated loan market and shows that firms whose syndicate lead lender was heavily exposed to the Lehman default received less credit and reduced employment compared to clients of less-affected lead lenders. Cingano et al. (2016) use Khwaja and Mian's methodology to estimate the real effects of the recent financial crisis using the Italian credit register. The authors find large negative effects of banks' pre-crisis interbank exposure on their credit supply during the crisis and on the investment, employment and other performance indicators of their customers. Balduzzi et al. (2015) study the effect of the crisis on employment and investment of Italian firms using financial market rather than balance sheet data to identify bank health. We add to these studies by analyzing the effect of exposure of lenders to US asset markets and thus studying an asset-sided bank lending channel, and by exploring the role of relationship lending on credit supply during a financial crisis.

Our paper therefore also relates to studies that have analyzed the value of relationship lending during a crisis in terms of access to credit. Bolton et al. (2016) present a theoretical model in which "relationship banks" have the capacity to monitor a firm's type and continue lending during a financial crisis if the firm is of the high type. Transaction banks decide on loan continuation based on pre-crisis firm observables and charge higher interest rates than the relationship bank if they do continue lending. To finance costly monitoring, relationship banks charge higher interest rates in normal times than transaction banks. Using the Italian Credit register, the authors test and largely confirm their predictions. Using a sample of Eastern European firms, Beck et al. (2017) find that the presence of relationship banks in the vicinity of a firm is associated with less severe credit constraints in the crisis period 2008-09, but not during the 2005 credit boom. Using the Italian Credit register, Sette and Gobbi (2015) show that the longer a bank-borrower relationship is, the shorter the distance between the bank and the firm and the higher the share of credit held by the bank, the more the transmission of the Lehman default to the supply of credit in Italy is mitigated. The results of Carbó-Valverde et al. (2012) and Vickery (2005) also suggest that relying on relationship lending helps in financial crises. We add to the above papers by controlling for a bank's individual exposure to the crisis when analyzing its change in lending to a relationship client.

3 Background and Data

Bernanke et al. (1996) have argued that an initial financial shock to an economy is amplified and propagated through an increase in the cost of funding for financial intermediaries, which is passed on to firms and households via reductions in credit supply and/or higher interest rates ("financial accelerator"). In the context of the recent financial crisis, the original source of the shock can be regarded as the Lehman default. The empirical literature has provided evidence that this original shock in the US was transmitted to the European financial system through an increase in the cost of interbank borrowing (Iyer et al., 2014; Cingano et al., 2016). Indeed, the cost of unsecured interbank funding increased sharply with the Lehman default, as the development of the Euribor-Eonia swap spread shows (see Figure 1). As a consequence, also the volume of unsecured interbank deposits contracted on a global scale (Brunnermeier, 2009). Crucially, it was difficult for banks to fully substitute the lack of interbank funding during the crisis with other sources of finance. Due to the uncertainty following the shock, the cost of issuing bonds increased, while the sudden nature of the shock and the following recession made it impossible to increase retail deposits quickly (Brunnermeier, 2009).

Although the business model of most banks operating in Austria did not rely heavily on the interbank market or on borrowing from US banks, the crisis was felt in Austria through the interbank market and through a deterioration of bank's capital ratios (Schürz et al., 2009). As Figure 2 shows, banks operating in Austria continuously reduced both interbank lending and borrowing after a peak in late 2008. After an initial resilience to the crisis, by 2008 banks in Austria were feeling the repercussions of the crisis and, as predicted by theory, the increase in funding costs translated in tighter lending standards, higher margins and eventually in a reduction of credit to non-financial corporations (see Figures 3 to 5). Given this evidence, we adopt pre-crisis interbank exposure as one of our proxies for bank-specific exposure to the crisis. We measure interbank exposure as total interbank borrowing divided by total assets on the bank's balance sheet in December 2006. The data comes from the *OeNB* database of monthly bank balance sheets of all banks operating in Austria. We choose December 2006 as our point of measurement since we want to avoid that banks adjusted their interbank exposure as a response to the rise in the cost of unsecured interbank funding in mid-2007. This would cause a problem if we measured interbank exposure in 2007, since we might observe banks with a low interbank-, but high crisis exposure. In a robustness check, we work with the *average* interbank exposure in 2006 and also with the *net* interbank exposure of banks, i.e. the ratio of interbank borrowing minus interbank lending and total assets. The results are robust to these modifications.

As a second proxy for bank-specific exposure to the crisis, we feature the exposure of banks operating in Austria to the US financial market and real economy. We measure this as the sum of securities, stocks and money market funds issued in the United States and loans to U.S. customers – in whichever currency – divided by the total amount of securities, stocks, money market funds and loans a bank had on its balance sheet, in December 2006.[1] We feature this proxy since the crisis originated in the United States, and the

[1] Our measure includes any type of loan: loans to banks, firms, the government and institutions.

burst of the housing market bubble reduced the value of assets issued by US financial intermediaries and potentially reduced the value of loans to US customers. In addition, there was considerable uncertainty on the future development of the value of these assets. These two factors potentially affected lending in several ways. On the one hand, the reduction in the value of assets reduces the collateral a bank can provide to a lender, which increases the cost of funding and thus potentially reduces lending. Similarly, the higher the uncertainty of future asset values, the higher the uncertainty on the collateral value. On the other hand, the reduction of asset value leads to a reduction in bank profits, which, same as an increase in uncertainty on future asset values, may lead to a reduction of a bank's credit supply even if funding costs are unchanged. We thus expect that, ceteris paribus, the more US assets an Austrian bank held before the crisis, the more it reduced credit supply to its firms during the crisis. Importantly, the US asset exposure proxy thus investigates a distinct bank lending channel compared to the interbank exposure proxy, which purely captures shocks to a bank's refinancing cost rather than shocks to the value of a bank's assets.

In the first part of our analysis, we are interested in the change in credit supply of a given bank to a given client firm, as well as the change in the total amount of bank credit supply to the same firm, between before and during the crisis. We obtain this information from the Austrian credit register (ZKR), which documents all bank-firm credit relationships over time as long as the credit line offered by bank j to firm i exceeds €350,000 at time t. While the credit register reports both the credit line granted as well as the actual usage of the credit line (credit line drawndown), we use the granted credit line volume as our time-varying measure of credit supply, as it is less affected by a firm's demand for credit. We carefully deal with all remaining variation in credit demand in our analysis. The credit line of bank j to firm i in month t is the maximum amount of credit firm i can obtain from bank j in month t.[2] Figure 6 contains summary statistics on the banks and bank-firm specific credit lines that are included in our main specifications. The threshold of €350,000 implies that relatively small loan relationships are never observed in the data, or appear and disappear in the data over time. The set of small Austrian firms is therefore not fully covered in our sample. Figure 7 contains summary statistics on the firms included in our main specifications.

In terms of timing, Figures 3 and 4 shows that lending standards reported by Austria's main banks continuously deteriorated during the crisis until the fourth quarter of 2009 (Source: Austrian Bank Lending Survey). In our main analysis, we thus determine December 2009 as the moment of (most severe) credit crisis. The moment in time we define as "before the crisis" is December 2006. This is in line with our chosen timing of interbank and US asset exposure.

Given this choice of timing, the main dependent variables when analyzing the effect of bank exposure on access to credit are therefore the change in the credit line granted by bank j to firm i between December

[2] Unfortunately, the credit register does not contain information on the interest rates charged on loans.

2006 and December 2009 as well as the change in the total credit line granted to firm i over the same time period. In section 6.3, we will discuss robustness checks in which we redefine the timing of the crisis; the results are robust to these modifications.

For all firms that we do observe in the credit register, we use the legal requirement of the bank to provide its own name and the name of the firm to match our firm balance sheet data and the credit register. The firm balance sheet data allows us to analyze the effects of the crisis on firm performance and to include firm-specific control variables in our specifications. The data is obtained from more than 2000 firms that have voluntarily shared their balance sheets with the OeNB on an annual basis over the past decades.

4 Bank Exposure and Access to Credit

4.1 Empirical Strategy

In the first part of our analysis, we are interested in the effect of the 2008-9 financial crisis on bank credit supply to the corporate sector. In doing so, we differentiate banks with respect to their exposure to the crisis, and attempt to analyze if and by how much a (cross-sectional) increase in crisis exposure lead to a reduction in lending. In particular, we examine the effect of interbank and US asset exposure of bank j on the change in the credit line granted by j to its client firm i. The corresponding model is equation 1, which represents an initial "naive" specification.

$$\Delta log(CreditLine_{ij}) = \alpha_0 + \alpha_1 InterbankExposure_j + \alpha_2 USExposure_j + \alpha_3 B_j + \alpha_4 Drawn/Granted_{ij} + \epsilon_{ij} \quad (1)$$

$\Delta log(CreditLine_{ij})$ approximates the percentage change in the credit line volume offered by bank j to firm i between December 2006 and December 2009. Importantly, the credit line volume conceptually differs from the "credit line drawdown", which is the amount firm i actually used from the credit line offered by bank j. We use the latter variable in a control variable: specifically, we include the ratio of credit drawn to credit granted in December 2006 into our specification, as this might affect the credit line volume offered by bank j to firm i during the crisis. *InterbankExposure* is the ratio of interbank borrowing to total assets in December 2006, and *USExposure* the ratio of US assets to total assets in December 2006, as described in section 3. B_j is a vector of additional bank-level controls that may also affect credit supply during the crisis and may be correlated with our exposure variables. These are: the ratio of cash and balance with central banks and loans and advances to governments and credit institutions to total assets (following Jiménez et al., 2012, as a proxy for liquidity, which helps to absorb liquidity shocks (Iyer et al., 2014)); the bank's market share in total interbank lending of banks operating in Austria (following Schnabl, 2012); the ratio of equity and total risk-weighted assets (Tier 1 Ratio); the ratio of net income to total assets (i.e. the return on assets (ROA)) (following Cingano et al., 2016, capturing the ability of banks to take risk and absorb losses during the crisis); and Herfindahl indices of industry- and province-specific lending, respectively (following Jiménez et al., 2012,

capturing the exposure of banks to industry-specific or regional shocks). In a robustness check in section 6.2, we examine whether conditional on these controls, there is remaining unobserved bank heterogeneity that might bias our results.

Since our dependent variable is the *change* in the credit line over time granted to a firm, we control for any time-invariant firm-specific factors that affect the firm's ability to obtain credit ("creditworthiness") as well as its demand for credit. However, this may not be sufficient, due to potential *time-varying* heterogeneity in creditworthiness and/or credit demand. In particular, for α_1 and α_2 to be unbiased in equation (1), it must hold that a bank's Interbank and US asset exposure are uncorrelated with the *change* in the creditworthiness and credit demand of the bank's clients between December 2006 and December 2009. This is a strong and untestable assumption, which makes equation 1 an unsuited empirical specification. We tackle this issue by restricting the sample to firms that borrow from multiple banks and applying the method of Khwaja and Mian (2008). Having a panel of bank-firm specific loans at hand, the essence of this restriction and method is that one observes credit lines of multiple banks for each firm, which enables to include firm fixed effects into equation 1:

$$\begin{aligned}\Delta log(CreditLine_{ij}) = \alpha_0 + \alpha_1 InterbankExposure_j + \alpha_2 USExposure_j \\ + \alpha_3 B_j + \alpha_4 Drawn/Granted_{ij} + \eta_i + \epsilon_{ij}\end{aligned} \tag{2}$$

The great advantage is that these fixed effects absorb all firm-specific changes in creditworthiness and credit demand between December 2006 and December 2009, since they are introduced after first-differencing the dependent variable. Intuitively, the fixed effects imply that we compare the effect of crisis exposure on the change in the credit line volume across all banks of one particular firm rather than across all firms. All factors that are firm-specific are captured by the fixed effect, rather than partially absorbed by the exposure variables. For example, for a firm with two pre-crisis banks, the method tests whether the firm experienced a larger decline in credit line volume from the bank that was more exposed to the crisis compared to the other bank that was less exposed, conditional on the change in credit demand and creditworthiness of the firm.

The identifying assumption for an unbiased estimation of α_1 and α_2 in Equation 2 is that a firm does not disproportionally demand more or less credit during the crisis from those of its banks that are particularly strongly or weakly exposed to the crisis. This assumption would fail for example if firms approached only their most important lender, call it relationship lender, when in need for additional credit during the crisis, and at the same time banks that focus on the business model of relationship lending are more or less affected by the crisis than the average bank. To test this assumption, we feature a series of robustness checks on our main results in section 6.1.

While the estimates of α_1 and α_2 in equation 2 inform us if a heavily-exposed bank cuts lending to a client firm more than others, it does not tell us if a firm with multiple lending relationships actually suffers from

this in terms of total credit availability. In particular, if a firm can easily substitute any loss of credit from an exposed bank with additional credit from a less-exposed existing or new lending bank, then the heavy exposure of one partner bank may be a negligible issue, depending on the cost of the new credit. To understand if a firm's overall access to credit is affected by the crisis exposure of one or more of its pre-crisis banks, we run a second specification ("firm borrowing channel"). The unit of observation in this specification is the firm, and the dependent variable is the change in the *total* credit line volume granted to firm i between December 2006 and December 2009. Thereby, we also capture credit lines from newly established banking relationships. On the right-hand side, we feature the same bank-specific control variables as in equation 2, but now measured as the weighted average of all banks that were lending to firm i in December 2006. The weight of pre-crisis lender j is equal to its share in the total credit line volume granted to firm i in December 2006. Since this specification features only one observation per firm, we cannot include the firm fixed effects as in equation 2. Therefore, the coefficients on the weighted crisis exposure measures would be biased if the crisis exposure of a firm's banks and the firm's change in creditworthiness or credit demand during the crisis were correlated. However, as Bonaccorsi di Patti and Sette (2012) and Cingano et al. (2016) show, it is possible to correct for this potential bias by including the fixed effect *estimates* of equation 2 into the firm borrowing channel specification.[3] The firm borrowing specification looks as follows:

$$\Delta log(CreditLine_i) = \beta_0 + \beta_1 \overline{InterbankExposure_i} + \beta_2 \overline{USExposure_i} + \beta_3 \overline{B_i} + \beta_4 Drawn/Granted_i + \hat{\eta}_i + \epsilon_i \tag{3}$$

If loss of credit from affected banks can be perfectly substituted by additional credit from other banks, then $\beta_1 = \beta_2 = 0$. However, if $\beta_1 < 0$ and/or $\beta_2 < 0$, then the weighted-average interbank and/or US asset exposure of the pre-crisis banks of a firm do negatively affect the firm's access to credit during the crisis. In this case, we also expect these variables to affect firm performance during the crisis.

4.2 Results: The Bank Lending Channel

The results on the bank lending channel (equation 2) are reported in Table 1. Columns 1 and 3 include the full sample of bank-firm relationships of firms with more than one bank. In columns 2 and 4, we restrict the sample to those firms with multiple banks for which we have information on investment during the crisis. Since we only observe the sum of all credit lines from bank j to firm i, the unit of observation is a specific bank-firm pair. We scale all bank-level variables as their realization divided by the variable's standard deviation such that we can compare the magnitude of the coefficients of the different variables.

Consistent with the literature, we find that banks that relied much on interbank funding before the crisis reduced lending to their client firms during the crisis compared to banks that borrowed relatively less on the interbank market in December 2006, controlling for firm fixed effects and bank controls. However, the

[3] A numerical correction using the difference in the α-coefficients across equations 2 and 1 as in Jiménez, Mian, Peydró, and Saurina (Jiménez et al.) would equally correct for the bias, but makes the interpretation of the coefficients in equation 3 more difficult.

coefficient is only statistically significant – and increases in magnitude – if we include our bank-level controls. The results of the specification including bank controls estimated on our preferred sample (see column 4) suggest that as a bank increases pre-crisis interbank borrowing by one standard deviation, it reduces the credit line volume to its average corporate customer by 7.8 percent between December 2006 and December 2009. Again in line with our expectations, banks that had relatively more U.S. assets on their balance sheet before the crisis cut lending significantly more than their counterparts during the crisis, conditional on firm fixed effects and bank controls. While the magnitude of the coefficient varies by sample and increases with the addition of bank controls, it is significant at the 1% level across all specifications. The results of our preferred specification and sample (column 4) suggest that a one standard deviation increase in US asset exposure reduces the credit line volume by 13.4 percent, on average.

4.3 Testing Common trends before the crisis

We can only interpret the obtained results as the effect of the financial crisis on bank lending if our measures of crisis exposure do not affect lending in normal times. In other words, it is necessary that we observe a *common trend* in credit line volume before the crisis across borrowers of weakly- and highly-exposed banks as measured by our key explanatory variables. We test the common trend in credit supply by regressing the change in credit line volume granted by bank j to firm i between December 2003 and December 2006 on the right-hand side variables of equation (2). The results of this placebo test are reported in Table 6. The hypothesis that the lending behavior of banks that were highly exposed to the interbank market followed a different trend than the lending behavior of their counterparts before the crisis cannot be rejected. Further, the sign of the coefficients changes across specifications, which is very reassuring. The coefficient on US asset exposure is positive and marginally significant in our preferred specification. While this does not suggest a common pre-crisis trend, it suggests that the difference-in-difference across banks with high vs. low US asset exposure and across the two time periods would have been positive in the absence of the financial crisis. If so, then the effect of US asset exposure on credit supply during the crisis was potentially even more negative than the coefficient of our baseline results suggests. However, the fact that we cannot clearly reject the absence of a common trend remains a worry: for example, the pre-crisis pattern and the negative coefficient during the crisis could also be partly explained by a stronger response to the business cycle in terms of lending by banks that are highly exposed to the US.

4.4 Results: The firm borrowing channel

Table 2, Column 1 presents the results of the firm borrowing channel (equation 3). We focus on the sample of multiple-bank firms for which we have data on investment during the crisis, given that we study real outcomes in the next section. The results clearly suggest that the average interbank and US asset exposure of a firm's pre-crisis banks negatively affected the firm's access to credit during the financial crisis. This

suggests that substitution of credit from highly-exposed banks to less-exposed banks was difficult during the crisis.

5 Real Effects of the 2008-9 financial crisis

Given our results on the firm borrowing channel, we expect that the crisis had real effects, especially on those firms that were borrowing from banks that were hit relatively hard by the crisis. In order to test this hypothesis, we exploit our results on the firm borrowing channel as a "conceptual first stage", and study the reduced form impact of crisis exposure of a firm's banks on real outcomes, following Chodorow-Reich (2014) and Cingano et al. (2016). In our particular case, this means that we regress weighted-average interbank and US asset exposure on firm investment and employment same as we regressed these variables on the change in the total credit line volume granted to the firm between before and during the crisis, but add controls that capture the (real) nature of the left-hand side variables. Given the firm borrowing channel results, any effect we find can then arguably be attributed to a reduction in credit supply to the firm. This is a pragmatic approach to the question of real effects of the crisis, since it does not answer the most interesting question, which is the effect of a reduction in credit supply by one euro on a firm's investment or employment during the crisis. The problem with the latter question is that credit supply is endogenous, and the validity of the exclusion restriction of an instrumental variable approach cannot be defended in our setting. In particular, while our results suggest that interbank and US asset exposure affect bank credit supply, it would be naive to argue that the only way these variables affect firm performance is through a change in credit supply of the exposed bank. Specifically, a bank that is more exposed to the crisis may also raise interest rates charged on credit lines, or may affect a firm's expectation of future credit availability from the affected bank. The reduced-form approach is more sound, since it does not require such an exclusion restriction to hold. When analyzing investment, the reduced-form specification looks as follows:

$$InvRate_{i,Crisis} = \gamma_0 + \gamma_1 \overline{InterbankExposure_i} + \gamma_2 \overline{USExposure_i} + \gamma_3 \overline{B_i} + \gamma_4 X_i + \hat{\eta}_i + \varepsilon_i \qquad (4)$$

The dependent variable is the sum of firm i's capital expenditures in 2007, 2008 and 2009 divided by i's total assets in 2006. We include a vector of firm controls X_i that contains variables that shall capture financial frictions (cash holdings over assets, leverage, total credit line drawdowns divided by the total credit line volume), credit risk (the average probability of default of the firm's loans as evaluated by the firm's pre-crisis banks and reported in the credit register) and investment opportunities (size in total assets, sales over assets, age, lagged sales growth and the firm's pre-crisis investment rate, measured as total capital expenditures in 2004-2006 divided by total assets in 2003) during the crisis. All these variables except probability of default are measured as of 2006 and thus well before the crisis, in order to avoid that they

were affected by the health of their banks and/or low investment during the crisis.[4] We also include the firm fixed effect estimates, since to a certain extent, changes in credit demand may capture differences in (the level of) investment opportunities during the crisis across firms. Further, we include industry and province fixed effects into the equation. To estimate the effect on employment, we replace the dependent variable of equation (4) with the change in employment between 2006 and 2009 and feature a smaller set of firm controls.[5]

5.1 Results

Table 4 presents the results on investment (equation 4). The sample remains the set of firms with multiple pre-crisis banks. The dependent variable is winsorized at the 95th percentile in order to account for extreme values; the results are relatively robust to winsorizing at the 99th percentile (see Table 12). In column 1, we only include the weighted average interbank and US asset exposure as well as the usual bank control variables into the regression. In column 2, we add the firm fixed effect estimate, which captures changes in firm credit demand and thus to some extent, the firm's investment opportunities during the crisis. In column 3, we add a number of standard firm controls that shall further capture investment opportunities and in column 4 we add controls for financial frictions. The results suggest that firm investment opportunities are highly positively correlated with the crisis exposure of its bank: the coefficients and their significance changes a lot with the inclusion of the firm controls. The results shown in column 4 suggest that the interbank and especially US asset exposure of a firm's banks negatively affect investment. However, these results are not robust in terms of statistical significance to the inclusion of two further controls, specifically lagged sales growth and the lagged investment growth. While these are demanding on the data in the sense that their inclusion halves the sample size, they are important proxies for investment opportunities. The coefficient on the pre-crisis investment rate (capital expenditures 2004-2006 divided by total assets 2003) is positive and significant, and the coefficients on the crisis exposure proxies are pushed upwards. These results suggest that a firm's pre-crisis investment rate and the crisis exposure of its banks were negatively correlated, i.e. there was no common trend in investment across relatively highly- and relatively lowly-treated firms to begin with. We further test the common trend in investment by regressing the pre-crisis investment rate on the right-hand side variables of equation 4 (RESULTS STILL MISSING).

Table 5 shows the effect of variation in crisis exposure of a firm's banks on the percentage change in the firm's employment between 2006 and 2009. The coefficients are not significant and even positive, thus our results do not suggest a negative effect of credit frictions on firm employment. This may be explained by the relatively inflexible Austrian labor market.

[4] The requirement that banks must report the probability of default of a granted credit line which needs to be reported in the credit register was only introduced in 2008. We therefore compute the average realization across banks in the earliest month in which at least one realization is reported in 2008.

[5] In particular, the firm's fixed effect estimate, total assets, sales/assets, age, the average probability of default of the firm's 2008 loans, return on assets, cash holdings/total assets, leverage and total credit drawn over total credit granted.

6 Robustness checks

6.1 The Bank Lending Channel: Discussion and Robustness Checks

In equation (2), the identifying assumption for an unbiased estimation of α_1 and α_2 is that a firm did not disproportionally demand more or less credit during the crisis from those of its banks that were particularly strongly or weakly exposed to the crisis. This assumption would fail for example if firms only approached their most important lender, call it relationship lender, when in need for additional credit during the crisis, and at the same time banks that focus on the business model of relationship lending were more or less affected by the crisis than the average bank. To test this assumption, we feature a series of robustness checks on our main results. In Table 7, column 3, we do not only carry out our analysis within the firm, but also within types of loans, specifically revolving and non-revolving credit lines, i.e. term loans. This is done by interacting the firm fixed effect with a dummy which takes the value one if a positive fraction of the credit line is used as a revolving credit line, and including this interaction in our regression on top of the standard firm fixed effect.[6] The underlying idea is that the more similar two credit lines are, the more likely it is that the firm asks the offering banks for an equal adjustment (in percent) of its credit line as the firm's credit demand changes. Along similar lines, in column 4 we additionally include an interaction of the fixed effect with a dummy which equals one if the pre-crisis share of the bank-firm-specific credit line volume in the total credit line volume is above the median share. This implies that we estimate equation 2 within the banks of a firm that are relatively important and within the banks that are relatively unimportant for the firm in terms of credit line volume. In Table 8, column 3 we restrict the sample to those firms for which the shares of each bank in the total credit line volume vary a lot over time – specifically, more than for the median firm in that respect.[7] The motivation is that for these firms, the importance of a specific bank varies relatively much over time, and it therefore probably more random which bank(s) the firm approaches first when it changes its demand for credit, or more likely that it will approach all at the same time. The main results are very robust to these robustness checks, which increases our confidence that the discussed assumption holds true. In Table 7, column 2, we redefine interbank exposure as *net* interbank exposure, specifically interbank borrowing minus interbank lending, divided by total assets in December 2006. The idea behind this robustness check is that banks that did not only borrow, but also lend a lot on the interbank market before the crisis were less affected by the dry-up of the interbank market. In line with this argument, we observe that the coefficient becomes more negative, and stays statistically significant.

Most remaining robustness checks deal with the specific nature and peculiarities of the Austrian credit register. In Table 7, column 5, we run a robustness check which deals with the credit register threshold of €350,000. A bank that is highly exposed to the crisis may reduce the credit line of one of its clients by so

[6] We only know which fraction of the total credit line is *used*, i.e. drawn down, as a specific loan type, but do not know the specific supply structure of the bank in terms of the different types of credit, within the given credit line. For this reason, we define the revolving credit dummy in terms of usage, i.e. drawdowns.

[7] We use the years 2006-2009 to compute the variation in bank shares in the total credit line volume.

much that the loan falls below the threshold and drops out of the data. If those credit lines that are closer to the reporting threshold are more affected by bank exposure (potentially because they are smaller banks that have less capacity to absorb a shock), then the magnitude of β_1 and/or β_2 is biased downward. To test this hypothesis, we restrict the sample to all credit lines which are observed in each month between December 2006 and December 2009, and thus are further away from the threshold, on average. The results are indeed greater in magnitude, but only slightly so.[8] In Table 8, column 2, we estimate equation 2 on those bank-firm relationships for which the coefficient of variation in the credit line volume over the period December 2006 - December 2009 is below the median realization: This throws out credit lines which "jump around" a lot over time, and the results might therefore be sensitive to the chosen timing of the beginning and peak of the crisis. In column 4, we restrict the sample to those firms for which the credit line usage never exceeded the credit line during December 2006 - December 2009. This can occur if the firm and the bank have agreed on multiple credit lines which include a type of credit line which has no limit. The idea behind the restriction is that those firms for which credit line drawdowns never exceeded the joint volume of all credit lines with a reporting requirement are less likely to have a credit line that has no limit, and therefore are more bank-credit-constrained on average. In column 5, we feature only those firms for which the reported credit line volume is always above €350,000. Despite the threshold, the reported number is sometimes below it, which indicates that the sum of all credit lines together exceeds the threshold, but not the volume of all single credit lines have to enter the report. By excluding credit lines for which this happens at least once during December 2006 - December 2009, we are confident to increase the fraction of those firm-bank relationships in which such credit lines do not exist. This is helpful if for example banks that are more exposed to the crisis shift credit line volume from credit lines that have to be reported to those that do not have to be reported, such that we observe a reduction in the credit line volume while de facto it remains constant, and we thus overestimate the magnitude of the crisis exposure coefficients. With the exception of the last robustness check – which is however very demanding on the data as we lose many observations – the results are very robust to these modifications.

Last, but not least, we test the robustness of our coefficients on US asset exposure by changing our definition of US asset exposure. In Table 9, we define US asset exposure as the ratio of loans, securities, money market funds and stocks *denominated in US dollars* to the sum of loans, securities, money market funds and stocks. The coefficient remains statistically significant in our preferred specification (column 4) and has a similar magnitude, which is reassuring. In Table 14, we study the effects of the components of US asset exposure separately. We see that the coefficient of all components is negative and statistically significant, which is again reassuring.[9]

[8] An issue with this robustness check is that the restriction also implies that we analyze larger firms, for which the relationship of lender exposure to the crisis and access to credit may generally be different. We test this hypothesis in a separate specification in which we interact our crisis exposure proxies with firm size (RESULTS STILL MISSING).

[9] In practice, no bank in our sample held US money market funds (or they are de-facto not reported in the balance sheet), therefore we do not feature money market funds as a separate component in this set of regressions.

6.2 Controlling for unobserved Bank heterogeneity

* While we control for a whole set of bank-specific variables that may be correlated with interbank and/or US asset exposure, there might remain unobserved heterogeneity across banks of different crisis exposure, which biases our results on access to credit and real outcomes. We check this issue by including "main bank fixed effects" into equations 3 and 4. In particular, for each firm in our sample, we first determine the bank which had the largest share in the firm's total credit line volume in December 2006 and define this bank as the firm's main bank. Then, for each bank j that is the main bank of at least one firm, we include a dummy variable "Bank j". For a given firm i, this dummy equals one if bank j is the main bank of firm i and zero otherwise. The inclusion of this set of dummies implies that we analyze the effect of bank crisis exposure on the change in total credit and investment, respectively, within the firm within firms that have the same main bank. In this way, we control for all unobserved heterogeneity of "main banks" that might bias our results. 92 out of 183 banks are the main bank of at least one firm, which implies that this robustness check is not perfect, but nevertheless valuable. The results of the main bank robustness check of the firm borrowing channel (equation 3) are reported in Table 10, column 2, while column 1 repeats our preferred baseline specification. We observe that the coefficient of interbank exposure remains very similar, but turns insignificant. In general, the inclusion of the main bank fixed effects appear to decrease efficiency: the standard errors increase and the adjusted R^2 decreases, which implies that the reduction in bias does not outweigh the loss in efficiency. The fact that the coefficient remains similar is reassuring that there is little bias due to the omission of certain bank controls. The coefficient of US asset exposure remains significant and negative and becomes larger in magnitude. This suggests that there are omitted bank-level controls that bias the coefficient on US asset exposure upward. The conclusion we draw is that the coefficients on US asset exposure in our main analysis are upper bounds.

The results of the main bank robustness check on our investment specification are reported in Table 11. In column 1, we repeat the specification of Table 4, column 4. The coefficients change and turn insignificant as we include main bank fixed effects, thus the results suggest that there are unobserved bank-specific factors that are correlated with the investment opportunities of their clients during the crisis.

6.3 Timing of the crisis

Besides measures taken by the ECB to stabilize the interbank market (especially for dollar transactions), in October 2008, the Austrian government responded to the crisis with the Austrian bank stabilization package. The objective was to restore confidence in the interbank market, avoid a run on deposits and help banks with their recapitalization efforts. The package constituted of a series of guarantees for banks and the creation of a clearing bank to strengthen the interbank markets and guarantees from the federal state backing this clearing bank (Rechnungshof, 2012; Schmitz et al., 2009). As a result of this policy measure, retail customer deposits increased and credit growth recovered temporarily in Austria. By 2009, the economic crisis that

hit Europe and Austria caused a significant decrease in aggregate demand, including the demand for bank credit. Thus, while restrictions to the supply of lending were averted partly by the measures taken by the ECB and the Austrian government in 2008, Beer et al. (2012) argue that the strong reduction in lending observed during 2009 was mainly demand-driven. With this background, in a robustness check we focus our attention on the first phase of the crisis in which supply factors seem to have played a more dominant role, and compare the change in credit granted between December 2006 and December 2008, instead of December 2009 (see Table 15). The results yield that both the effect of interbank exposure and US asset exposure is negative and significant in our preferred specifications (columns 3 and 4), but slightly smaller than in our main specification (see Table 1). This confirms that supply factors were already present in 2008, but also suggests that credit supply conditions further worsened in 2009, consistent with Figures 4 and 5.
In a further robustness check, we redefine the investment rate as the sum of capital expenditures in 2007, 2008, 2009 *and 2010*, which is motivated by the fact that access to credit may have lagged and/or longer-lasting effects. As the results reported in Table 13 show, the coefficients are indeed larger in magnitude.

7 Access to credit of single-bank firms: Does relationship lending help?

Compared to most other European countries, in Austria it is particularly common for firms to have only one bank; in fact, this holds true for about half of the firms in the Austrian Credit register.[10] Firms that only have one bank have usually established a strong business relationship with that bank. Focusing on firms with more than one bank as done above thus not only leads to a drastic reduction in the sample size, but also overlooks the most common bank lending model in Austria, relationship lending, and its role and performance during the crisis. This is a drawback especially because to our knowledge, no paper has convincingly analyzed the real effects of a financial crisis in the context of relationship lending. Ex ante, one might expect that a bank that is highly exposed to the crisis cuts lending first to those firms with which it does *not* have a strong lending relationship, but tries to protect its "relationship firms". Bolton et al. (2016) and Beck et al. (2017) provide empirical evidence in favor of this reasoning. On the other hand, any decrease in credit supply by a specific bank is probably more problematic for a firm that has no other existing bank relationship and thus faces more difficulties in substituting the loss of bank credit. Depending on whether the advantage of easier credit substitution or the potential advantage of higher protection by the bank is stronger, the true coefficient of equation 3 in the single-bank sample may be smaller, equal or larger than the same coefficient in the multi-bank sample. Methodologically, however, we face the problem of not being able to include the fixed effect estimates $\hat{\eta}$ in equation (3) for the sample of single-bank firms, and thus lose a convincing control variable for firm credit demand.

[10] Since we observe relatively large firms due to the reporting threshold, and small firms are more likely to have only one bank, the percentage is even higher in the sample of all Austrian firms.

The most obvious, but imperfect way to also incorporate single-bank firms into the analysis would be to replace the firm fixed effect estimate $\hat{\eta}_i$ in equation (3) with a vector of firm-level controls F_i that may capture firm credit demand during the crisis:

$$\Delta Credit_i = \beta_0 + \beta_1 \overline{InterbankExposure_i} + \beta_2 \overline{USExposure_i} + \beta_3 \overline{B_i} + \beta_4 F_i + \epsilon_i \quad (5)$$

The error term of equation (5) contains the variation in the change of creditworthiness and credit demand compared to before the crisis which is not absorbed by our firm controls F_i. We term this component D_i and rewrite $\epsilon_i = \delta D_i + e_i$, where e_i is white noise. While the total credit line volume is not a binding constraint for all firms that have higher credit demand during the crisis and not all firms for which it is binding can negotiate an increase in credit supply from existing or new lenders, the latter are certainly true for some firms. This implies that an increase in credit demand increases the credit line volume, on average. Further, a decrease in creditworthiness decreases the credit line on average, thus $\delta > 0$. Given $\epsilon_i = \delta D_i + e_i$ and $\delta > 0$, the assumption for an unbiased identification of β_1 and β_2 in equation (5) is that conditional on F_i, the crisis exposure measures of firm i's bank(s) are uncorrelated with the change in firm-specific creditworthiness and credit demand during the crisis, i.e. $corr(\overline{Exp_i}, D_i) = corr(\overline{Exp_i}, \epsilon_i) = 0$ (where $\overline{Exp_i}$ stands for the weighted-average interbank exposure or US asset exposure).

Importantly, if those banks that were *more* exposed to the crisis as measured by our crisis exposure variables had formed relationships with firms that had *higher* creditworthiness and/or credit demand during the crisis, on average, then the corresponding β is biased *upwards*. The implication is that if we can find evidence suggesting that $corr(\overline{Exp_i}, \epsilon_i) > 0$ in the sample of single-bank firms, we may conclude that the corresponding β is *over*estimated in equation (5). This would be valuable because if $\hat{\beta}$ turned out to be negative and significant, then we could conclude that the crisis exposure of the firm's banks negatively affected its access to bank credit during the crisis, and that the order of magnitude was weakly larger than the observed coefficient.[11]

We test the correlation of the error term of equation 5 and a firm's banks' weighted average crisis exposure using the sample of multi-bank firms. In particular, we estimate equation 5 using this sample and then compare the obtained coefficients on interbank and US asset exposure to the coefficients of the same variables obtained by estimating equation 5 on the same sample but including the firm fixed effect estimate. The results of the prior regression are reported in Table 2, column 2, and the results of the latter are reported in Table 2, column 3. We observe that the coefficients of both interbank and US asset exposure increase. This implies that conditional on all included control variables, the change in a firm's creditworthiness and/or credit demand during the crisis is indeed positively correlated with the crisis exposure of the firm's banks in this sample. In a nutshell, it appears that banks that were more exposed to the crisis appear to have lent to firms that were more sound during the crisis. As Figures 8 and 9 show, firms that were borrowing from banks that were more exposed to the crisis had a higher return on assets in 2006, which strengthens the

[11] A similar argument has been used by Khwaja and Mian (2008) to incorporate single-bank firms, which are the great majority in Pakistan, into the analysis.

argument; and further, the figures also reveal that banks that were more exposed to the crisis had a higher return on assets in 2006, which – together with the evidence just discussed – suggests that before the crisis, "good banks" were matching with "good firms".[12]

If we assume that the correlation of the error term of equation 5 and a firm's banks' weighted average firm exposure is equal across the sample of multi-bank and single-bank firms or more positive in the sample of single-bank firms, then the results we just obtained imply that β_1 and β_2 in equation 5, estimated on the single-bank firms, are biased upwards. Table 3, column 5 estimates equation 5 for the sample of banks with only one pre-crisis lender. While the coefficient on interbank exposure becomes more negative but also insignificant, the coefficient on US asset exposure remains negative and significant and increases in magnitude. Specifically, conditional on the mentioned assumption holding true, the results suggest that an increase in the weighted average US asset exposure of a firm's banks by one standard deviation reduces the granted credit line volume by *at least* 17.3 percent between December 2006 and December 2009. This implies that firms that had only one bank in December 2006, and thus were likely to have a stronger lending relationship to the bank than other firms, suffered a larger decline in total credit line volume compared to their counterparts. Interestingly, this cannot be explained only by more difficult credit substitution: even if we compare the coefficient to the coefficient on US asset exposure obtained from estimating equation 2 on the sample of multi-bank firms – which reflects the effect of US asset exposure of a *specific* bank on the change in credit to a multi-bank firm, the coefficient is larger in magnitude. These results are not in line with previous studies, such as Bolton et al. (2016) and Beck et al. (2017), and need further investigation.

8 Conclusion

In this paper, we analyzed the effect of the 2008-9 financial crisis on access to credit and real outcomes of Austrian firms. Using the method of Khwaja and Mian (2008) and thus focusing on firms with multiple banks, we first showed that banks that relied more on interbank funding and/or were more invested in the United States cut lending to their client firms by more than their counterparts. We also showed that the weighted average interbank and US asset exposure of a firm's pre-crisis banks negatively affected the firm's overall access to bank credit during the crisis. We exploited this as a conceptual first stage to our analysis of real firm outcomes, in which we estimate the reduced-form impact of credit frictions on investment and employment. We find that firms that borrowed from banks that were more exposed to the crisis invested less during the crisis; however, this result is not statistically significant across all specifications. Our results suggest that the crisis exposure of a firm's banks had no effect on employment. In an extension of the study, we presented evidence that firms that had only one bank before the crisis suffered a larger decline in credit than firms that had multiple banks. Our study contributes to a better understanding of the transmission channels of a financial crisis to the real economy, and also on the role of relationship lending during a financial

[12] One explanation for this is that banks of higher quality are better able to screen the creditworthiness of firms and the profitability of their projects.

crisis.

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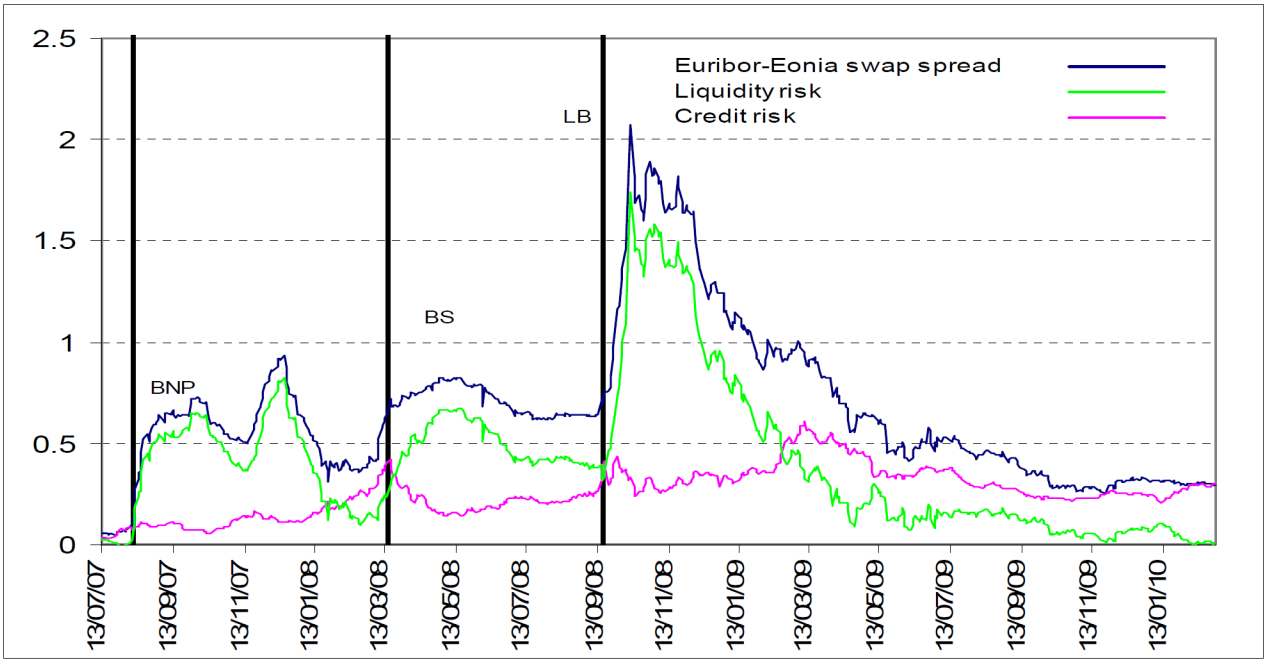
9 Figures and Tables

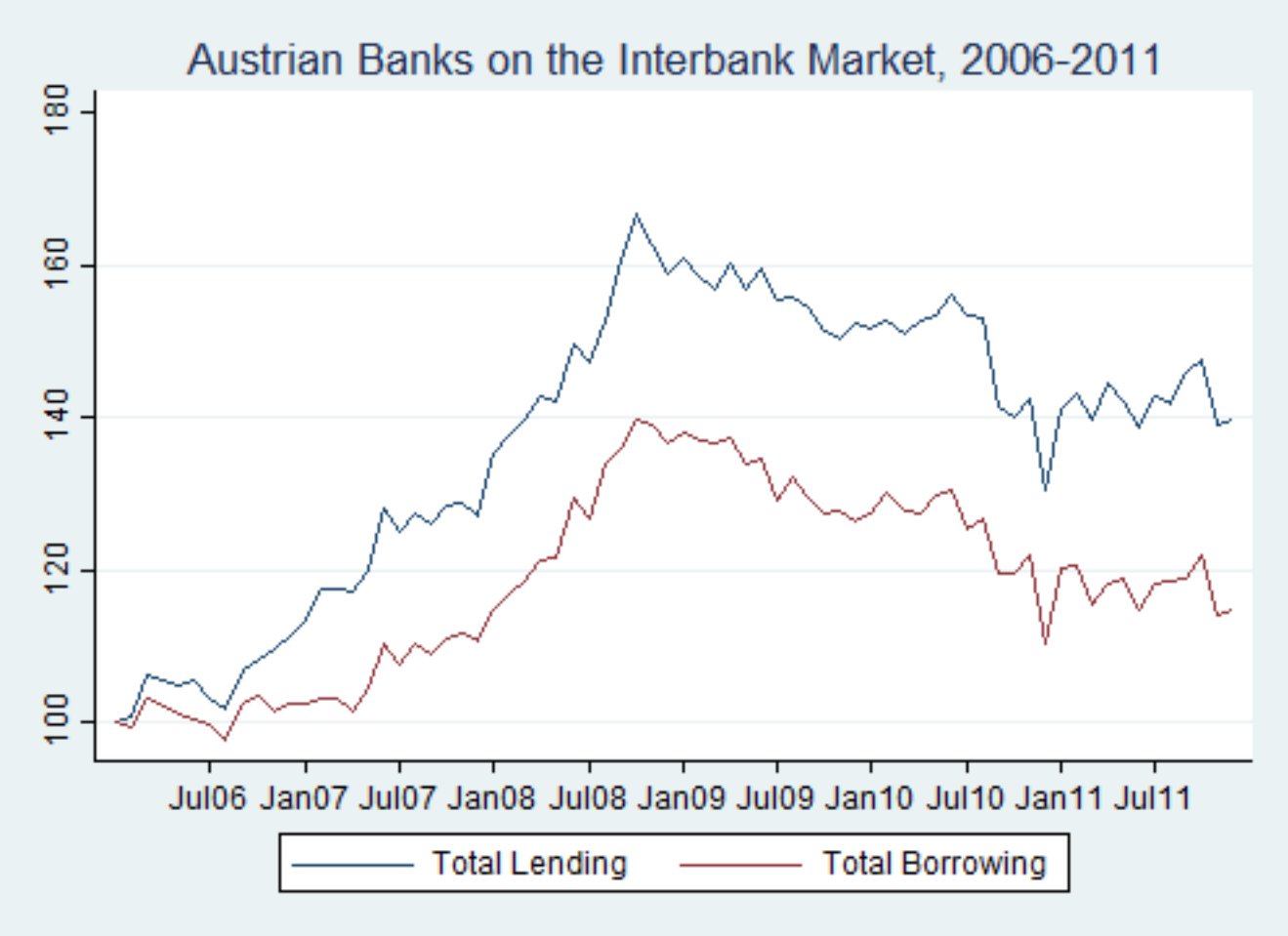
Figure 1: The price of unsecured interbank funding during the crisis



Note: BNP is August 9, 2007; BS is March 14, 2008; LB is September 15, 2008.

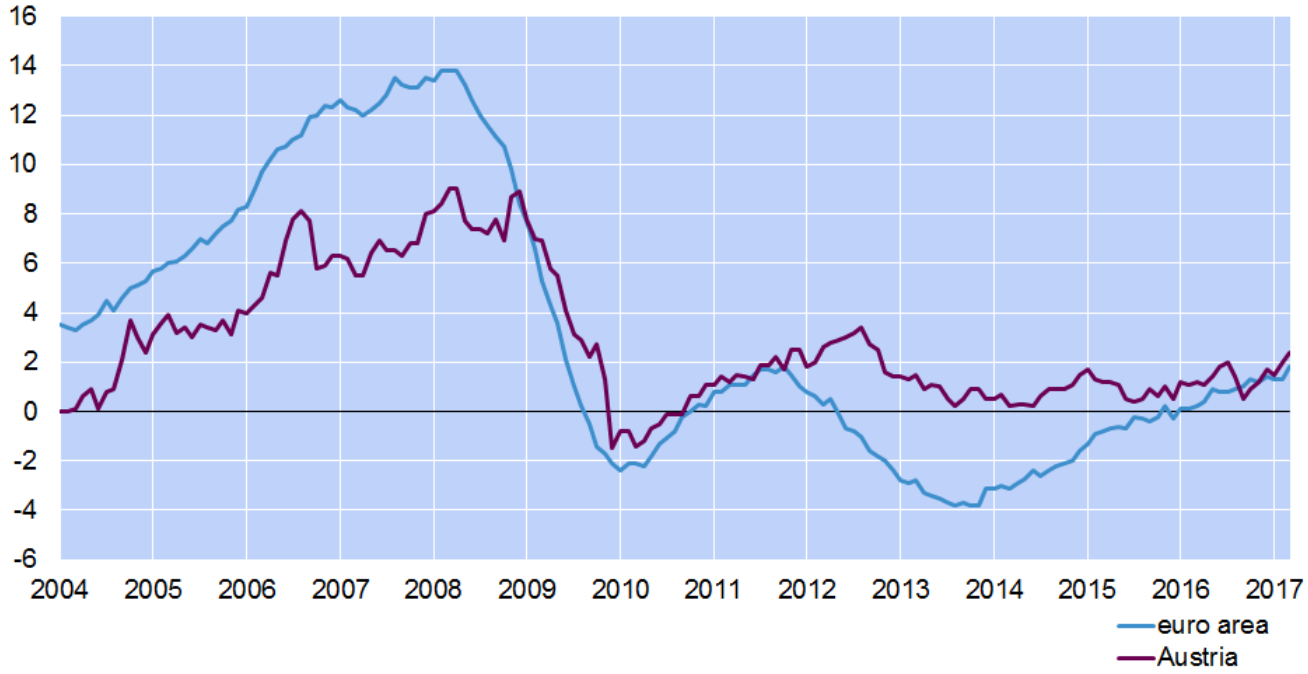
Source: De Socio (2011).

Figure 2: Interbank Lending and Borrowing of Austrian Banks 2006-2011



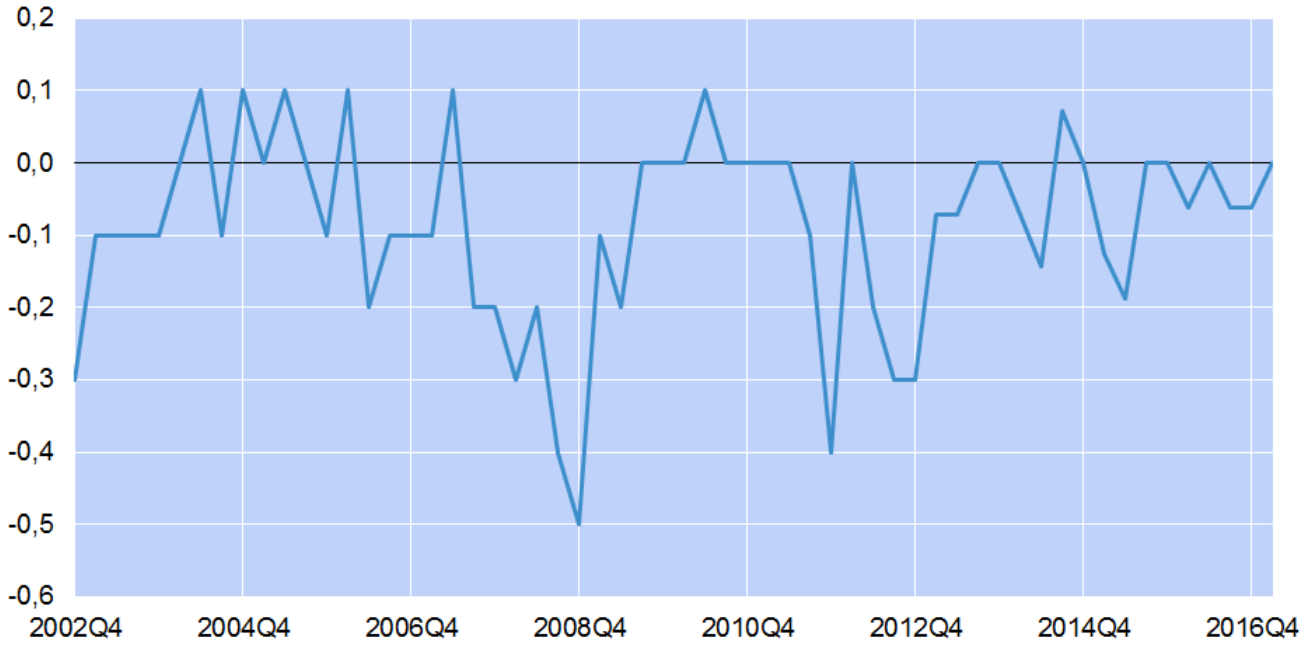
Source: OeNB.

Figure 3: Lending to Non-Financial Companies, % year-on-year change



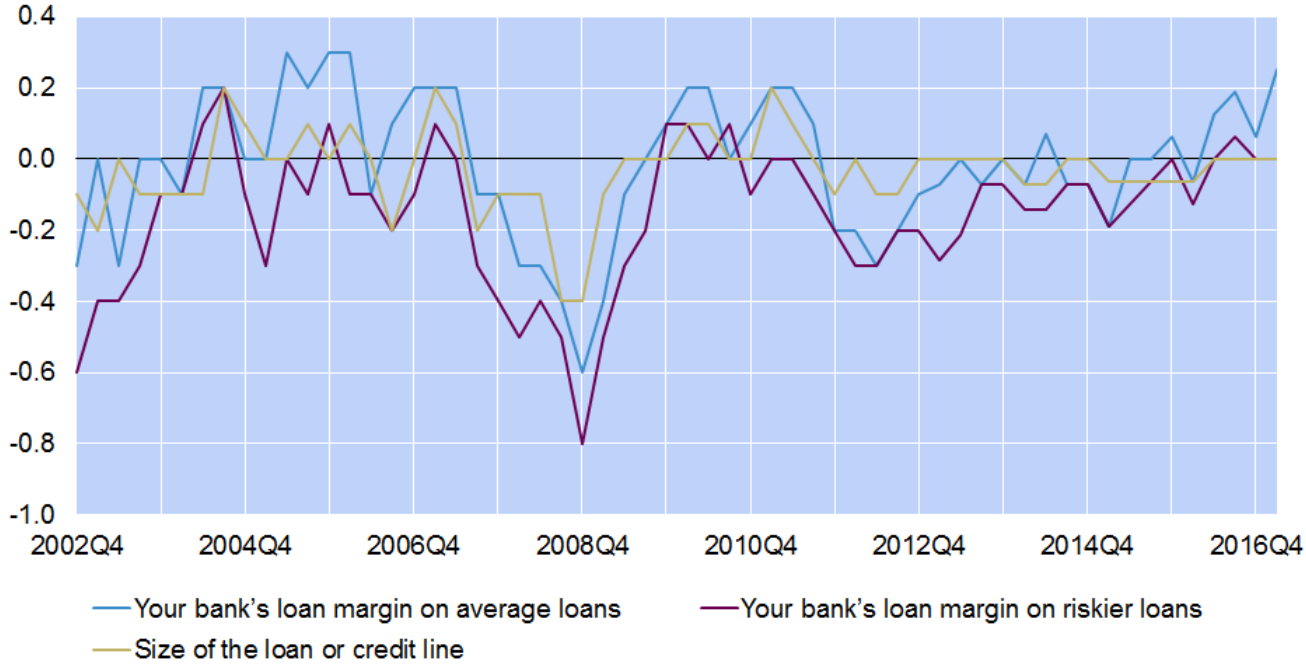
Source: OeNB.

Figure 4: Lending Standards of Austrian Banks, Diffusion Index



Source: OeNB, Bank Lending Survey.

Figure 5: Lending Standards of Austrian Banks, Diffusion Index, Detailed



Source: OeNB, Bank Lending Survey.

Figure 6: Bank-specific and Credit Line - specific Descriptive Statistics

	Mean	Median	Min	Max	Standard deviation	# Obs.
Interbank Borrowing / Total Assets 12/2006	16.372	11.266	0.000	88.834	15.098	248
Net Interbank Borrowing / Total Assets 12/2006	-0.603	-3.017	-86.373	86.794	18.337	248
US Assets / Total Assets 12/2006	0.418	0.054	0.000	5.463	0.781	248
USD Assets / Total Assets 12/2006	1.129	0.242	0.000	56.122	4.391	248
Total Assets 12/2006 (mln euros)	2492.029	312.785	85.521	129920.300	10921.750	248
Market Share 12/2006	0.330	0.026	0.002	18.067	1.866	248
Industry Lending HHI 12/2006	0.072	0.04	0.000	0.665	0.090	248
Province Lending HHI 12/2006	0.142	0.096	0.000	1.000	0.156	248
Tier 1 Ratio 12/2006	15.998	14.574	5.805	90.467	8.242	248
Net Income / Total Assets 2006	0.392	0.344	-2.362	8.525	0.663	248
Loan charge-offs / Total Assets 2006	0.240	0.037	0.0002	11.935	0.663	214
Loan value corrections / Total Assets 2006	1.431	1.285	0.004	8.590	0.985	243
Liquid assets / Total Assets 12/2006	18.064	15.222	0.450	94.627	10.653	248
Log(Rahmen 12/2009) - Log(Rahmen 12/2006)	-0.0207	-0.0224	-8.602	6.668	0.905	6299
Rahmen 12/2006	10498.84	2925	1	681222	28815.53	6299
Rahmen 12/2009	10026	3000	3	707887	25854.88	6299
Drawn/Granted 12/2006 if Drawn <= Granted	72.53	88.294	0	1	33.514	6299
Drawn/Granted 12/2009 if Drawn <= Granted	89.43	91.54	0	1	27.432	6299
Fraction of Firms present in each month	82.584					6299

Figure 7: Firm-specific Descriptive Statistics

	Mean	Median	Min	Max	Standard deviation	# Obs.
Investment rate 2007-2009	20.238	11.531	0	167.987	26.182	883
Investment rate 2004-2006	22.137	13.628	0	154.539	27.656	883
Credit demand	0.005	0.036	-3.918	2.515	0.663	883
Assets (in 000 Euro)	18448.99	3196.7	126.5	1727810	86230.17	883
Cash holdings	4.963	1.715	0	81.385	8.701	883
Sales / Assets	149.119	131.129	0	949.593	121.164	883
Return on Assets	10.372	7.571	-222.22	71.859	17.922	883
Leverage	37.223	3.119	-304.398	16173.83	579.785	883
Credit drawn / granted 12/2006	74.602	78.727	0.154	293.277	29.294	883
Credit drawn / granted 12/2009	97.03	92.146	81.179	123.05	15.814	883
Credit drawn / granted 12/2006 if <=1	69.501	75.203	0.154	1	24.209	883
Credit drawn / granted 12/2009 if <=1	90.524	91.202	81.179	98.511	7.16	883
Age	22.423	17	0	137	20.122	874
Probability of Default	2.129	0.4	0	100	9.087	883
Sum of Credit Lines 12/2006 ('000 Euros)	46911.38	12526	704	1909471	131407.5	883
Sum of Credit Lines 12/2009 ('000 Euros)	44920.37	12774	901	1797289	120482.1	883
Number of Banks 12/2006	4.761	3	2	70	5.776	883
Number of Banks 12/2009	5.532	4	2	127	8.643	883
Firm Interbank Exposure	32.647	33.524	2.344	73.894	9.956	883
Firm US Exposure	1.305	1.26	0.0008	3.631	0.688	883
Firm USD Exposure	5.096	4.196	0	37.805	3.91	883
Firm Liquidity Exposure	24.458	23.893	5.576	61.78	7.82	883
Firm Market Share Exposure	7.375	6.713	0.013	18.058	5.654	883
Firm Industry-HHI exposure	0.034	0.026	0.0009	0.572	0.033	883
Firm Province-HHI exposure	0.112	0.101	0.001	0.457	0.045	883
Firm ROA Exposure	0.38	0.381	-0.06	2.176	0.15	883
Firm Tier 1 Ratio Exposure	11.429	10.93	5.89	23.39	2.662	883

Figure 8: Firm Descriptives within quartiles of weighted-average interbank exposure of their banks

	1st Quartile	2nd Quartile	3rd Quartile	4th Quartile	ndard deviat	# Obs.
Investment rate 2007-2009	20.605	22.674	22.821	14.827	26.182	883
Investment rate 2004-2006	25.219	23.332	21.93	18.752	27.656	883
Credit demand	-0.003	0.044	-0.0003	-0.0204	0.663	883
Assets ('000 Euros)	13035.02	20749.36	19608.15	20412.31	86230.17	883
Cash holdings	5.449	5.419	4.411	4.572	8.701	883
Sales / Assets	139.72	172.202	153.191	131.283	121.164	883
Return on Assets	8.624	10.766	11.094	11.002	17.922	883
Leverage	6.604	79.81	36.643	25.781	579.785	883
Credit drawn / granted 12/2006	75.302	74.614	73.998	74.496	29.294	883
Age	25.418	21.244	21.128	21.884	20.122	883
Probability of Default	1.554	2.605	2.485	1.868	9.087	883
Average Bank Tier 1 Ratio	11.347	10.908	11.906	11.558	2.666	883
Average Bank Size (mln Euros)	25731.15	46906.7	68120.02	56212.12	35787.56	883
Average Bank Return on Assets	0.326	0.365	0.421	0.407	0.150	883

Figure 9: Firm Descriptives within quartiles of weighted-average US asset exposure of their banks

	1st Quartile	2nd Quartile	3rd Quartile	4th Quartile	ndard deviat	# Obs.
Investment rate 2007-2009	24.317	20.29	21.456	14.862	26.182	883
Investment rate 2004-2006	19.859	23.813	24.96	19.287	27.656	883
Credit demand	0.09	0.064	-0.039	-0.1	0.663	883
Assets	3752.215	7459.997	2898.033	33672.29	86230.17	883
Cash holdings	4.318	5.189	4.937	5.412	8.701	883
Sales / Assets	153.648	160.261	140.977	141.556	121.164	883
Return on Assets	8.401	10.063	10.955	12.07	17.922	883
Leverage	6.17	7.02	93.08	42.64	579.785	883
Credit drawn / granted 12/2006	78.06	71.281	72.48	76.6	29.294	883
Age	22.95	20.73	25.286	20.735	20.122	883
Probability of Default	3.806	1.381	1.643	1.681	9.087	883
Average Bank Tier 1 Ratio	11.55	11.17	12.01	10.98	2.666	883
Average Bank Size (mln Euros)	13686.32	36979.67	66136.96	80275.93	35787.56	883
Average Bank Return on Assets	0.342	0.357	0.396	0.424	0.15	883

Table 1: The bank lending channel

Dependent variable	$\Delta Credit\ Line_{ij}$ between 2006:12 - 2009:12			
	All firm-bank pairs (credit lines), no controls	All firm-bank pairs with firm investment info, no controls	All firm-bank pairs (credit lines), incl. controls	All firm-bank pairs with firm investment info, incl. controls
	(1)	(2)	(3)	(4)
Interbank Borrowing / Total Assets 12/2006	-0.029	-0.037	-0.045**	-0.078**
	(0.024)	(0.033)	(0.018)	(0.032)
US Assets / Total Assets 12/2006	-0.058***	-0.084***	-0.095***	-0.134***
	(0.022)	(0.032)	(0.028)	(0.037)
Tier 1 Ratio Q4 2006			-0.182	-0.770
			(0.381)	(0.585)
Liquid assets / Total Assets 12/2006			0.028	0.119**
			(0.028)	(0.050)
Market Share 12/2006			0.013**	0.012*
			(0.006)	(0.007)
Industry Lending HHI 12/2006			-0.138*	-0.121
			(0.074)	(0.095)
Province Lending HHI 12/2006			0.120**	0.147*
			(0.057)	(0.079)
Return on Assets 2006			0.082***	0.099***
			(0.022)	(0.026)
Credit drawn / Credit Line 12/2006			0.017	0.030
			(0.056)	(0.086)
Firm Fixed Effects	Yes	Yes	Yes	Yes
# Bank-Firm pairs	6332	2743	6299	2719
# Banks	254	189	248	183
# Firms	1994	888	1987	883
adj. R^2	0.164	0.142	0.173	0.158

This table shows the results of equation 2, i.e. estimates the effect of bank-specific crisis exposure on bank lending in Austria during the recent financial crisis using the method of Khwaja and Mian (2008). The unit of observation is the loan of bank j to firm i, and the sample consists of loans to firms that borrow from at least two banks. The dependent variable is the change in the maximum amount of credit firm i can obtain from bank j via a credit line offered by bank j, between December 2006 and December 2009. All independent variables are bank-specific and measured in December 2006, apart from the ratio of the credit line drawdown to the credit line volume, which is at the loan level, and the Khwaja-Mian firm fixed effects. Conditional on the assumption discussed in the main text, the latter capture the change in firm credit demand between the pre-crisis and crisis period and thus enable a clean identification of the effect of crisis exposure on the change in credit supply. Our proxies for exposure to the crisis are the variables *Interbank Borrowing / Total Assets* and *US Assets / Total Assets*. The latter is defined as the sum of securities, stocks and money market funds issued in the United States and loans to US customers – in whichever currency – divided by the total amount of securities, stocks, money market funds and loans a bank has on its balance sheet in December 2006. The *Tier 1 Ratio* is the ratio of bank equity to total risk-weighted assets; *Liquid Assets* stands for the ratio of cash and balance with central banks and loans and advances to governments and credit institutions to total assets; *Market Share* is computed as the share of the bank's interbank lending in total interbank lending of banks; *Industry Lending HHI* and *Province Lending HHI* are Herfindahl indices of industry- and province-specific lending concentration; and *Return on Assets 2006* equals net income divided by the average total assets in 2006. Standard errors are clustered at the bank level and are in parentheses.

Table 2: The firm borrowing channel

Dependent variable	$\Delta Total\ Credit\ Line_i$ between 2006:M12 and 2009:M12		
	Firms with inv. info, $\hat{FE}$, no controls	Firms with inv. info, $\hat{FE}$ & controls	Firms with inv. info, no $\hat{FE}$ & controls
	(1)	(2)	(3)
WA Interbank Borrowing / Total Assets 12/2006	-0.062**	-0.055	-0.028
	(0.031)	(0.039)	(0.058)
WA US Assets / Total Assets 12/2006	-0.110***	-0.092**	-0.051
	(0.035)	(0.041)	(0.067)
WA Bank Controls	Yes	Yes	Yes
Total Credit drawn / Total Credit Line 12/2006	0.074	0.101	0.318***
	(0.059)	(0.065)	(0.102)
Firm Fixed Effect Estimate 2006	0.829***	0.806***	
	(0.042)	(0.044)	
Firm Cash holdings / Assets 2006		0.232	0.459*
		(0.146)	(0.266)
Firm Leverage 2006		0.000***	0.000**
		(0.000)	(0.000)
Firm Return on Assets 2006		0.190**	0.564***
		(0.081)	(0.163)
Firm Size 2006		-0.000	-0.000***
		(0.000)	(0.000)
Firm Age 2006		-0.000	-0.001
		(0.001)	(0.001)
Firm AVG Probability of Default 2008		-0.002	-0.001
		(0.002)	(0.003)
Industry Fixed Effects	No	Yes	Yes
Province Fixed Effects	No	Yes	Yes
# Firms	883	874	874
adj. R^2	0.633	0.637	0.092

This table presents the results of equation 3, i.e. the firm borrowing channel. The results give us insights on how easily firms can substitute loss of credit from a bank that is highly exposed to the crisis with credit from less exposed banks, and thus how much the firm is affected by high crisis exposure of a subset of its banks during the crisis. The unit of observation is now the firm. The sample only contains firms that had more than one banking relationship in December 2006, same as in Table 1. Any given bank variable on the right-hand side is now the firm-specific weighted average (thus *WA*) of the realizations of all banks that lent to the firm in December 2006. The weight attached to each pre-crisis bank is its share in the total credit line volume granted to the firm in December 2006. Please see Table 1 for a description of the bank balance sheet variables. *Total Credit drawn / Total Credit line* is the usage of the total credit line volume granted to the firm in percent. The *Firm Fixed Effect Estimate* is the firm-specific estimate of the fixed effect in equation (1); the specification used is the one of Table 1, column 4. *Firm Leverage* equals total assets divided by the firm's equity; *Return on Assets* is the firm's profits divided by total assets; and *Firm Size* is the firm's total assets. *Probability of Default* has to be reported by each bank when it gives a loan to a firm and refers to the loan, not the firm. We compute the simple average of this measure; it is computed in the earliest available month of the year 2008, as the reporting requirement was only introduced in this year. In column 1, we feature only the weighted-average bank variables and the firm fixed effects estimates, in column 2 we add firm controls and in column 3, we replace the firm fixed effect estimate with the firm-specific controls. Robust standard errors are in parentheses.

Table 3: The firm borrowing channel: Including single-bank firms

	Firms with inv. info & # banks > 1 $\hat{FE}$, no controls	Firms with inv. info & # banks > 1 no $\hat{FE}$, no controls	Firms with inv. info & # banks > 1 no $\hat{FE}$, controls	Firms with inv. info & # banks > 1 imp. $\hat{FE}$, no contr.	Firms with inv. info & # banks = 1, with controls	Firms with inv. info & # banks = 1, no controls
	(1)	(2)	(3)	(4)	(5)	(6)
WA Interbank Borrowing / Total Assets 12/2006	-0.062**	-0.003	-0.029	-0.026	-0.065	-0.022
	(0.031)	(0.044)	(0.058)	(0.044)	(0.081)	(0.065)
WA US Assets / Total Assets 12/2006	-0.110***	-0.112*	-0.055	-0.073	-0.173**	-0.072
	(0.035)	(0.058)	(0.067)	(0.054)	(0.080)	(0.072)
WA Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes
Total Credit drawn / Total Credit Line 12/2006	0.074	0.224**	0.316***	0.037	0.215***	0.194***
	(0.059)	(0.090)	(0.102)	(0.100)	(0.064)	(0.059)
Firm Fixed Effect Estimate	0.829***					
	(0.042)					
Firm Cash holdings / Assets 2006			0.483*		-1.314**	
			(0.267)		(0.610)	
Firm Leverage 2006			0.000*		-0.000	
			(0.000)		(0.000)	
Firm Tangible assets / Total Assets 2006			-0.154		0.274	
			(0.198)		(0.376)	
Firm Return on Assets 2006			0.564***		0.198**	
			(0.160)		(0.094)	
Firm Size 2006			-0.000***		0.000***	
			(0.000)		(0.000)	
Firm Age 2006			-0.001		0.000	
			(0.001)		(0.004)	
Firm AVG Probability of Default 2008			-0.001		0.007	0.003
			(0.002)		(0.005)	(0.004)
Imputed Fixed Effect Estimate				0.968***		
				(0.185)		
Constant						-0.082
						(0.199)
Industry Fixed Effects	No	No	Yes	Yes	Yes	No
Province Fixed Effects	No	No	Yes	Yes	Yes	No
# Firms	883	883	874	883	620	625
adj. R^2	0.633	0.021	0.092	0.066	0.085	0.022

Please see section 7 for a description of selected specifications of this table. Robust standard errors are in parentheses.

Table 4: The effect of lender exposure to the crisis on corporate investment

Dependent variable	Total Capital Expenditures 2007-2009 / Total Assets 2006				
	Firms with inv. info, no $\hat{FE}$, no firm controls	Firms with inv. info, $\hat{FE}$, no firm controls	Firms with inv. info, $\hat{FE}$, firm controls	Firms with inv. info, $\hat{FE}$, firm controls	Firms with inv. info, $\hat{FE}$, firm controls
	(1)	(2)	(3)	(4)	(5)
WA Interbank Borrowing / Total Assets 12/2006	0.034**	0.029**	-0.022	-0.023	-0.006
	(0.014)	(0.013)	(0.015)	(0.016)	(0.031)
WA US Assets / Total Assets 12/2006	-0.000	-0.002	-0.055***	-0.054***	-0.014
	(0.017)	(0.016)	(0.020)	(0.020)	(0.038)
WA Bank Controls	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effect Estimate		0.058***	0.046***	0.047***	0.071***
		(0.010)	(0.009)	(0.009)	(0.014)
Firm Size 2006			0.000	0.000	0.000
			(0.000)	(0.000)	(0.000)
Firm Sales / Assets 2006			0.009	0.007	0.001
			(0.006)	(0.006)	(0.009)
Firm Age 2006			-0.000	-0.000	-0.000
			(0.000)	(0.000)	(0.000)
Firm AVG Probability of Default 2008			-0.001***	-0.001**	0.000
			(0.000)	(0.000)	(0.001)
Firm Return on Assets 2006				0.012	-0.071
				(0.035)	(0.068)
Firm Cash holdings / Assets 2006				-0.013	0.125
				(0.065)	(0.130)
Firm Leverage 2006				-0.000	-0.000
				(0.000)	(0.000)
Total Credit drawn / Total Credit Line 12/2006				-0.041*	-0.042
				(0.022)	(0.029)
Δ Sales 2005-2006					-0.013
					(0.008)
Firm Investment rate Pre-crisis					0.324***
					(0.068)
Industry Fixed Effects	No	No	Yes	Yes	Yes
Province Fixed Effects	No	No	Yes	Yes	Yes
# Firms	883	883	874	874	422
adj. R^2	0.456	0.476	0.279	0.278	0.326

This table shows the effect of variation in the crisis exposure of a firm's banks on the firm's investment rate during the financial crisis. The unit of observation is the firm, and the sample only contains firms that had more than one banking relationship in December 2006. The dependent variable is the sum of capital expenditures in 2007, 2008 and 2009 divided by the firm's total assets in 2006. We winsorized the dependent variable from above at the 95th percentile. Please see Table 3 for a description of most independent variables. In column 1, we only include our crisis exposure proxies. In column 2 we add the fixed effect estimates of equation 2. In column 3 we add a series of firm controls that shall capture firm investment opportunities. In column 4, we add controls that shall capture financial frictions and thus the ability to invest. In column 5, we add lagged sales growth and the pre-crisis investment rate (which equals the sum of capital expenditures in 2004, 2005 and 2006 divided by total assets in 2003), in order to add more controls capturing investment opportunities during the crisis. Robust standard errors are in parentheses.

Table 5: The effect of lender exposure to the crisis on corporate employment

Dependent variable	Log(Employment 2009) - Log(Employment 2006)			
	Firms with inv. info, no $\hat{FE}$, no firm controls	Firms with inv. info, $\hat{FE}$, no firm controls	Firms with inv. info, $\hat{FE}$, firm controls	Firms with inv. info, $\hat{FE}$, firm controls
	(1)	(2)	(3)	(4)
WA Interbank Borrowing / Total Assets 12/2006	0.014	0.009	0.032	0.030
	(0.026)	(0.026)	(0.037)	(0.037)
WA US Assets / Total Assets 12/2006	0.036	0.035	0.027	0.027
	(0.037)	(0.037)	(0.042)	(0.042)
WA Bank Controls	Yes	Yes	Yes	Yes
Firm Fixed Effect Estimate 2006		0.059	0.061	0.061
		(0.054)	(0.047)	(0.048)
Firm Size 2006			-0.000	-0.000
			(0.000)	(0.000)
Firm Sales / Assets 2006			0.006	0.002
			(0.018)	(0.018)
Firm Age 2006			-0.001	-0.001
			(0.001)	(0.001)
Firm AVG Probability of Default 2008			0.002	0.002
			(0.002)	(0.002)
Firm Return on Assets 2006				0.041
				(0.094)
Firm Cash holdings / Assets 2006				0.100
				(0.155)
Firm Leverage 2006				-0.000
				(0.000)
Total Credit drawn / Total Credit Line 12/2006				-0.066
				(0.076)
Industry Fixed Effects	No	No	Yes	Yes
Province Fixed Effects	No	No	Yes	Yes
# Firms	851	851	842	842
adj. R^2	0.001	0.005	0.016	0.013

This table shows the effect of variation in bank crisis exposure on the change in employment between 2006 and 2009 of the bank's clients during the financial crisis. The unit of observation is the firm, and the sample only contains firms that had more than one banking relationship in December 2006. Please see Table 3 for a description of most independent variables. In column 1, we only include our crisis exposure proxies. In column 2 we add the fixed effect estimates of equation 2. In column 3 we add a series of firm controls that shall capture the ability of the firm to weather a crisis. In column 4, we add controls that capture financial frictions. Robust standard errors are in parentheses.

Table 6: Pre-Crisis Trends: Placebo Regression at the Loan level

Dependent variable	$\Delta Credit\ Line_{ij}$ between 2003:12 - 2006:12			
	All firm-bank pairs (credit lines), no controls	All firm-bank pairs with firm investment info, no controls	All firm-bank pairs (credit lines), incl. controls	All firm-bank pairs with firm investment info, incl. controls
	(1)	(2)	(3)	(4)
Interbank Borrowing / Total Assets 12/2006	-0.005	0.011	-0.011	0.004
	(0.021)	(0.029)	(0.017)	(0.024)
US Assets / Total Assets 12/2006	0.024	0.039	0.030	0.056*
	(0.028)	(0.037)	(0.024)	(0.033)
Tier 1 Ratio Q4 2006			-0.940**	-0.735
			(0.465)	(0.746)
Liquid assets / Total Assets 12/2006			0.063*	0.059
			(0.036)	(0.048)
Market Share 12/2006			-0.008	-0.012*
			(0.005)	(0.007)
Industry Lending HHI 12/2006			0.020	-0.023
			(0.058)	(0.070)
Province Lending HHI 12/2006			0.004	0.073
			(0.053)	(0.068)
Return on Assets 2006			0.002	0.036
			(0.033)	(0.037)
Credit drawn / Credit Line 12/2006			-0.280***	-0.160
			(0.069)	(0.101)
Firm Fixed Effects	Yes	Yes	Yes	Yes
# Bank-Firm Pairs	6279	2680	6242	2655
# Firms	1922	803	1913	797
# Banks	246	198	241	193
adj. R^2	0.124	0.086	0.140	0.095

This table shows a placebo regression which examines the common trend of credit line volumes across banks of different exposure to the 2008-09 financial crisis. The dependent variable is the change in the maximum amount of credit firm i can obtain from bank j via a credit line offered by bank j, between December 2003 and December 2006. Standard errors are clustered at the bank level and are in parentheses.

Table 7: The bank lending channel: Robustness I

Dependent variable	$\Delta Credit\ Line_{ij}$ between 2006:12 - 2009:12				
	(1)	(2)	(3)	(4)	(5)
	Baseline	Net IBexp	Firm-loan type FE	Firm-credit weight FE	Observed each month
Interbank Borrowing / Total Assets 12/2006	-0.045**		-0.044**	-0.043**	-0.049***
	(0.018)		(0.018)	(0.016)	(0.016)
US Assets / Total Assets 12/2006	-0.095***	-0.095***	-0.113***	-0.104***	-0.109***
	(0.028)	(0.028)	(0.028)	(0.030)	(0.017)
Net Interbank Borrowing / Total Assets 12/2006		-0.071**			
		(0.028)			
Bank Controls	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes
# Bank-Firm pairs	6299	6299	5185	5034	4841
# Banks	248	248	246	246	241
# Firms	1987	1987	1553	1536	1550
adj. R^2	0.173	0.174	0.176	0.219	0.181

This table presents a series of robustness checks of the results of our estimation of equation 2, which are estimated in Table 1. Column 1 repeats our preferred specification in Table 1, the results of which are reported in Table 1, column 4. Please see section 6 for an explanation and motivation of the separate robustness checks. Standard errors are clustered at the bank level and are in parentheses.

Table 8: The bank lending channel: Robustness II

Dependent variable	$\Delta Credit\ Line_{ij}$ between 2006:12 - 2009:12					
	Baseline	Small credit line variation	High bank weight variation	Binding credit line	Always above Threshold	No Firm Fixed Effects
	(1)	(2)	(3)	(4)	(5)	(6)
Interbank Borrowing / Total Assets 12/2006	-0.045**	-0.026***	-0.062*	-0.058**	-0.035	-0.035**
	(0.018)	(0.007)	(0.034)	(0.027)	(0.022)	(0.017)
US Assets / Total Assets 12/2006	-0.095***	-0.035***	-0.137***	-0.147***	-0.097***	-0.085***
	(0.028)	(0.013)	(0.047)	(0.028)	(0.029)	(0.025)
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	No
Bank-Firm pairs	6299	2433	2445	2135	1831	6299
Banks	248	223	193	210	200	248
Firms	1987	811	993	730	677	1987
adj. R^2	0.173	0.167	0.108	0.159	0.223	0.008

This table presents a series of further robustness checks of the results of our estimation of equation 2, which are estimated in Table 1. Column 1 repeats our preferred specification in Table 1, the results of which are reported in Table 1, column 4. Please see section 6 for an explanation and motivation of the separate robustness checks. Standard errors are clustered at the bank level and are in parentheses.

Table 9: The bank lending channel: US$ asset exposure instead of US asset exposure

Dependent variable	$\Delta Credit\ Line_{ij}$ between 2006:12 - 2009:12			
	All firm-bank pairs (credit lines)	All firm-bank pairs (credit lines)	All firm-bank pairs (credit lines)	All firm-bank pairs (credit lines)
	(1)	(2)	(3)	(4)
Interbank Borrowing / Total Assets 12/2006	-0.029	-0.044	-0.036**	-0.062**
	(0.023)	(0.032)	(0.017)	(0.028)
USD Assets / Total Assets 12/2006	-0.043	-0.040	-0.083*	-0.108**
	(0.030)	(0.039)	(0.043)	(0.051)
Tier 1 Ratio Q4 2006			-0.012	-0.404
			(0.404)	(0.610)
Liquid assets / Total Assets 12/2006			0.043	0.137**
			(0.032)	(0.062)
Market Share 12/2006			0.005	0.001
			(0.005)	(0.006)
Industry Lending HHI 12/2006			-0.113	-0.090
			(0.076)	(0.105)
Province Lending HHI 12/2006			0.098	0.122
			(0.059)	(0.087)
Net Income / Total Assets avg2006			0.089***	0.107***
			(0.021)	(0.026)
Credit drawn / Credit Line 12/2006			0.015	0.038
			(0.058)	(0.088)
Firm Fixed Effects	Yes	Yes	Yes	Yes
# Bank-Firm pairs	6327	2739	6299	2719
# Banks	254	189	248	183
# Firms	1994	888	1987	883
adj. R^2	0.163	0.140	0.171	0.154

This table presents a further robustness check of the results of our estimation of equation 2, which are estimated in Table 1. Column 1 repeats our preferred specification in Table 1, the results of which are reported in Table 1, column 4. Please see section 6 for an explanation and motivation of this robustness check. Standard errors are clustered at the bank level and are in parentheses. Standard errors are clustered at the bank level and are in parentheses.

Table 10: The firm borrowing channel: Robustness

Dependent variable	$\Delta Total\ Credit\ Line_i$ between 2006:M12 and 2009:M12	
	Firms with inv. info, $\hat{FE}$, no controls	Firms with inv. info, no $\hat{FE}$, no controls, Main Bank FE
	(1)	(2)
WA Interbank Borrowing / Total Assets 12/2006	-0.062**	-0.063
	(0.031)	(0.059)
WA US Assets / Total Assets 12/2006	-0.110***	-0.156**
	(0.035)	(0.068)
WA Tier 1 Ratio Q4 2006	0.448	-0.565
	(0.576)	(1.154)
WA Liquid assets / Total Assets 12/2006	-0.070	0.032
	(0.071)	(0.110)
WA Industry Lending HHI 12/2006	-0.196***	-0.060
	(0.067)	(0.168)
WA Province Lending HHI 12/2006	0.218***	0.216
	(0.059)	(0.158)
WA Net Income / Total Assets 2006	0.034	0.071
	(0.102)	(0.132)
WA Market Share 12/2006	0.028***	0.027
	(0.009)	(0.017)
Total Credit drawn / Total Credit Line 12/2006	0.074	0.097
	(0.059)	(0.065)
Firm Fixed Effect Estimate	0.829***	0.819***
	(0.042)	(0.044)
Industry Fixed Effects	No	No
Province Fixed Effects	No	No
Main Bank Fixed Effects	No	Yes
# Firms	883	883
# Main Banks	n.a.	92
adj. R^2	0.633	0.627

This table presents a robustness check of our results on the firm borrowing channel, specifically the inclusion of main bank fixed effects. Column 1 displays the results of our preferred specification of the firm borrowing channel specification, see Table 2, column 1. Please see section 6 for an explanation and motivation of this robustness check. Robust standard errors are in parentheses.

Table 11: The effect of lender exposure to the crisis on Firm Investment: Robustness

Dependent variable	Total Capital Expenditures 2007-2009 / Total Assets 2006	
	Firms with inv. info, $\hat{FE}$ & controls	Firms with inv. info, $\hat{FE}$ & controls & Main Bank FE
	(1)	(2)
WA Interbank Borrowing / Total Assets 12/2006	-0.023	-0.015
	(0.016)	(0.028)
WA US Assets / Total Assets 12/2006	-0.054***	-0.017
	(0.020)	(0.041)
Total Credit drawn / Total Credit Line 12/2006		
Firm Fixed Effect Estimates	Yes	Yes
WA Bank Controls	Yes	Yes
Firm controls	Yes	Yes
Industry Fixed Effects	Yes	Yes
Province Fixed Effects	Yes	Yes
N	874	874
adj. R^2	0.278	0.311

This table presents a robustness check of our results on the effect of bank crisis exposure on firm investment, specifically the inclusion of main bank fixed effects. Column 1 again displays the results reported in Table 4, column 4. Please see section 6 for an explanation and motivation of this robustness check. Robust standard errors are in parentheses.

Table 12: The effect of lender exposure on Firm Investment.
Note: Investment rate is winsorized from above at 99%.

Dependent variable	Total Capital Expenditures 2007-2009 / Total Assets 2006				
	Firms with inv. info, no $\hat{FE}$, no firm controls	Firms with inv. info, $\hat{FE}$, no firm controls	Firms with inv. info, $\hat{FE}$, firm controls	Firms with inv. info, $\hat{FE}$, firm controls	Firms with inv. info, $\hat{FE}$, firm controls
	(1)	(2)	(3)	(4)	(5)
WA Interbank Borrowing / Total Assets 12/2006	0.042**	0.035**	-0.030*	-0.033*	-0.004
	(0.016)	(0.016)	(0.018)	(0.018)	(0.041)
WA US Assets / Total Assets 12/2006	0.004	0.002	-0.062*	-0.061*	0.014
	(0.025)	(0.024)	(0.032)	(0.032)	(0.060)
WA Bank Controls	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effect Estimate		0.073***	0.058***	0.059***	0.091***
		(0.013)	(0.012)	(0.012)	(0.021)
Firm Size 2006			0.000	0.000	0.000
			(0.000)	(0.000)	(0.000)
Firm Sales / Assets 2006			0.012*	0.009	0.006
			(0.007)	(0.007)	(0.012)
Firm Age 2006			-0.000	-0.000	-0.000
			(0.000)	(0.000)	(0.000)
Firm AVG Probability of Default 2008			-0.002***	-0.001***	-0.001
			(0.000)	(0.000)	(0.001)
Firm Return on Assets 2006				0.050	-0.046
				(0.046)	(0.092)
Firm Cash holdings / Assets 2006				0.010	0.243
				(0.081)	(0.184)
Firm Leverage 2006				-0.000	-0.000
				(0.000)	(0.000)
Total Credit drawn / Total Credit Line 12/2006				-0.053*	-0.073*
				(0.028)	(0.039)
Δ Sales 2005-2006					-0.021
					(0.016)
Pre-crisis Investment rate					0.301***
					(0.102)
Industry Fixed Effects	No	No	Yes	Yes	Yes
Province Fixed Effects	No	No	Yes	Yes	Yes
# Firms	883	883	874	874	422
adj. R^2	0.362	0.383	0.271	0.272	0.342

This table presents a robustness check of our results on the effect of bank crisis exposure on firm investment; we winsorize the dependent variable at the 99th percentile instead of the 99th percentile. Robust standard errors are in parentheses.

Table 13: The effect of lender exposure on Firm Investment: 2007-2010.
Note: Investment rate is winsorized from above at 95%.

Dependent variable	Total Capital Expenditures 2007-2010 / Total Assets 2006				
	Firms with inv. info, no $\hat{FE}$, no firm controls	Firms with inv. info, $\hat{FE}$, no firm controls	Firms with inv. info, $\hat{FE}$, firm controls	Firms with inv. info, $\hat{FE}$, firm controls	Firms with inv. info, $\hat{FE}$, firm controls
	(1)	(2)	(3)	(4)	(5)
WA Interbank Borrowing / Total Assets 12/2006	0.056**	0.045**	-0.029	-0.032	-0.007
	(0.022)	(0.021)	(0.025)	(0.024)	(0.049)
WA US Assets / Total Assets 12/2006	-0.007	-0.008	-0.088**	-0.087**	-0.025
	(0.029)	(0.028)	(0.039)	(0.039)	(0.064)
WA Bank Controls	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effect Estimate		0.096***	0.072***	0.073***	0.109***
		(0.017)	(0.016)	(0.017)	(0.026)
Firm Size 2006			0.000	0.000	0.000
			(0.000)	(0.000)	(0.000)
Firm Sales / Assets 2006			0.013	0.010	0.014
			(0.009)	(0.009)	(0.014)
Firm Age 2006			-0.000	-0.000	-0.000
			(0.000)	(0.000)	(0.001)
Firm AVG Probability of Default 2008			-0.001	-0.001	-0.000
			(0.001)	(0.001)	(0.002)
Firm Return on Assets 2006				0.045	-0.060
				(0.073)	(0.104)
Firm Cash holdings / Assets 2006				0.004	0.265
				(0.099)	(0.200)
Firm Leverage 2006				0.000	-0.000
				(0.000)	(0.000)
Total Credit drawn / Total Credit Line 12/2006				-0.066*	-0.064
				(0.036)	(0.044)
Δ Sales 2005-2006					-0.023
					(0.019)
Firm Investment rate Pre-crisis					0.363***
					(0.110)
Industry Fixed Effects	No	No	Yes	Yes	Yes
Province Fixed Effects	No	No	Yes	Yes	Yes
# Firms	812	812	803	803	398
adj. R^2	0.395	0.417	0.301	0.301	0.396

This table presents a robustness check of our results on the effect of bank crisis exposure on firm investment; in particular, we include investment 2010 in our computation of the investment rate, to allow for lagged effects of a credit crunch on investment. See section 6 for details. Robust standard errors are in parentheses.

Table 14: The bank lending channel: Decomposing US asset exposure

Dependent variable	$\Delta Credit\ Line_{ij}$ between 2006:12 - 2009:12			
	All firm-bank pairs (credit lines)	All firm-bank pairs (credit lines)	All firm-bank pairs (credit lines)	All firm-bank pairs (credit lines)
	(1)	(2)	(3)	(4)
Interbank Borrowing / Total Assets 12/2006	-0.045**	-0.039**	-0.044**	-0.042**
	(0.018)	(0.017)	(0.019)	(0.017)
US Assets / Total Assets 12/2006	-0.095***			
	(0.028)			
Tier 1 Ratio Q4 2006	-0.182	-0.037	0.009	0.178
	(0.381)	(0.417)	(0.362)	(0.374)
Liquid assets / Total Assets 12/2006	0.028	0.045	0.006	0.002
	(0.028)	(0.033)	(0.026)	(0.026)
Market Share 12/2006	0.013**	0.010	0.004	0.002
	(0.006)	(0.007)	(0.005)	(0.004)
Industry Lending HHI 12/2006	-0.138*	-0.126*	-0.152**	-0.165**
	(0.074)	(0.076)	(0.074)	(0.079)
Province Lending HHI 12/2006	0.120**	0.103*	0.122**	0.130**
	(0.057)	(0.059)	(0.056)	(0.059)
Net Income / Total Assets avg2006	0.082***	0.084***	0.088***	0.094***
	(0.022)	(0.023)	(0.023)	(0.023)
Credit drawn / Credit Line 12/2006	0.017	0.013	0.017	0.009
	(0.056)	(0.057)	(0.057)	(0.056)
Loans to US / Total Assets 12/2006		-0.069**		
		(0.034)		
US Bonds / Total Assets 12/2006			-0.067**	
			(0.031)	
US Stocks / Total Assets 12/2006				-0.531*
				(0.312)
Firm Fixed Effects	Yes	Yes	Yes	Yes
# Bank-Firm pairs	6299	6299	6299	6299
# Banks	248	248	248	248
# Firms	1987	1987	1987	1987
adj. R^2	0.173	0.172	0.172	0.171

In this robustness check of the results of equation 2, we separately include the components of US asset exposure in the regression. Please see section 6 for an explanation and motivation of this robustness check. Standard errors are clustered at the bank level and are in parentheses.

Table 15: The bank lending channel: Analyzing a shorter time horizon

Dependent variable	$\Delta Credit\ Line_{ij}$ between 2006:12 - 2008:12			
	All firm-bank pairs (credit lines), no controls	All firm-bank pairs (credit lines) with inv. info, no controls	All firm-bank pairs (credit lines), with controls	All firm-bank pairs (credit lines) with inv. info, with controls
	(1)	(2)	(3)	(4)
Interbank Borrowing / Total Assets 12/2006	-0.032*	-0.028	-0.045***	-0.063**
	(0.019)	(0.028)	(0.016)	(0.027)
US Assets / Total Assets 12/2006	-0.027	-0.042	-0.053**	-0.087***
	(0.019)	(0.032)	(0.022)	(0.029)
Tier 1 Ratio Q4 2006			-0.503	-0.790
			(0.362)	(0.603)
Liquid assets / Total Assets 12/2006			0.005	0.075
			(0.028)	(0.050)
Market Share 12/2006			0.005*	0.006
			(0.003)	(0.004)
Industry Lending HHI 12/2006			-0.114*	-0.063
			(0.067)	(0.087)
Province Lending HHI 12/2006			0.075	0.043
			(0.052)	(0.079)
Net Income / Total Assets avg2006			0.044	0.034
			(0.029)	(0.037)
Credit drawn / Credit Line 12/2006			-0.075	-0.065
			(0.047)	(0.066)
Firm Fixed Effects	Yes	Yes	Yes	Yes
# Bank-Firm Pairs	7150	3041	7098	3007
# Banks	260	195	254	189
# Firms	2232	957	2220	950
adj. R^2	0.156	0.146	0.168	0.152

In this robustness check of the results of equation 2, we feature the dependent variable as the change in the credit line between December 2006 and December 2008. Standard errors are clustered at the bank level and are in parentheses.