DOES CREDIT CRUNCH INVESTMENTS DOWN? NEW EVIDENCE ON THE REAL EFFECTS OF THE BANK-LENDING CHANNEL

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New evidence on the real effects of the bank-lending channel

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Abstract

This paper shows evidence on the real effects of the bank lending channel exploiting the dramatic 2007 liquidity drought in interbank markets as a source of variation in banks' credit supply. For a large sample of Italian firms we combine information on firm-bank credit relationships, firms and banks balance sheet data, and estimate both the direct effect of the liquidity drought on the investment rate and the sensitivity to bank credit of investment (as well as of other firms outcomes) in 2007-10. We find that: (i) pre-crisis exposure to the interbank markets does predict banks subsequent credit supply; (ii) banks exposure also has a significant direct impact on firms investment rate, accounting for more than 40% of the negative trend in investment observed in the sample; (iii) firms' investments are highly sensitive to bank credit: a 10 percentage point fall in credit growth reduces the investment rate by 8-14 points over four years, depending on the definition of the credit variable; (iv) credit shocks have a significant impact on broader economic activity, lowering firms' value added, employment and intermediate inputs purchases; we also find evidence of its propagation through a contraction in the supply of trade credit by firms.

JEL-Code: E22, E44, G01, G21, G32.
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1 Introduction

The 2007-2008 financial crisis has been followed by the deepest recession since the 1930s. Most developed countries featured, in particular, a dramatic drop of investment expenditure, with gross fixed capital formation falling, between 2006 and 2010, by 10.8% on average within OECD countries. Because it followed a series of major shocks to banks' liquidity, the drop in investments has been often traced back to a supply-driven contraction of credit (a 'credit crunch'), in that intermediaries proved unable to mitigate the consequences of liquidity shortages on their lending (the so-called "'bank lending channel"', BLC).

Empirically assessing the impact of the BLC on investments (as opposed to, say, the impact of a fall in demand, or deteriorating borrowers' balance-sheets) is a challenging task, however. Identification requires credibly isolating supply from demand determinants of credit growth, and disentangling the role of credit from that of other (observed and unobserved) determinants of investment. Yet, such exercise has a key policy relevance. If the fall in investment is mostly demand-driven, policies that foster private and public consumption would have a direct positive effect on output. The same policies would be much less effective if the drop in investment is mainly due to a credit crunch. Indeed, in this case, policies aimed at improving banks' capital and liquidity position, and at restoring confidence in financial markets, would be more effective in sustaining investments.

In this paper, we exploit the peculiar transmission of the 2007-2008 liquidity crisis to the Italian banking system, arguing that it allows for a particularly clean identification of the real effects of the BLC. The 2007 and 2008 financial shocks (owed to the subprime mortgage crisis and to Lehman's default, respectively) originated outside the Italian economy and hit its banking system through a dramatic liquidity drought in interbank markets. As a result, banks that relied more on interbank borrowing *before* the crisis (i.e. at the end of 2006) suffered more from the subsequent liquidity drought (Bonaccorsi and Sette 2012). Italy is particularly suited for identifying the BLC because concurrent shocks to other asset markets (such as the real estate one) have been negligible (Angelini et al. 2011, Affinito 2012).

We construct a unique dataset that combines detailed information on each firm-bank relationship from the Italian Credit Register with firm and bank balance-

sheet data for a sample of around 30,000 (mostly unlisted) non-financial firms. For each firm, we compute a measure of exposure to the credit shock based on its lenders' exposure to the interbank markets before the crisis. More specifically, firm's exposure is obtained as a credit-share weighted average of the interbank funding-to-assets ratio (measured in 2006) of all the banks lending to the firm (in 2006).

We perform several tests showing that pre-crisis exposure to the financial shock is both significantly negatively related to credit growth during the crisis, and not correlated with credit growth before the crisis. Moreover, firms' exposure is not significantly related to firms pre-crisis observable characteristics (liquidity, profitability, size or investment rates), to their expectations of future investment in early 2007 (right before the onset of the crisis), nor to their demand for credit in 2007-10.

Reassured by this evidence, we use firms' pre-crisis exposure to the liquidity shock to assess the relevance of the BLC on real outcomes. We start by estimating the reduced-form impact of firms'exposure on their 2006-2010 investment rate. This allows recovering the drop in total investments in the sample that can be traced to the collapse of the interbank market, an important step forward relative to recent analyses documenting its impact on credit supply (Iyer et al., 2013). Next, we use exposure as an instrumental variable to obtain a direct and robust estimate of the sensitivity of firms' investments to bank credit. The only other paper we are aware of that estimates such parameter is the contemporaneous work by Amiti and Weinstein (2013), who look at investments by listed Japanese firms. One important way we add to their work is by extending the analysis beyond investments decisions, to a variety of other firm level outcomes (as value added, employment, intermediate inputs, trade credit, and trade debit). Another is by looking beyond listed firms, focusing on a sample that is more representative of the actual firm size distribution. In both respects our work also relates to Chodorow-Reich (2013) who highlights the relevance of credit shocks following the 2008 financial crisis in explaining the subsequent decline of employment at small and medium US firms.[1]

[1]The empirical literature on the consequences of credit shocks for investments is very large, and will be discussed at length in section 5. Due to the lack of data on firm-level access to credit most of these works resort to observable firms' characteristics, mainly linked to credit constraints to identify firms' exposure to the shocks.

Our results show a sizeable real effect of the BLC during the crisis. In our preferred reduced-form specification we estimate that a 1 percentage point increase in the average interbank funding-to-assets ratio reduces the investment rate by almost 1 percentage point. This effect is stronger for firms that were ex-ante more likely to be credit constrained (as captured by their cash-holdings, tangible assets, and profitability). Our estimates imply that, had the interbank market not collapsed, total aggregate investment by firms in the sample would have been 47.8% higher than observed in the subseqeunt years. As to the estimated sensitivity of the investment rate to bank credit, we find it is highly significant. Our estimates imply that a 10 percentage points reduction in the growth rate of credit lowers the investment rate by 8-14 points, depending on the adopted definition of credit (the lowest bound is obtained restricting to long-term loans, which is likely the most suitable measure of credit when thinking about financing investments).

Our analysis also highlights that the negative credit supply shock induced a significant downsizing of firm's activity, as measured by value added or sales, employment, labor costs and intermediate inputs expenditures. For example, we find that lowering credit growth by 10 percentage points induces value added and employment to fall by nearly 3% and 1.4%, respectively. Moreover, our results suggest that the effect of the credit crunch may have been amplified through firms' trade credit chains, as predicted by the theoretical model of Kiyotaki and Moore (2004). According to our estimates a 10 percentage points decrease in bank credit growth induces firms to reduce trade credit growth by 5 percentage points on average (a larger drop than the one in sales).

Our findings have a direct relevance for the current policy debate about the business model of banks. While being very effective in normal times, a high exposure to volatile sources of funding such as the interbank market may represent an important source of contagion during financial crises. Precautionary measures aimed at assuring that banks hold sufficient levels of liquidity (such as the Net Stable Funding Ratio criterion envisaged in the Basel III regulatory framework) may help dampening the transmission of shocks from financial markets to the real sector.

The remainder of the paper is structured as follows. In Section 2 we present our empirical strategy to identify the real effects of the BLC and the sensitivity of investments to bank credit. In that section, we also provide evidence of the

validity of our identification hypotheses. Section 3 introduces the data used for the empirical exercises and presents descriptive statistics of it. Section 4 discusses the results, distinguishing between short and medium term effects on investments, heterogeneity analysis, robustness checks, and extensions (the effect of the credit crunch on firm's downsizing and on its credit chain). Section 5 contains a more thorough discussion of the related literature and of the contribution of the paper. Section 6 concludes.

2 Empirical strategy

2.1 The crunch of the interbank market as a source of credit supply shocks

The interbank market is the money market generated by the (mostly short-term) funding needs of banks, which borrow from other intermediaries with excess liquidity. It represents a critical source of funding for banks because it allows them to readily fill liquidity needs of different maturities (from overnight to more than one year) through both secured and unsecured contracts. At the end of 2006, total interbank funding represented over 13.3% of total assets of Italian banks.[2]

The collapse of the interbank market started in July 2007, when fears about banks' exposure to toxic assets made it extremely difficult to evaluate counterparty risk (Brunnermeier 2009). The situation worsened further after Lehman's default in September 2008. The freeze of the interbank market in Italy can be appreciated by observing the drop in interbank transactions among Italian banks. Figure 2 shows the evolution of total interbank transactions between 1999 and 2010 on the eMID market. Total transactions topped up at over 24 billions of euros in 2006, while at the end of 2010 they had dropped to 4.7 billions. This sharp fall was mainly driven by higher counterparty risk, as shown in Figure 3 which plots the trend in the spread between unsecured (Euribor) and secured (Eurepo) interbank lending in Euros. After the Lehman default such spread increased by 3 or 4 times, depending on the maturity, implying a huge increase in the cost of unsecured interbank deposits. Secured deposits contracted and their cost raised as well, as high quality collateral became scarcer and banks were less willing to lend funds,

[2]The distribution of the interbank liabilities-to-assets ratio across banks is highly positively skewed, ranging between 0 to more than 80% with a median value of around 1%.

even through secured transactions (Gorton and Metrick 2009).

The classical theory of the bank lending channel (summarized in Bernanke and Gertler 1995) posits that when banks are hit by liquidity shocks, they reduce their supply of loans if they cannot tap other sources of funding. More recent versions of the theory (Holmstrom and Tirole 1997, Bernanke 2007) suggest that banks may be affected by an external finance premium, essentialy in the same way as non-financial firms. When the external finance premium widens, the marginal cost of funds for banks increases, and banks are forced to tighten credit supply to borrowers.

There is large evidence that banks reduce their supply of loans when hit by liquidity shocks, as predicted by the bank lending channel (Kashyap and Stein 2000, Khwaja and Mian 2008). In particular, Iyer et al. (2013), Bonaccorsi and Sette (2012), Kapan and Minoiu (2013) show that during the 2007-2008 financial crisis the intensity of the credit supply tightening can be traced to the degree of banks reliance on interbank funding. As a consequence, the reliance of banks on interbank funding represents an important source of variation in banks' exposure to the liquidity shock.

Interbank markets did not come back to their pre-crisis levels even after the ECB liquidity injections (Bank of Italy 2009). Indeed, as we show in Section 2.2, we do not find evidence that the strength of the effect of the pre-crisis exposure to the interbank market on subsequent credit growth weakened after 2008 (when the ECB full allotment auctions were in place). This result is common to other papers looking at the consequences of liquidity shocks for credit in other European countries, and has been interpreted as evidence of liquidity hoarding (Iyer et al 2013, Brunetti et al. 2011).

The freeze in the interbank market is a particularly good instrument to identify the effect of the financial crisis on firm investment in the case of Italian banks, as other channels that may confound its identification were negligible. Indeed, the capital of Italian banks was not eroded by losses due to holdings of the assets that became "'toxic"' during the crisis (Asset Backed Securities, Collateralized Debt Obligations, etc.), or by off-balance sheet exposures towards Special Purpose Vehicles, and towards Lehman's liabilities, as all these were very limited (Bank of Italy 2009). In addition, unlike most other countries, Italy did not experience a

real estate bubble (Nobili and Zollino 2012).[3] Hence, Italian banks did not suffer much from losses on mortgages granted to households, households were not hit by adverse wealth effects, and firms were not harmed by reductions in commercial property prices, which may decrease the availability of collateral. In other words, in Italy the shock to bank funding was not amplified by concurrent shocks on other key asset markets.

In principle, banks' reliance on interbank funding before the financial shock may reflect differences in the business model of intermediaries, as well as banks' (or clients') characteristics that might be correlated with their lending policies before the crisis. These issues are extensively explored in the next Section.

2.2 Evidence on the validity of our empirical strategy

Our empirical strategy relies on two important identification hypotheses: namely, the unconfoundedness of interbank exposure with respect to (i) pre-crisis credit market's characteristics (as equilibrium credit growth and credit demand) and (ii) observable and unobservable firms' characteristics.

A first piece of evidence supporting the first assumption is proposed in Figure 4. The figure shows the dynamics of the average growth rate of credit (measured with respect to July 2007, i.e. the onset of the crisis) for two groups of banks: those whose interbank-to-assets ratio was above the median of the distribution in 2006, and those below the median. Consistently with our first assumption, the dynamics were very similar until September 2007, when they started diverging: credit from banks with high interbank-to-assets ratio rose at lower pace (and ultimately declined, since January 2009) with respect to credit from less exposed banks.

This differential trend during the crisis may be driven by selection, whereas banks with a high exposure to the interbank market before the crisis may lend more to firms with lower demand for loans, or more fragile during the crisis. To test whether this is the case, we study the growth rate of credit from different banks *within* the same borrower. Following the methodology developed by Khwaja and Mian (2008), we assume that, for each bank-firm relationship, the equilibrium

[3] Italian house prices significantly underperformed the boom-bust cycle occurred, for example, in the US, Spain, the UK or Ireland.

credit flows between year 2006 and any year t can be expressed as:

$$c_{ij} = \alpha + \beta B_j + d_i + \varepsilon_{ij} \tag{1}$$

where c_{ij} is the growth rate of credit granted to firm i by bank j, and B_j is the pre-crisis exposure to the interbank market (measured on December 31^{st} 2006). The firm fixed effect d_i captures all firm observable or unobservable characteristics that may affect the credit relationship. Importantly, it controls for credit demand (Khwaja and Mian 2008).[4]

We estimate model 1 using different time spans (see Table 2). In particular we consider the growth rate of credit granted from 2006 backward until 2002 and forward until 2010. The within-firm specification confirms the graphical result appreciated in Figure 4: before the crisis (columns 1 to 4) the within-firm growth rate of credit was not affected by banks' exposure to interbank funding. Starting in 2007, credit flows for the same firm grew at a lower pace the more the bank was reliant on interbank funding.

In addition, the model allows for a first test of the unconfoundedness of Exposure to credit demand. Indeed, a Hausman test fails to reject the null of orthogonality between the fixed effect and the Exposure variable (the p-value ranges from 0.38 to 0.92, see the last row of Table 2).[5]

Identifying a within-firm effect may not be enough, as firms may substitute the credit contraction from one bank with credit from other banks (Jimenez et al. 2011). For this reason, additional evidence on the role of exposure to interbank market can be obtained from the following firm-level equation:

$$c_i = \bar{\alpha} + \bar{\beta}\bar{B}_i + \gamma d_i + \theta_s + \rho_p + \bar{\varepsilon}_i \tag{2}$$

where c_i is the growth rate of *total* credit granted to firm i, operating in sector s and province p;[6] $\bar{B}_j$ is the weighted average of the initial exposure to the interbank market of banks lending to firm i, with weights equal to their share of credit granted (from now on, "Exposure"); and θ_s and ρ_p are sector and province fixed effects,

[4]The model can only be estimated among those firms that had credit granted from at least two banks at the end of 2006. Khwaja and Mian (2008) derive this empirical specification from a simple model of banking with limited liquidity, assuming firm's credit demand is not bank-specific.

[5]The Hausman test exploits the artificial regression approach developed by Arellano (1993) to allow for heteroskedasticity and serial correlation at the bank level in the error terms.

[6]Notice that the dependent variable may encompass credit from financial intermediaries that were not lending to the firm at the beginning of the period. Hence, $c_i \geq \sum_j c_{ij}$.

respectively. The firm-specific demand shock d_i cannot be directly computed in (2). However, an unbiased estimate can be retrieved from equation (1) (Bonaccorsi and Sette 2012).[7]

We single-out two periods: the pre-crisis period, from December 2002 to December 2006, and the crisis period, from December 2006 to December 2010. For each period separately, we estimate the effect of Exposure measured at the beginning of period on the growth rate of credit granted. The pre-crisis period represents a sort of "placebo" test: we expect initial interbank exposure to have no effects on lending strategies. Conversely, we expect the crisis period to yield a negative and significant effect of $\bar{B}_i$ on c_i, if firms were not able to perfectly substitute credit cuts with new borrowing lines. Consistently with these hypotheses, results in column 9 and 10 of Table 2 show that Exposure in 2002 did not affect the growth rate of credit from 2002 to 2006. However, Exposure in 2006 did have a negative and significant effect on the growth rate of credit: a 1 percentage point increase in the interbank-to-assets ratio reduced credit granted by 0.7 percentage points.

As to our second identification assumption, requiring that pre-crisis Exposure to the shock is uncorrelated with firms' observable and unobservable characteristics, we provide three pieces of supporting evidence. The first is that, as we just discussed, Exposure is not correlated with firm's unobserved heterogeneity in credit growth regressions as (1), where fixed effects are interpreted as capturing firm specific credit demand. Consistently with this fact, Exposure is not correlated with relevant firm's pre-crisis observable characteristics. This is shown in Table 3. In column (1) we focus on the regressors that will be included in the investment equations, including firm size, profitability and liquidity, and the estimated demand for credit (see Section 2.3). Column (2) focuses on other characteristics measuring firms financial health, level of value added or labor costs in 2006 (see the next Section for a detailed description of the data). Similar results are obtained if all controls are included in the model (column 3): none of them is statistically correlated with Exposure. As a third piece of evidence, we focus on an alternative firm-level dataset (the Bank of Italy's Survey of Industrial and Service Firms

[7] An alternative approach is used by Jimenez et al. (2010): they suggest correcting the OLS estimate of $\bar{\beta}$ computed *without* including the firm-specific demand shock in (2) with an estimate of the covariance between B_j and d_i obtained from (1). It is apparent that the two approaches are statistically equivalent: in the remainder of the paper, we follow Bonaccorsi and Sette (2012) and we show among the robustness checks that Jimenez et al. (2010) methodology yields similar results.

- SISF), where investment expectations are directly elicited every year with the questionnaire. As we will detail in section 4.4, bank's pre-crisis Exposure is not significantly correlated with firm's investment expectations elicited immediately before the crisis.

2.3 Empirical model

The availability of bank-firm matched data containing detailed firm balance sheet information allows for a comprehensive assessment of the real impact of bank liquidity shocks (the "bank lending channel", BLC). First, we augment a standard investment equation by including Exposure ($\bar{B}_i$) to obtain a direct estimate of the effect of the bank lending channel on firm's investment (λ):

$$\frac{I_{i,1}}{K_i} = \pi + \lambda \bar{B}_{i,0} + X_i \Phi + \epsilon_{it} \tag{3}$$

where $\frac{I_i}{K_i}$ is the investment rate of firm i over the sample period, and X_i is a matrix of controls which will be detailed below. Importantly, these include the estimated firm-level demand for credit from (1).

We then notice that (3) can be read as the reduced-form expression for a 2-stage approach to estimating the sensitivity of investment to credit growth where Exposure is used as a source of exogenous variation for bank credit (see section 2.2):

$$\frac{I_{i,1}}{K_{i,0}} = \pi + \delta c_{i,1} + X_i \Phi + \epsilon_{it} \tag{4}$$

where c_i, the average growth rate of credit to firm i over the sample period, is instrumented with $\bar{B}_i$. Conditional on the validity of Exposure as an instrumental variable, δ is an unbiased estimate of the sensitivity of firm investment to bank credit.

The vector of firm-level controls X_i include the standard regressors of an investment equation. In the empirical investment literature, a key well-known problem is to control for investment opportunities, typically unobserved. The literature usually circumvents this issue by relying on (a proxy of) Tobin's Q as a sufficient statistic for investment expectations (see Hayashi 1982). But constructing such proxies implies restricting to listed firms which represent less than 1% of firms

in our sample. Moreover, Q-based investment regressions have been increasingly subject to several criticisms.[8]

We address this identification issue in several complementary ways. First, we follow recent studies which proxy investment opportunities by including low order polynomials in variables (sales, size or measures of profitability) that are available for a larger set of firms.[9] Second, we augment the model with an unbiased estimate of firm's demand for credit: the firm fixed effect d_i estimated in (1). This would capture investment opportunities to the extent that they are correlated with firm's demand for credit. Finally, in Section 4.4, we estimate model (4) on a smaller dataset (the Bank of Italy's Survey of Industrial and Service Firms - SISF), which allows us to directly account for firms' self-reported investment prospects (measured in April 2007). While our baseline estimates are very similar to those obtained in the larger sample, they are not affected by the inclusion of the measure of investment prospects (which is, in turn, a relevant predictor of subsequent investment rates).

As in the rest of the relevant literature we focus on credit quantities implicitly assuming this is the relevant dimension of bank credit to look at in an investment regression. While other characteristics of bank credit might in principle be relevant, this assumption seems reasonable if, as suggested by Stiglitz and Weiss (1981), banks are mainly concerned about the consequences of adverse selection that would arise if they chose to, say, raise interest rates or require more collateral rather than cut quantities. Reducing the quantities of loans is also the quickest and most effective way banks have to maintain the desired capital ratio when, as is the case during financial crises, they expect an increase in losses feeding back negatively on capital ratios (Santos, 2011).

[8] See, among others, Fazzari et al. (1988), Bond and Cummins (2000) and Gilchrist et al. (2005)

[9] Gala and Gomes (2013) show that, under very general assumptions about the nature of technology and markets, the optimal investment policy can be written as a function of low order polynomials in few basic state variables that can be more precisely measured at the firm level, such as sales and size. Alternatively, in line with the early neoclassical literature, Asker et al. (2013) rely on lagged sales growth and on a measure of firm profitability (ROA).

3 Data

3.1 Datasets

We build our dataset by matching data from three sources. First we obtain balance sheet information for Italian companies, mostly privately held, from the Company Accounts Data System (CADS). This is a proprietary database, kept by a consortium of Italian banks for credit risk evaluation. The CADS collects detailed balance-sheet information on a large sample of non-financial incorporated firms since 1982. It is used by banks for credit decision and, hence, the data are carefully controlled. In 2006, firms in CADS accounted for more than 75% of total net revenues of Italian incorporated firms. The sample, however, is not randomly drawn, since a firm is observed only if it borrows money from at least one bank.

From CADS we select balance-sheet data from 2006 to 2010 to obtain the main variables we use in our baseline regression (investment, assets, return on assets (ROA)), and other balance-sheet variables that we use in the heterogeneity analysis and for the extensions.

The second source of data is the Italian Credit Register (CR). This database, owned by the Bank of Italy, collects from all intermediaries operating in Italy (banks, other financial intermediaries providing credit, special purpose vehicles) individual data on borrowers with exposures above 75,000 euros towards a single intermediary.[10] The CR contains data on the outstanding bank debt of each borrower, distinguished into loans backed by account receivables, term loans, and revolving credit lines. The CR also contains information about the granting institution and the unique tax identification number of the borrower. The quality of the CR data is ensured by the fact that banks routinely use the CR as a tool to monitor borrowers. We select all credit relationships between banks and firms in each year from 2006 to 2010. We also select data back to 2002 to run the placebo regressions.

The third source of data is the Supervisory Reports submitted by banks to the Bank of Italy. These contain balance-sheet data of all banks operating in Italy, including banks that are not listed on the stock market. From these data we select

[10]Exposures include both debt and guarantees. A borrower with debt of, say, 20,000 euros towards a bank appears in the CR if she also provides guarantees worth at least 55,000 euros to another individual borrowing from the same bank. The 75,000 euros threshold has been lowered to 30,000 euros since January 2009.

interbank borrowing by each bank and total bank assets at December 2006 (at December 2005 for the placebo regression), to construct the interbank to assets ratio, on which we base our instrument for credit growth. We use consolidated data, to exclude interbank transactions made by banks belonging to the same banking group.

3.2 Sample selection

First, we match data on each bank-firm relationship from the CR with data on banks' interbank to asset ratio from the Supervisory Reports using the unique bank identification number ('ABI code'). Then we aggregate data on all loans to each firm from the CR and we match them with firm balance sheet data using firms' unique tax identification number.

We exclude branches of foreign banks since they fund their activity almost exclusively through interbank transactions from the headquarter, and we cannot distinguish true external interbank funding from internal transfer of funds. Branches of foreign banks grant only a small share of total loans to Italian firms (about 6 percent).

To estimate the fixed effects in model (1), we restrict our attention to firms that obtain loans from at least two banks, as in, among others, Khwaja and Mian (2008) and Jimenez et al. (2010). Multiple banking is common in Italy, even among small firms (Detragiache et al. (2000), Gobbi and Sette (2013)).[11] Finally, we include firms that are active in all years from 2006 to 2010, to compute investment over the crisis period. This amounts to excluding firms that disappear from the sample. If the probability of exiting the market is higher for credit constrained firms, our estimates are a lower bound of the full effect of credit availability on investment. Overall, the sample we use in the baseline regression includes 29,132 firms.[12]

Table 1 shows descriptive statistics of the firms included in the sample. The 2007-2010 investment rate is equal to cumulative investments over the 4 years normalized by firm assets.[13] Data indicate that total gross investments over 4

[11] Gobbi and Sette (2013) using a similar sample, find that about 7 percent of the firms in the CADS have only one banking relationships. Such firms are smaller, less leveraged, invest a smaller fraction of their revenues than the average firm.

[12] The inclusion of all firm-level controls additionally excludes 9 firms from the sample, as they did not report complete balance sheet data in CADS.

[13] We trim the top 10% observations, as the book value of capital and investment are extremely noisy, and we want to avoid our results to be driven by outliers. We test the robustness of all results to different

years are, for the median firm, equal to its initial capital. This corresponds to an yearly investment rate of about 25 percent, in line with the evidence from the US and Japan.[14]

Credit growth is the cumulative growth rate of credit granted (commitments) from December 2006 to December 2010.[15] On average, credit granted grew over the period, although almost half of the firms experienced a contraction in credit granted.[16]

All other variables refer to 2006 (end of year data). In particular, the average exposure to the interbank market (interbank funding to bank assets ratio) is around 12 percent. Firms are small (median fixed assets are 2.1 million euros, about 2.7 million US Dollars), and the vast majority of them are not listed (only less than 1 percent are listed on the stock market).

The table also shows the distribution of sampled firms by industry: manufacturing represents more than half of the sample, services about 40, construction about 7 per cent.

Finally, the table shows the distribution of other outcome variables that may be affected by the credit crunch: value added, employment (average number of employees during the year), labor costs, purchase of intermediate inputs, and trade debit and credit. We test the effect of the credit supply shock on these variables in Section 4.5

4 Results

4.1 Reduced form estimates: the BLC and investment

We start by estimating the direct (reduced-form) effect of Exposure on firms' investment. Table 4 reports results for alternative specifications of the reduced-form model (3), each pointing to a negative and significant effect of firms exposure to

trimming thresholds, and to winsorize data instead of trimming, in Section 4.

[14]The investment to asset (book capital) ratio of large Japanese firms in Gan (2007b) is on average 31 percent; that of US Compustat firms used in Almeida and Campello (2007) is around 25-30 percent.

[15]In computing the growth rate of credit, we keep track of existing credit relationships over time even after a bank disappears from the sample due to a merger or an acquisition. In this case, we assume the firm had a relationship with the new bank from the beginning.

[16]Since in our data yearly growth rates of credit granted higher than 10% are widespread, in the baseline specification we compute the actual growth rate for each bank-firm relationship that is present before the crisis. In addition, we have verified that our results are robust even to a log-differences specification. Results are available from the authors upon request.

the credit shock and their investment rate. Column 1 shows estimates from the baseline model without controls. The estimated coefficient implies that a 10 percentage point increase in Exposure induces a fall of slightly more than 10 percent in the cumulated 2007-10 investment rate. Interestingly, the firm fixed effect retrieved from equation (1) has a positive and significant coefficient, consistent with it capturing firm-level demand for credit.

Our estimate of the strength of the BLC does not change when firm-level controls are included in the regression (column 2 to 6), providing support to the hypothesis that Exposure is not correlated with firm characteristics. In Column 2, following Gala and Gomes (2013), we include fixed assets (linear and squared to account for potential non-linearities of the effect of size), the sales to assets ratio, and the investment ratio in 2006, to proxy for investment opportunities. The coefficient of Exposure is still negative and significant at the 5% level: a 10 percentage points increase induces a decrease of the investment-rate by 9% over four years. Column 3 also includes the cash holdings to assets ratio, a commonly used control in investment equations that accounts for credit constraints. The estimate in Column 4 controls for the growth rate of sales, as in a standard investment accelerator-model (Bernanke et al. 1999), while Column 5 adds cash holdings to account for imperfect access to capital markets. Finally, Column 6 proxies Tobin's Q with firm's Returns-On-Assets (ROA), as in Asker et al. (2013). This represents our preferred specification since it is a standard investment equation for unlisted firms, augmented by Exposure and the estimated firm effect.

The estimated impact of the credit shock on investment is not only statistically significant but also economically relevant. It imples that, absent the shock, investment expenditure by firms in the sample would have been 47.8% higher than its actual value in 2007 and 2010.[17]

4.2 IV estimates: the sensitivity of investment to bank credit

We now turn to estimating the sensitivity of the investment rate to the growth rate of bank credit (Table 5). This amounts to using Exposure as an instrument for credit growth, and estimate model (4) via 2SLS, as described in Section 2.3.

[17]This is obtained as follows: for each firm we first compute the predicted drop in investment rates over 2007-10 relative to a scenario in which no crisis occurred ($\delta \times \bar{B}_{i,0}$). We then multiply this by the firm's capital stock measured before the crisis $K_{i,0}$ to obtain the predicted drop in investments for each firm, which is eventually aggregated over the sample and compared to actual investments.

The fairly high first stage F-test statistics reported at the bottom of the table (over 40), suggest that Exposure is a strong instrument for credit growth.

The 2SLS coefficients reported in column 1 and 2 of Table 5 are positive and significant, and point to an economically large effect of credit availability on investment.[18] The only difference between the two columns is the measure of credit we use. In column (1) we use total bank credit (the same variable used for the placebo tests in section 2.2). In column (2), we restrict to the long term component of total credit (i.e. term loans). Term loans include mortgages and leasing, have longer maturities and their dynamics are presumably more directly linked to investment decisions. Total credit, on the other hand, is likely to include loans used to finance other than investment expenditures (e.g. working capital). This difference is likely to explain the different point estimates we obtain in the two cases, which imply that a 10 percentage point decrease in credit growth lowers firms investment rate by 14 and 8 percent, respectively. In terms of standardized effects, however, both exercises yield similar conclusions: lowering credit growth by one standard deviation would reduce the investment rate by around 40% of a standad deviation.

A very similar effect of credit on investment is implied by the coefficient reported in column 3, where we adopt a different approach proposed by Jimenez et al. (2013). They obtain an unbiased estimate of the firm-level ("aggregate") impact of the bank lending channel by computing the covariance between bank-specific credit supply shocks and firm-specific credit demand shocks. Their approach yields an exact estimate of the firm-level credit supply shock. It is reassuring that our estimates are not statistically different from those obtained using their approach, which has the drawback that computing standard errors for the estimated firm-level credit supply shock is not straightforward.

Interestingly, our estimates are larger than those obtained by Amiti and Weinstein (2013) for the case of Japan.[19] These differences can be due to several

[18]The results reported in this and the following tables correspond to the specification used in Column 6 of Table 4). Our findings do not change using the other sets of firm-specific controls experimented in that table).

[19]Comparison of their results with ours is complicated by the fact that Amiti and Weinstein (2013) only report the sensitivity of investment to credit supply shocks interacted with other firm-level variables, such as the loans-to-assets ratio. Using the descriptive statistics of loans-to-assets ratio provided in their paper, the sensitivity to credit supply shocks measured at the mean of the interacting variable is a tiny 0.049, while that measured at the maximum is 0.495.

factors. First, they focus on a sample of listed firms only, while we look at a large pool of mostly small-medium size firms, for which bank credit is more relevant.[20] Second, access to other sources of finance is likely easier in Japan than in Italy, since capital markets are more developed, and firms are larger. If the development of capital markets and the firm size distribution shape the strength of the real effect of the BLC, we should expect a larger impact in countries such as Italy, Spain, or France than in the US, or the UK.

Finally, column 4 reports the OLS estimates of equation (4). Least squares likely produce distorted estimates in this context, but the direction of the bias is a priori ambiguous. If higher investment rates induce higher demand for credit (reverse causality), or if banks prefer to lend to more profitable firms, and this expected profitability is positively correlated with investment (omitted variable bias), the bias would be upwards. In contrast, OLS might under-estimate the true effect if higher loan demand reflect unhealthy firms needing to cushon a fall in revenues. Our findings are clearly consistent with this second hypothesis.[21]

4.3 Heterogeneity

An important question is to what extent the effects we estimate are heterogeneous across firms. Two relevant dimensions of heterogeneity are the capability of firms to substitute bank credit with internal finance and their capability to post collateral to soften the credit crunch (Almeida and Campello 2007, Campello, Graham and Harvey 2010, Sufi 2009). We proxy for the availability of internal finance using firm liquidity holdings (cash holdings over fixed assets) and firm cash-flow (Ebitda over value added). Availability of collateral is proxied by the ratio of tangible to total assets. All these variables are measured in December 2006.

Panel A of Table 6 reports the results for the impact of Exposure on investment, while Panel B focuses on heterogeneity in the sensitivity to credit growth. In both

[20] Consistently, Asker et al (2013) found that listed firms are less responsive to changes in investment opportunities, even during the recent financial crisis.

[21] OLS being downward biased is consistent, for example, with the idea that economic downturns reduce both investment prospect and cash-flows, with more severely affected firms are also requiring more external funding to finance working capital. A downward bias has been detected by the trade literature studying the effects of credit on export (see e.g. Paravisini et al. 2013, Del Prete and Federico 2013). Paravisini et al. (2013) note that "a collapse in the prices and demand for a firm's exports reduces substantially the cash-flows generated by the firm internally through revenues. To substitute for this decline in internally generated cash, firm's demand for external finance increases".

cases, the relevant variable is interacted with a dummy that identifies firms above and below the median of the (conditional) distribution of the three indicators.[22]

Results show that the consequences of the credit shock, and more generally the sensitivity of investment expenditure to credit growth, are more severe for liquidity constrained and less profitable firms. This is consistent with the idea that such firms are less able to substitute bank credit with other sources of finance: because they lack substantial buffers of cash, have less pledgeable collateral, or generate lower cash-flows.

These findings suggest a further extension of the analysis, where we estimate the impact of the credit shock on investment at different time horizons. Figure 5 plots the estimated effects for the two groups of firms with below-median and above-median cash-holdings we used in column 1 of Table 6. We find that the absolute value of the effect for low cash-holding firms increases over time; it is significantly different from zero at the 10% level in 2008 and at the 5% level from 2009 onwards. Conversely, high cash-holding firms do not experiment any drop in investments induced by the credit crunch, neither in the short nor in the medium term.[23]

4.4 Robustness checks

We test the robustness of our results to several checks accounting, in particular, for potentially relevant omitted confounding factors, for firms investment opportunities, and for the role of outliers. The corresponding results are reported in Tables 7-9.[24]

Changes in the baseline specification.

The first column of Table 7 deals with the potential sorting of banks and firms based on banks' Exposure and firms' investment prospects. This may happen if, for instance, larger banks were more exposed to interbank markets and better able to estimate investment opportunities. In this case, our estimates would be biased downwards. To at least partially control for this issue (more on investment

[22] We first regress each of these variables on the baseline set of pre-crisis controls (assets, ROA, sales, and investment rate), to purge the heterogeneity analysis from other possible confounding factors that affect their distribution. The coefficient obtained based on the unconditional distributions would be qualitatively similar, though less precisely estimated.

[23] In this exercise, the firm fixed effect has been estimated separately for each time-horizon.

[24] Unless otherwise indicated, all the subsequent estimate include the same controls as in Column 6 of Table 4. However, results are robust to all the other baseline specifications.

opportunities are reported below) we augment our baseline specification with a set of fixed effects for the main bank lending to the firm. For each borrower, this is defined as the bank with the highest share of lending at the end of 2006. If sorting was a relevant phenomenon, then the inclusion of such controls should significantly change the estimated coefficients. However, the point estimates for both the reduced form and the 2SLS models remain very similar to those of the corresponding baselines, and statistically significant.

In Column 2 we include sector-province fixed effect. This accounts for the plausible possibility that firms belonging to the same sector and located in the same province face similar shocks to demand or opportunities.[25] Even in this case, however, both estimated coefficients remain very similar to the baseline findings.

Column 3 shows that neither result is affected even when accounting for both bank fixed effects and area-industry fixed effects at the same time. Hence, identification arises from comparing firms linked to the same main lender and yet subject to different credit shocks, net of common area-industry counfounds.

Finally, we focus on the issue of measurement of bank exposure to the interbank markets. So far, this was captured by the ratio between average gross interbank liabilities and firm's total assets. Yet, banks may simultaneously borrow and lend on interbank markets, and it is important to test the robustness of our results to using *net* interbank liabilities, normalized by firm's assets, to measure banks' exposure to the shock. Column 4 of Table 7 shows that results are unchanged.

Accounting for investment opportunities.

As in most of the empirical investment literature, our estimates so far do not account for firms investment opportunities. Hence, a bias may emerge if firms pre-crisis opportunities are correlated with interbank funding-to-assets ratio of the banks lending to it. This may happen if, for instance, larger investment opportunities by firms exercise pressure on bank funding. Although in Section 2.1 we have shown that our measure of Exposure is not correlated with firms demand for credit (as proxied by firm fixed effect), more direct evidence that Exposure is not correlated with expected investment opportunities can be provided using the Bank of Italy Survey of Investment of Industrial Firms (INVIND). This is an annual representative survey of medium and large Italian firms from manufactur-

[25] In principle, the additive structure of the province and sector fixed effects in our baseline model may upwardly bias the estimated effect if, for instance, banks that were less exposed to the interbank market were more able to identify sector profitability at the province level.

ing, construction, and private services sectors. It collects information both on the actual level of investments of the year before the survey and on its expected levels at the end of the survey year. Crucially for our analysis, it is administered in April of every year: i.e., for 2007, *before* the onset of the global financial crisis. Hence, we can estimate models (3) and (4) using as a dependent variable the expected growth rate of investments from 2006 to 2007. Results are shown in Table 8. In Column 1, we regress the expected growth rate of investment on Exposure and show that they are not significantly correlated. Second, we replicate our baseline model with INVIND data. Because of imperfect matching between the Credit Register and INVIND, and of panel attrition over the 2006-2010 period, the final dataset is composed of 996 firms (around 1/3 of firms included in INVIND in every year). The result (Column 2) is consistent with our baseline finding: a 1% increase in Exposure reduces the investment rate by 0.8%. The inclusion of investment expectations among the controls (Column 3) increases the precision of the estimate, but does not change significantly the point estimate. Finally, Column 4 performs the 2SLS model to identify the sensitivity of investments to a credit supply shock. The resulting point estimate is less precisely estimated than the one obtained from the full sample. Though the point estimate is smaller, the standardized effect is very similar to the one obtained in Section 4.2: a 1 standard deviation increase in bank credit raises the investment rate by 49% of a standard deviation.

Changes in the sample.

As discussed in Section 3, our dependent variable is trimmed at the top 10% to reduce the influence of outliers. It is therefore important to show that our estimates are not significantly affected by this way of dealing with extreme observations.

The first Column in Table 9 shows results of estimating our baseline model on the 5% trimmed sample. This affects markedly all estimated moments of the distribution of investment rates, whose average reaches 300.9, and standard deviation 874.4: in both cases, a threefold increase relative to the 10% trimmed distribution. Accordingly, the point estimates of both the estimated coefficents (the direct effect of exposure, in Panel A, and the sensitivity of investment to credit, Panel B) are around five times larger than in the corresponding baseline. When evaluating the implied effect of a credit contraction in standardized terms, however, the results are similar to those obtained in Table 5. A 1 standard deviation increase in credit growth raises the investment rate by around half of a standard deviation. Similar

results are obtained if we winsorize the distribution, instead of trimming it, at 5% or 10% (see columns 2 and 3, respectively).

Finally, column 4 shows results obtained by weighting observations by firm sales; that is, giving larger weights to larger firms in the estimate. This may be important as the size distribution of firms in our sample is positively skewed, and the results might therefore be driven by small firms only. Nonetheless, results are robust to this weighting: the coefficient of exposure is still negative and significant (now at the 1% level) and the standardized effect is larger: one standard deviation increase in interbank exposure induces an increase of 4.5% of a standard deviation in the (sales-weighted) investment rate.[26]

4.5 Bank credit and firms activity

Our findings so far indicate that the consequences of credit supply shocks on capital accumulation are relevant, and significantly contributed to explain the large fall in investments observed after the 2007 crisis. We now explore whether the shock had more general consequences on firm activity. To our knowledge, this is still a largely unexplored though very relevant issue.[27]

Our firm balance-sheet data contain information on value added and sales, employment and labor cost, expenditures on intermediate inputs, and trade credit. In Table 10 we report the results obtained estimating the sensitivity of such outcomes to bank credit according to model (4).[28] Identification requires that the credit shock was not related to unobservable firm specific supply or demand shocks.

Our findings suggest that the impact of bank credit on firm's measured output is relevant. According to our estimate in column 1, for example, a 10 percentage point decrease in total credit granted lowers value added by 2.8%. The corresponding (not reported) implied effect for total sales is 1.5%. The fall in output is backed by a significant reduction in production factors. Credit growth significantly

[26] Some 338 firms were excluded from the sample because they did not provide information on investments for some years between 2007 and 2010. In the fourth Column of Panel A we include them and use the average yearly investment rate, instead of the cumulative rate, as our dependent variable. The results strongly indicate that their exclusion does not drive any of our findings

[27] One notable exception is the forthcoming work by Chodorow-Reich (2014), who finds that the shock to bank credit following the Lehman bankruptcy accounts for between one-third and one-half of the employment decline at US small and medium firms in the sample in the following year.

[28] In the case of employment, the data is available for a subsample of 17,486 firms. When replicating all estimates presented below restricting to that subsample we obtained qualitatively and quantitatively similar results (available upon request).

affects the total wage bill and the purchases of intermediate goods and services. Importantly, our estimates imply that a 10 percentage point fall in new credit induces a reduction of employment of nearly 1.4%. Thus, the credit crunch seems to have had an effect also on the overall scale of firm activity.

We then look at the activity of firms as providers of trade credit to customers and receivers of trade credit from suppliers, as part of a credit chain (Kiyotaki and Moore 2004).[29] Evidence that an initial shock to bank credit propagates through the network of inter-firm trade credit would in fact highlight an important amplification mechanism of liquidity shortages. Our estimates, shown in Columns 5 and 6 of Table 10, indicate that firms borrowing from banks that were more affected by the crisis granted less trade credit to their customers. More specifically, they imply that a 10 percentage point decrease in the growth rate of bank credit reduces the growth rate of commercial lending by the firm by 5 percentage points. Conversely, we do not find any significant effect on the amount of trade debit that firms receive.

The negative effect on trade credit is not explained by firm downsizing, that is by a reduction in credit to customers that follows and is proportional to that of sales. This can is shown in Column 7, where we use the growth rate of the trade credit to sales ratio as dependent variable. We still obtaine a significant, albeit lower in magnitude, positive coefficent indicating that a negative credit shock reduces trade credits more than sales.

5 Discussion and related literature

Our findings indicate a large real effect of the bank lending channel: banks pre-crisis exposure to the shock account for more than 40% of the negative trend in investment observed in the sample; the sensitivity of investment to actual bank credit at the firm level is large, ranging from 0.8 to about 1, which imply a one-to-one change of investment to credit. Our sample includes a substantial fraction of SMEs highly bank-dependent for their funding, thus our results may also be regarded as direct estimates of the effects of credit constraints during a crisis. The use of actual credit granted to the firm instead of proxies for credit constraints

[29] See also Garcia-Appendini and Montoriol-Garriga (2013) for evidence on the effect of the 2007-2008 crisis on trade credit.

represents an important contribution of our paper.

Our work complements and extends the large, and growing, literature on the bank lending channel which is mainly concerned on the effects of shocks to bank balance sheets on the supply of credit. Khwaja and Mian (2008) pioneered the identification strategy we build on in our paper. Jimenez et al (2010) and (2013) provide important results on the magnitude of the bank lending channel using credit registry data. Ivashina and Scharfstein (2010) provide first evidence on the impact of the 2007-2008 financial crisis on bank lending in the US, using syndicated loan data. Our work is especially close to Iyer et al. (2013) who use the exposure to interbank funding as a measure of banks' exposure to the 2007-2008 financial crisis. They look at the effect of the shock on bank credit. We extend the analysis one step further by looking at firm-level real outcomes, especially investment which is key to understand the transmission of the financial shock to the real economy.

Our results are also close to the findings of the contemporaneous work of Amiti and Weinstein (2013). They develop a methodology for decomposing credit flows into supply and demand shocks. They use a sample of listed Japanese companies and find that bank supply shocks explain 40 percent of aggregate loan and investment fluctuations. We complement their findings in several directions. First, we use a shock to the banking system that is free of confounding effects, such as the contemporaneous burst of the real estate bubble in the case of Japan. Second, our sample includes both large and small firms, many of them unlisted, and it is therefore more representative of the typical developed economy. Third, we look at a broader set of key firm outcome variables, such as sales, labor, trade credit, which are important to understand the full impact of the bank lending channel on firms' activity. In this respect, we also relate to a few other works studying the impact of the 2007-2008 crisis on employment. Chodorow - Reich (2013) shows that firms that had a credit relationship in the syndicated loan market with less healthy banks received less credit at higher rates and reduced employment by more compared to firms borrowing from healthier lenders. Bentolila et al. (2013) document a similar effect on Spanish firms, using actual bank-firm credit relationships from Credit Register data similar to ours.

Other closely related works are Gan (2007a) and (2007b). She studies the impact of the early 1990s burst of a real estate bubble in Japan on bank credit and on investment. Gan finds that firms borrowing from banks more exposed to

the real estate market invested less. We extend her results in three ways: first, we can explicitly control for firm's credit demand; second, we derive the sensitivity of investment to credit, and not only the reduced form estimate of the exposure to the crisis on investment; third, and more importantly, the Japanese real estate bubble used by Gan may be affecting directly both bank's liquidity *and* firms' collateral, in this way mixing the bank lending with the collateral channel (Chaney et al. 2012).

Our findings also contribute to the growing literature on the real effects of financial crises, and to that on the effects of financing constraints on investment. A key problem of these literatures is the identification of credit constrained firms. From the seminal paper of Fazzari et al. (1988), different works propose alternative proxies for financial constraints, and ways to address the endogeneity of the measures of financial constraints. A key tenet of the approach of Fazzari et al. is that the sensitivity of investment to internal finance is larger for more credit constrained firms. Kaplan and Zingales (1997) argue that this monotonicty is not a necessary feature of investment by credit constrained firms. Several subsequent work (among others Lamont (1997), and Almeida and Campello (2007)) attempt to make progress to find measures of credit constraints. Paper focusing on financial crises have identified credit constrained firms on the basis of ex-ante indicators, such as self-assessment from survey data (as in Campello et al. 2010 and Gaiotti (2013)), through proxies such as cash-flow and liquidity measures (as in Duchin et al. 2010, among others)) or through the absence of public debt rating (Chava and Purnanandam 2011) and their performance is compared to that of unconstrained firms during the crisis.[30] Yet, recent work by Farre-Mensa and Ljungqvist (2013) show that the most popular measure used to identify constrained firms actually measure mostly firm size and firm age. Moreover, these measures may be correlated with firm unobservables.

Our work extends the findings of these literatures in several dimensions. First, we directly observe bank credit granted to firms. Hence, we can directly observe which firms got restricted access to credit. Importantly, this also allows us to directly test the effect of the BLC on investment. Second, we identify a proxy for exposure to the credit crunch that is not correlated with firms' characteristics

[30]Usually, these empirical exercises are corroborated by testing whether the two groups of firms displayed the same trend before the financial shock.

(which are likely endogenous to investment opportunities). Indeed, while during periods of positive economic growth the general improvement in borrowers' and lenders' balance sheets may blur the difference between credit constrained and unconstrained firms, during crises the latter may outperform the former simply because the fall in demand affects more the worse-off firms. Finally, we complement the findings on investment by also looking at other key firm outcome variables. One important insight from this extension is the potential for amplification effects of the initial shock, effectst an credit supply shocks reduce the ability of firms to provide trade credit to other firms.

6 Conclusions

In this paper we provide new evidence on the effect of the 2007-2008 credit crunch on firms' investment rate over 2007-2010 period. We use a large sample of Italian firms, for which we observe both bank-firm relationships and balance sheets data before and during the economic downturn. For each firm in our sample, we proxy the exposure to a negative credit supply shock during the crisis with the pre-crisis average reliance on interbank funding of the banks lending to the firm. Average reliance on interbank funding significantly predicts both a drop in credit granted and a sizeable fall in the investment rate. The latter effect is stronger for firms that were ex-ante more likely to be credit constrained, as measured by pre-crisis cash-holdings over assets, tangible-to-total assets, and EBITDA-to-value added ratios.

We then use interbank exposure to instrument the growth rate of credit granted, and estimate the sensitivity of investment to bank credit. We show that the credit crunch had a causal effect not only on investment but also on sales, labor, purchases of intermediate inputs. This provides evidence of firm downsizing over the medium term in response to the credit crunch. Finally, We also find that firms that experienced a larger credit shock reduced their supply of trade credit. This suggests that the credit crunch has been amplified through firms credit chain.

7 References

Affinito, M. (2012), Do interbank customer relationships exist? And how did they function in the crisis? Learning from Italy, Journal of Banking and Finance, 36(12), 3163-3184.

Almeida, H. and M. Campello (2007), Financial constraints, asset tangibility, and corporate investments. The Review of Financial Studies, 20(5), 1429-1460.

Almeida, H., Campello, M., Laranjeira, B. and S. Weisbenner, Corporate Debt Maturity and the Real Effects of the 2007 Credit Crisis. Critical Finance Review 1.1, 3-58.

Amiti, M and D. Weinstein (2013), How Much do Bank Shocks Affect Investment? Evidence from Matched Bank-Firm Loan Data, NBER Working Papers 18890.

Angelini, P., A. Nobili, and C. Picillo (2011), The interbank market after August 2007: what has changed, and why?, Journal of Money, Credit and Banking, 43(5), 923-958.

Arellano, M. (1993), On the testing of correlated effects with panel data, Journal of Econometrics, 59(1-2), 87-97.

Asker, J., J. Farre-Mensa, and A. Ljungqvist (2013), Corporate investments and stock market listing: a puzzle?, ECGI - Finance Working Paper.

Bank of Italy (2009), Annual report, Rome, Italy.

Bentolila, S., M. Jansen, G. Jimenez, and S. Ruano (2013), When Credit Dries Up:Job Losses in the Great Recession, mimeo, Bank of Spain. Bernanke, B.S. (2007), Global imbalances: recent developments and prospects. Bundesbank Lecture. Berlin, Germany.

Bernanke, B.S. and M.L. Gertler (1995), Inside the black box: the credit channel of monetary policy transmission. Journal of Economic Perspectives, 9(4), 27-48.

Bernanke, B.S., and M.L. Gertler, and S. Gilchrist (1999), The financial accelerator in a quantitative business cycle framework, Handbook of Macroeconomics, 1(C), 1341-1393.

Bonaccorsi, E. and E. Sette (2012), Bank balance sheets and the transmission of financial shocks to borrowers: Evidence from the 2007-2008 crisis. Bank of Italy Working Papers, No. 848.

Brunetti, C., M. di Filippo, and J.H. Harris (2011), Effects of central bank intervention on the interbank market during the subprime crisis, Review of Financial Studies, 24(6), 2053-2083.

Brunnermeier, M. (2009), Deciphering the Liquidity and Credit Crunch 2007-2008, Journal of Economic Perspectives, vol. 23(1), pages 77-100, Winter.

Campello, M., JR Graham, and CR Harvey (2010), The real effects of financial constraints: Evidence from a financial crisis. Journal of Financial Economics, 97(3), 470-487.

Chaney, T., Sraer, D., and D. Thesmar (2012), The Collateral Channel: How Real Estate Shocks affect Corporate Investment, American Economic Review 102, 6: 2381-2409.

Chava, S. and A. Purnanandam (2011), The effect of banking crisis on bank-dependent borrowers, Journal of Financial Economics, 99, 1, 116-135.

Chodorow - Reich, G. (2013), The employment effects if credit market disruptions: firm-level evidence from the 2008-09 financial crisis, Quarterly Journal of economics, forthcoming.

Del Prete, S. and S. Federico (2013), Trade and finance: is there more than

just “trade finance”? Evidence from matched bank-firm data, mimeo.

Detragiache, E., P. Garella, and L. Guiso (2000), Multiple versus single bank relationships: theory and evidence. Journal of Finance, 55(3), 1133-1161.

Duchin, R., Ozbas, O. and B. Sensoy, (2010), Costly External Finance, Corporate Investment, and the Subprime Mortgage Credit Crisis, Journal of Financial Economics 97, 418-435 (2010)

Fazzari, S., Hubbard, G. and B. PETERSEN (1988), Financing Constraints and Corporate Investment, Brookings Papers on Economic Activity, Economic Studies Program, The Brookings Institution, vol. 19(1), pages 141-206.

Farre-Mensa, J. and A. Ljungqvist (2013), Do measures of financial constraints measure financial constraints?, NBER Working Paper Series, No. 19551.

Gaiotti, E. (2013), Credit availability and investment: lessons from the great recession, European Economic Review, 59,

Gala, V. and J.F. Gomes (2013), Beyond q: investments without asset prices, AFA 2013 San Diego Meetings Paper.

Gan, J. (2007a), Collateral, debt capacity, and corporate investments: Evidence from a natural experiment. Journal of Financial Economics, 85(3), 709-734.

Gan, J. (2007b), The Real Effects of Asset Market Bubbles: Loan- and Firm-Level Evidence of a Lending Channel. Review of Financial Studies 20, 1941-1973.

Garcia-Appendini, E. and J. Montoriol-Garriga (2013), Firms as liquidity providers: Evidence from the 2007-2008 financial crisis, Journal of Financial Economics, 109(1), 272-291.

Gobbi, G. and E. Sette (2012), Relationship lending in a financial turmoil, Mo.Fi.R. Working Paper, No. 59.

Holmstrom, B. and J. Tirole (1997), Financial intermediation, loanable funds, and the real sector. Quarterly Journal of Economics, 112(3), 663-691.

Iyer, R., S. Lopes, JL Peydrò, and A. Schoar (2013), Interbank liquidity crunch and the firm credit crunch: Evidence from the 2007-2009 crisis, Review of Financial Studies, forthcoming.

Jimenez, G., A. Mian, JL Peydrò, and J. Saurina (2010), Local versus aggregate lending channels: The effects of securitization on corporate credit supply in Spain. NBER Working Papers, No. 16595.

Jimenez, G., S. Ongena, and J. Saurina (2013), Hazardous times for monetary policy: what do 23 million loans say about the impact of monetary policy on credit risk-taking?, Econometrica, forthcoming.

Kapan, T. and C. Minoiu (2013), Balance sheet strength and bank lending during the global financial crisis, IMF Working Papers, No. 13/102.

Kaplan, S. and L. Zingales (1997), Do Investment-Cash Flow Sensitivities Provide Useful Measures of Financing Constraints?, The Quarterly Journal of Economics, 112 (1): 169-215.

Kashyap, A.K. and J.C. Stein (2000), What do a million observations on banks say about the transmission of monetary policy?, American Economic Review, 90(3), 407-428.

Khwaja, AJ and A. Mian (2008), Tracing the impact of bank liquidity shocks: Evidence from an emerging market. American Economic Review, 98(4), 1413-1442.

Kiyotaki N. and J. Moore (2004), Credit chains. ESE Discussion Papers, 2004-03.

Lamont, O. (1997), Cash flow and investment: Evidence from internal capital markets. Journal of Finance, 52, 83-109.

Nobili, A. and F. Zollino (2012), A structural model for the housing and credit markets in Italy, Bank of Italy Working Papers, No. 887.

Paravisini, D., V. Rappoport, , P. Schnabl, D. Wolfenzon (2013), Dissecting the Effect of Credit Supply on Trade: Evidence from Matched Credit-Export Data, Review of Economic Studies, Forthcoming.

8 Figures and Tables

Figure 1: Growth of credit to the private sector and of GDP in Italy

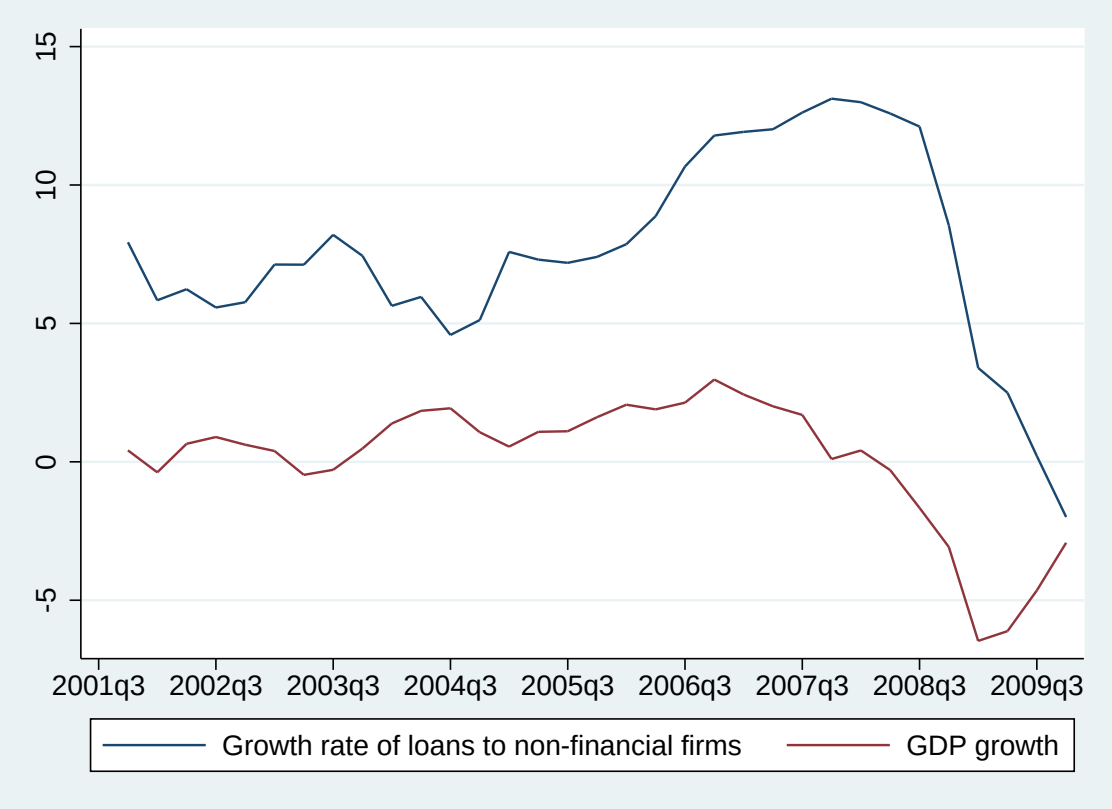

Figure 2: Total interbank deposits of Italian banks (e-MID market) in constant 2005 euros

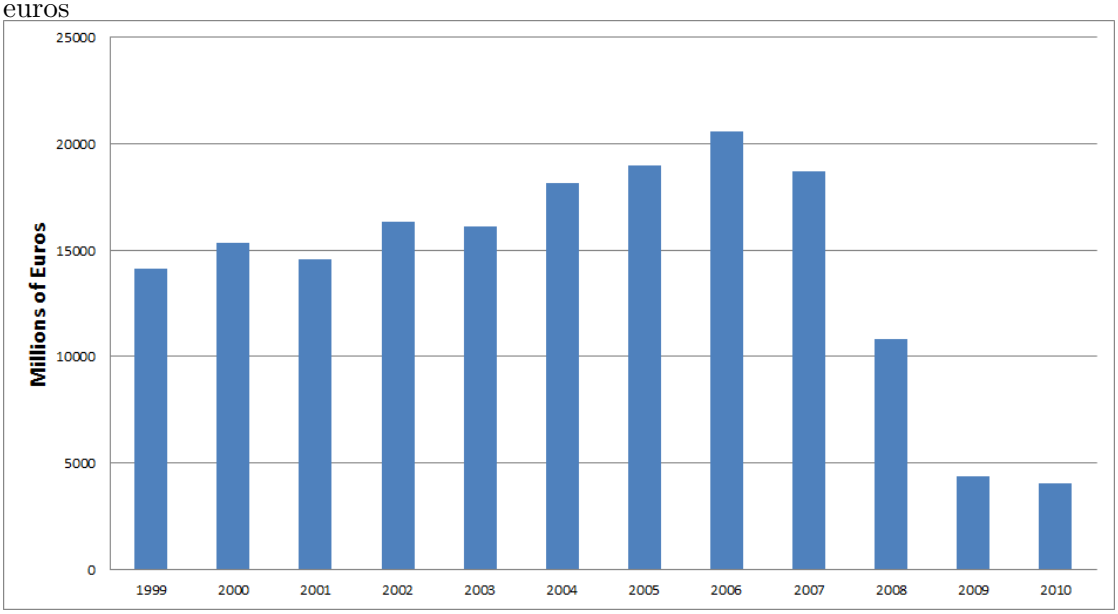

Figure 3: Euribor-Eurepo spread

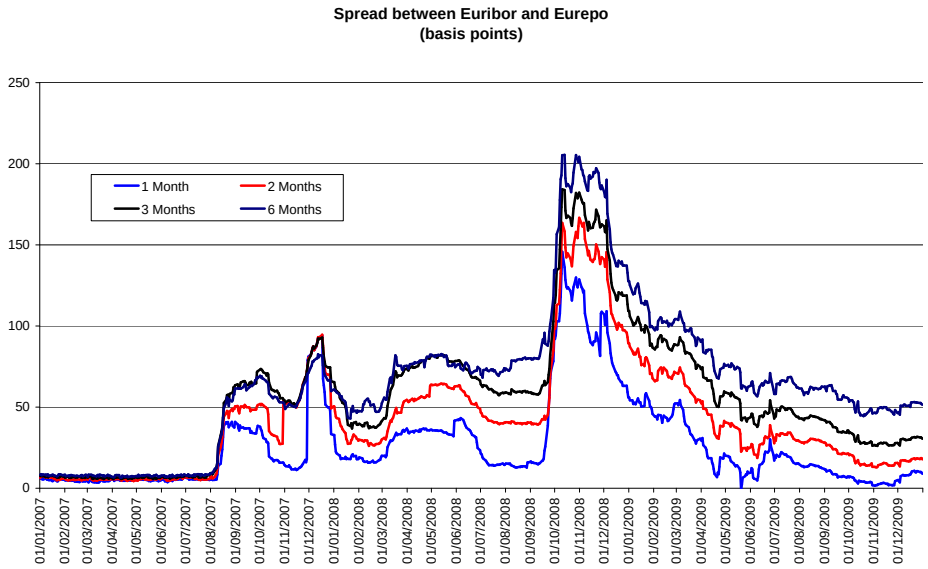

Figure 4: Growth of credit granted by banks above and below median interbank/asset ratio

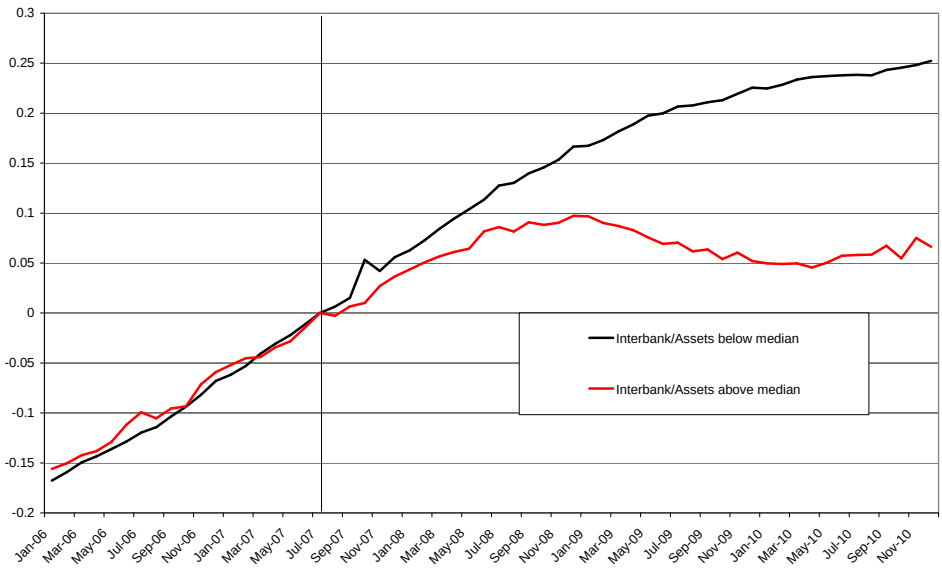

Figure 5: Effect of average exposure to the interbank market on growth rate of gross capital overtime - for firms with below-media and above-median cash-holdings-to-assets ratio (solid and dashed lines, respectively).

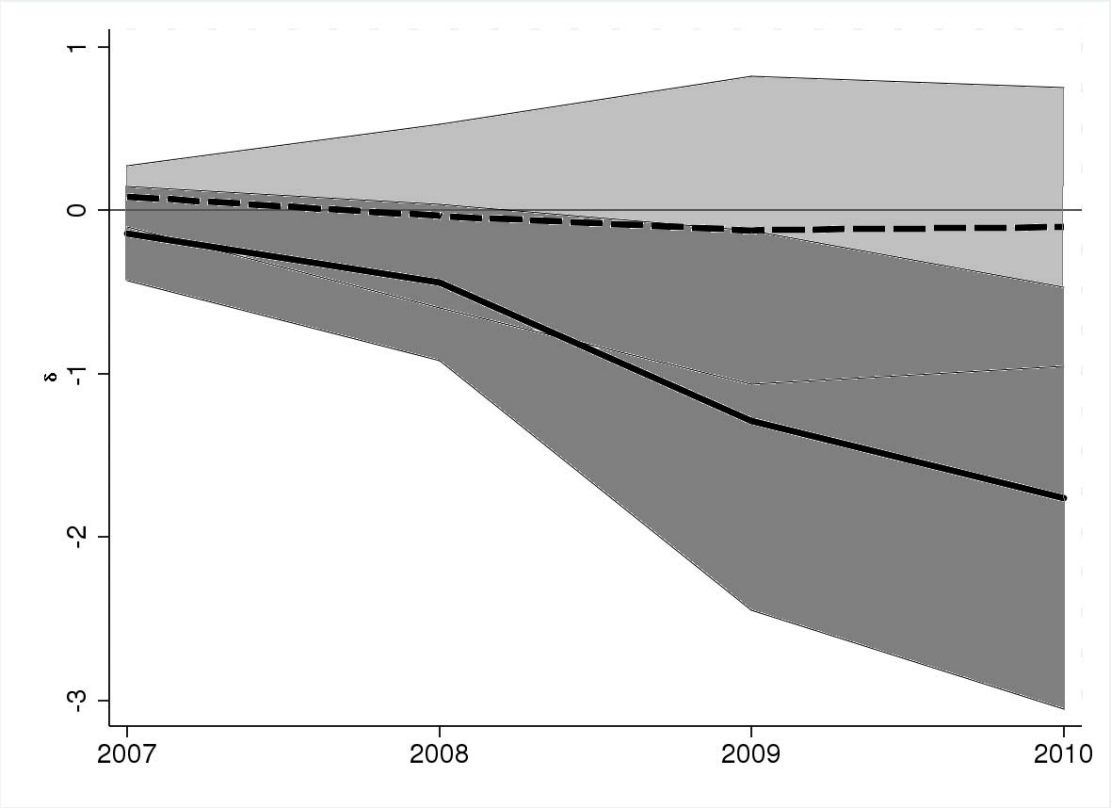

Table 1: Descriptive Statistics

	Mean	St.Dev.	Min	Max	Obs.
Investment Rate (%)	98.30	199.63	-99.40	1382.13	29123
Credit Growth (%)	6.78	51.61	-100	180.68	28227
Avg. Exposure to the Interbank Market (%)	11.83	3.41	.003	55.63	29123
Fixed Assets (000)	24985.63	804586.70	0	105902600	29123
ROA	6.15	7.05	-26.59	40.28	29123
Cash Holdings/Assets	1.57	12.27	0	305.09	29123
Sales/Assets	40.80	265.12	0	5881	29123
Investment Rate 2006	163.93	1019.25	0	12225	29123
Construction	.07	.26	0	1	28693
Tertiary	.39	.49	0	1	28693
Material/Assets	.81	.32	0	1	29123
EBITDA/VA	.40	2.76	-139	240.06	29113
Growth Rate of Long-Term Credit (%)	26.32	108.72	-100	506.52	25414
Growth Rate of Value Added (%)	3.39	43.55	-99.99	135.12	
Growth Rate of Employees (%)	-2.82	23.13	-99.23	46.06	
Growth Rate of Labor Cost (%)	10.16	34.64	-99.98	105.28	27193
Growth Rate of Intermediate Exp. (%)	-6.99	34.51	-99.92	81.32	27009
Growth Rate of Sales (%)	-6.59	35.83	-1553.12	77.91	27530
Growth Rate of Trade Credits (%)	2.87	46.45	-99.99	146.03	25709
Growth Rate of Trade Debits (%)	-2.95	44.45	-99.96	129.31	25634

Table 2: Effect of Banks' Exposure to the Interbank Market on the Growth Rate of Credit Granted, Before and During the Crisis

	(1) 2002	(2) 2003	(3) 2004	(4) 2005	(5) 2007	(6) 2008	(7) 2009	(8) 2010	(9) 2002-2006	(10) 2006-2010
Bank Exposure in 2006 (bank level)	-0.130	-0.127	-0.056	0.055	-0.309**	-0.625***	-0.295***	-0.679***		
	(0.240)	(0.219)	(0.182)	(0.089)	(0.131)	(0.163)	(0.101)	(0.121)		
Avg. Bank Exposure in 2002 (firm level)									-0.122	
									(0.130)	
Avg. Bank Exposure in 2006 (firm level)										-0.703***
										(0.123)
Firm Fixed-Effect	Y	Y	Y	Y	Y	Y	Y	Y	0.913***	0.880***
									(0.012)	(0.011)
Sector FE	N	N	N	N	N	N	N	N	Y	Y
Province FE	N	N	N	N	N	N	N	N	Y	Y
No. of Obs.	149972	161892	173500	187570	230189	223537	221283	221525	40964	31602
Hausman test - p-value	0.74	0.38	0.92	0.55	0.39	0.40	0.51	0.36		

Notes: The dependent variable in columns 1-8 is the credit growth between each year and year 2006. The dependent variable in columns 9-10 are the credit growth in period 2002-2006 and 2006-2010, respectively. Credit growth is measured as percentage change in total credit granted (credit commitments) within a bank-firm relationship. Bank Exposure is the ratio of interbank funding to total assets at the bank-level. Average Bank Exposure is the firm-level average of Bank Exposure weighted by the share of total credit granted to the firm by each bank. Data are from the Italian Credit Register. Heteroskedasticity robust standard errors clustered at the bank level (columns 1-8) and at the main bank and sector levels (column 9-10) in parentheses with *** p<0.01, ** p<0.05, * p<0.1.

Table 3: Unconfoundedness of Avg. Bank Exposure in 2006 with respect to firm-level variables.

	(1)	(2)	(3)
Firm FE	-0.001		0.002
	(0.006)		(0.008)
Fixed Assets	0.000		-0.001
	(0.000)		(0.001)
Sales/Assets	-0.001		-0.001
	(0.001)		(0.001)
ROA	-0.000		0.000
	(0.000)		(0.000)
Sales Growth Rate	0.000		0.000
	(0.000)		(0.000)
Cash Holds/Assets	0.007		0.012
	(0.023)		(0.037)
Invest. Rate 2006	-0.000		0.000
	(0.000)		(0.001)
Employees		0.001	0.002
		(0.001)	(0.001)
Labour Cost		0.000	0.000
		(0.000)	(0.000)
Value Added		-0.000	-0.000
		(0.000)	(0.000)
Degree of Self-Financing		-0.000	-0.000
		(0.000)	(0.000)
Short term indebtedness		0.000	0.000
		(0.000)	(0.000)
Profitability (EBITDA/VA)		0.075	0.076
		(0.075)	(0.076)
No. of Obs.	28912	25225	25048

Notes: The dependent variable is the average interbank exposure at firm level in 2006. Average Bank Exposure is the firm-level average of the ratio of interbank funding to total assets of each bank lending to the firm weighted by the share of total credit granted to the firm by each bank, computed in 2006. Data are from the Italian Credit Register and from the Company Accounts Data System. Heteroskedasticity robust standard errors clustered at the main bank and sector levels in parentheses with *** p<0.01, ** p<0.05, * p<0.1.

Table 4: Effect of Banks' Exposure to the Interbank Market on the 2007-2010 Investment Rate

	(1)	(2)	(3)	(4)	(5)	(6)
Exposure	-1.054**	-0.919**	-0.909**	-1.173***	-1.120***	-0.998**
	(0.485)	(0.428)	(0.449)	(0.436)	(0.421)	(0.432)
	[0.487]	[0.431]	[0.452]	[0.439]	[0.423]	[0.434]
Firm Fixed-Effect	0.355***	0.383***	0.384***	0.331***	0.362***	0.364***
	(0.036)	(0.031)	(0.030)	(0.035)	(0.030)	(0.030)
	[0.080]	[0.072]	[0.072]	[0.080]	[0.073]	[0.073]
Fixed Assets		-0.017**	-0.024***			-0.023***
		(0.007)	(0.008)			(0.008)
		[0.007]	[0.008]			[0.008]
Fixed Assets Sq.		0.000**	0.000***			0.000***
		(0.000)	(0.000)			(0.000)
		[0.000]	[0.000]			[0.000]
Sales/Assets		0.696***	0.105***			0.106***
		(0.096)	(0.023)			(0.023)
		[0.096]	[0.023]			[0.023]
Sales/Assets Sq.		-0.000***				
		(0.000)				
		[0.000]				
Invest Rate 2006		0.008***	0.010***			0.010***
		(0.001)	(0.001)			(0.001)
		[0.001]	[0.001]			[0.001]
Cash Holds/Assets			1.416***		2.965***	1.391***
			(0.252)		(0.412)	(0.246)
			[0.253]		[0.413]	[0.247]
Sales Growth Rate				-0.000	-0.000	
				(0.000)	(0.000)	
				[0.000]	[0.000]	
ROA				1.444***	1.347***	1.359***
				(0.156)	(0.169)	(0.175)
				[0.157]	[0.170]	[0.176]
Sector FE	Y	Y	Y	Y	Y	Y
Province FE	Y	Y	Y	Y	Y	
No. of Obs.	29132	29123	29123	28946	28946	29123

Notes: The dependent variable is the gross growth rate of capital between 2006 and 2010. Exposure is the firm-level average of the ratio of interbank funding to total assets of each bank lending to the firm weighted by the share of total credit granted to the firm by each bank, computed in 2006. Data are from the Italian Credit Register, from Supervisory Reports, and from the Company Accounts Data System. Heteroskedasticity robust standard errors clustered at the main bank and sector levels in parentheses with *** p<0.01, ** p<0.05, * p<0.1. Bootstrapped standard errors based on 200 replications in brackets.

Table 5: OLS and IV Estimates of the Effect of a Shock to the Growth Rate of Credit Granted on the 2007-2010 Investment Rate

	(1) IV	(2) IV	(3) IV	(4) OLS
Credit Growth	1.426**			0.506***
	(0.559)			(0.038)
Long-Term Credit Growth		0.781***		
		(0.276)		
Jimenez et al. (2010) Instrument			1.602**	
			(0.784)	
Controls	Y	Y	Y	Y
Sector FE	Y	Y	Y	Y
Province FE	Y	Y	Y	Y
No. of Obs	28218	25398	28218	28218
F-test on Excl. Instrument	43.966	55.889		
Std. Effect	0.376	0.437	0.423	0.133

Notes: The dependent variable is the gross growth rate of capital between 2006 and 2010. Credit Growth is the percentage change in total credit granted (credit commitments) to each firm between 2006 and 2010. Exposure is the firm-level average of the ratio of interbank funding to total assets of each bank lending to the firm weighted by the share of total credit granted to the firm by each bank, computed in 2006. Data are from the Italian Credit Register, from Supervisory Reports, and from the Company Accounts Data System. Controls include fixed assets, squared fixed assets, ROA, cash-holdings over assets, sales over assets, and the investment rate, all measured in 2006. Heteroskedasticity robust standard errors clustered at the main bank and sector levels in parentheses with *** p<0.01, ** p<0.05, * p<0.1.

Table 6: Heterogeneity in the Effect of Banks' Exposure and Credit Growth on the Investment Rate

	(1) by Cash Holdings/Assets	(2) by Material As./Assets	(3) by EBITDA/VA
Panel A: Effect of Exposure			
On Below Median Firms	-1.779**	-1.420**	-1.544***
	(0.696)	(0.663)	(0.405)
On Above Median Firms	-0.147	-0.298	-0.561
	(0.454)	(0.445)	(0.553)
Panel B: Effect of Credit Growth			
On Below Median Firms	2.060**	2.512**	2.025***
	(0.932)	(1.224)	(0.424)
On Above Median Firms	0.369	0.630	0.993
	(0.691)	(0.492)	(0.822)
Std. Effect - Below Median	0.467	0.500	0.518
Std. Effect - Above Median	0.121	0.339	0.270
Controls	Y	Y	Y
Sector FE	Y	Y	Y
Province FE	Y	Y	Y
No. of Obs.	28218	28218	28208

Notes: The dependent variable is the gross growth rate of capital between 2006 and 2010. Credit Growth is the percentage change in total credit granted (credit commitments) to each firm between 2006 and 2010. Exposure is the firm-level average of the ratio of interbank funding to total assets of each bank lending to the firm weighted by the share of total credit granted to the firm by each bank, computed in 2006. Data are from the Italian Credit Register, from Supervisory Reports, and from the Company Accounts Data System. Medians in columns 2, 3, and 4 are calculated on the distribution of the residuals of the specified variable, after regressing it on fixed assets, squared fixed assets, ROA, sales over assets, and the investment rate, all measured in 2006. Controls include fixed assets, squared fixed assets, ROA, cash-holdings over assets (except in column 2), sales over assets, and the investment rate, all measured in 2006. Bootstrapped standard errors based on 200 replications in parentheses with *** p<0.01, ** p<0.05, * p<0.1.

Table 7: Robustness Checks for the Effect of Exposure and of Credit Growth on Investment Rate

	(1) Sector-Province FE	(2) Main Bank FE	(3) Sec-Prov-Main Bank FE	(4) Net Interbank Exposition
Panel A: Effect of Exposure				
Exposure	-1.043*	-1.132**	-1.045**	-1.254***
	(0.549)	(0.562)	(0.417)	(0.278)
Panel B: Effect of Credit Growth				
Credit Growth	1.555***	1.524**	1.342***	2.003***
	(0.564)	(0.604)	(0.520)	(0.654)
Std. Effect	0.410	0.402	0.354	0.529
Controls	Y	Y	Y	Y
Sector FE	N	Y	Y	Y
Province FE	N	Y	Y	Y
Sector-Province FE	Y	N	N	N
No. of Obs.	28218	28218	28218	28218

Notes: The dependent variable is the gross growth rate of capital between 2006 and 2010. Credit Growth is the percentage change in total credit granted (credit commitments) to each firm between 2006 and 2010. Exposure is the firm-level average of the ratio of interbank funding to total assets of each bank lending to the firm weighted by the share of total credit granted to the firm by each bank, computed in 2006. Data are from the Italian Credit Register, from Supervisory Reports, and from the Company Accounts Data System. Controls include fixed assets, squared fixed assets, ROA, cash-holdings over assets, sales over assets, and the investment rate, all measured in 2006. Heteroskedasticity robust standard errors clustered at the main bank and sector levels in parentheses with *** p<0.01, ** p<0.05, * p<0.1.

Table 8: Estimate of the Effect of the Credit Crunch on the 2007-2010 Investment Rate Controlling for Investment Expectations

	(1) Expected Growth Rate of Investments (%)	(2) Growth Rate of Gross Capital	(3)	(4)
	OLS	OLS	OLS	IV
Exposure	0.245	-0.851*	-0.897**	
	(0.907)	(0.470)	(0.384)	
Exp. Growth of Inv. (%)			0.050***	0.036***
			(0.015)	(0.010)
Credit Growth				0.873*
				(0.480)
Controls	Y	Y	Y	Y
Sector FE	Y	Y	Y	Y
Province FE	Y	Y	Y	Y
N	952	996	952	952
F-test on Excl. Instrument				20.05
Std. Effect		-0.030	-.031	0.510

Notes: The dependent variable in (1) is the expected growth rate of investment between 2006 and 2007; the dependent variable in (2) to (4) is the growth rate of gross capital between 2006 and 2010. Credit Growth is the percentage change in total credit granted (credit commitments) to each firm between 2006 and 2010. Exposure is the firm-level average of the ratio of interbank funding to total assets of each bank lending to the firm weighted by the share of total credit granted to the firm by each bank, computed in 2006. Data are from the Italian Credit Register, from Supervisory Reports, and from the Survey of Investment by XXX. Controls include fixed assets, squared fixed assets, ROA, cash-holdings over assets, sales over assets, and the investment rate, all measured in 2006. Heteroskedasticity robust standard errors clustered at the main bank and sector levels in parentheses with *** p<0.01, ** p<0.05, * p<0.1.

Table 9: Robustness Checks on the Dependent Variable

	(1) Trimming at 5%	(2) Winsorizing at 5%	(3) Winsorizing at 10%	(4) Weighted by Sales
Panel A: Effect of Exposure				
Exposure	-5.164***	-6.722**	-3.062***	-1.683***
	(1.637)	(3.182)	(1.118)	(0.489)
Panel B: Effect of Credit Growth				
Credit Growth	6.695***	9.077**	4.234***	1.995**
	(1.720)	(3.930)	(1.148)	(0.951)
Std. Effect	0.470	0.327	0.509	0.526
Controls	Y	Y	Y	Y
Sector FE	Y	Y	Y	Y
Province FE	Y	Y	Y	Y
No. of Obs.	28218	28218	28218	28218

Notes: The dependent variable is the gross growth rate of capital between 2006 and 2010. Credit Growth is the percentage change in total credit granted (credit commitments) to each firm between 2006 and 2010. Exposure is the firm-level average of the ratio of interbank funding to total assets of each bank lending to the firm weighted by the share of total credit granted to the firm by each bank, computed in 2006. Data are from the Italian Credit Register, from Supervisory Reports, and from the Company Accounts Data System. Controls include fixed assets, squared fixed assets, ROA, cash-holdings over assets, sales over assets, and the investment rate, all measured in 2006. Heteroskedasticity robust standard errors clustered at the main bank and sector levels in parentheses with *** p<0.01, ** p<0.05, * p<0.1.

Table 10: IV estimates of the Effect of a Shock to the Growth Rate of Credit Granted on Additional Variables - Year 2010

	(1) Value Added	(2) Employment	(3) Labor Cost	(4) Intermediate Expenditures	(5) Trade Credits	(6) Trade Debits	(7) Growth of Trade Credits over Sales
Credit Growth	0.284***	0.135***	0.156***	0.112*	0.496***	0.182	0.214**
	(0.073)	(0.051)	(0.039)	(0.064)	(0.062)	(0.159)	(0.091)
Controls	Y	Y	Y	Y	Y	Y	Y
Sector FE	Y	Y	Y	Y	Y	Y	Y
Province FE	Y	Y	Y	Y	Y	Y	Y
No. of Obs.	28066	17486	28976	27637	27522	25359	
F-test on Excl. Instrument	120.979	79.338	99.813	88.913	142.388	86.620	145.041

Notes: Credit Growth is the percentage change in total credit granted (credit commitments) to each firm between 2006 and 2010. Data are from the Italian Credit Register, from Supervisory Reports, and from the Company Accounts Data System. Controls include fixed assets, squared fixed assets, ROA, cash-holdings over assets, sales over assets, and the investment rate, all measured in 2006. Heteroskedasticity robust standard errors clustered at the main bank and sector levels in parentheses with *** p<0.01, ** p<0.05, * p<0.1.