Bank Lending Standards and Credit to Firms during the Great Recession *

Lorenzo Ricci
European Stability Mechanism

Giovanni Soggia
Bank of Italy

Lorenzo Trimarchi
ULB and ECARES

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Abstract

This paper investigates the impact of unforeseen shifts in lending standards on firm credit in Italy on the onset of the Great Recession, using data from the Regional Bank Lending Survey (RBLS) to disentangle the effects of loan supply and demand. We combine our measure of change in bank supply with bank-firm loans retrieved from credit register. Our proposed methodology presents several benefits: it allows us to (i) estimate the impact of credit supply in the absence of an exogenous shock to banks, (ii) analyze credit policy throughout the sample period, and (iii) disentangle the effect of geographical heterogeneity within Italy using the rich information from our survey data. We find that a firm with a revocable credit line from a bank that tightens its lending standards suffers a reduction in credit growth of 0.43 percentage points more than if it had borrowed from a bank with unchanged lending standard. This effect differs significantly across sectors and geographic areas.

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1 Introduction

Following the sub-prime mortgage crisis in 2007–2008, we experienced a prolonged period of economic decline, the so-called "Great Recession". The financial origin of the Great Recession induced economists and policy-makers in attributing an increased attention to the role of banks in the economy as, parallel to the economic slowdown, it was observed a sharp decline in the credit to firms (Ivashina and Scharfstein, 2010) and real investment (Campello et al., 2010).

There are two competing mechanisms to explain why credit is pro-cyclical based on the relationship between asset price changes and credit growth (Bernanke and Gertler, 1989; Holmstrom and Tirole, 1997; Kiyotaki and Moore, 1997). During economic booms, companies pledge their assets as collateral to borrow more money, leading to an increase of the credit demand (the "borrower balance-sheet channel"). Meanwhile, banks increase their investments because of the lower cost of financing. Moreover, it is easier for banks to satisfy the regulatory capital requirement and, therefore, to increase the credit supply (the "bank balance-sheet channel").

The simultaneous combination of both effects depresses the equilibrium credit quantities during a crisis, generating the fundamental identification problem in empirical banking. Indeed, the challenge is to identify whether a change in lending to firms is induced by demand or supply factors. In this paper, we propose a new methodology to disentangle the effects of credit supply shocks from demand changes over time.

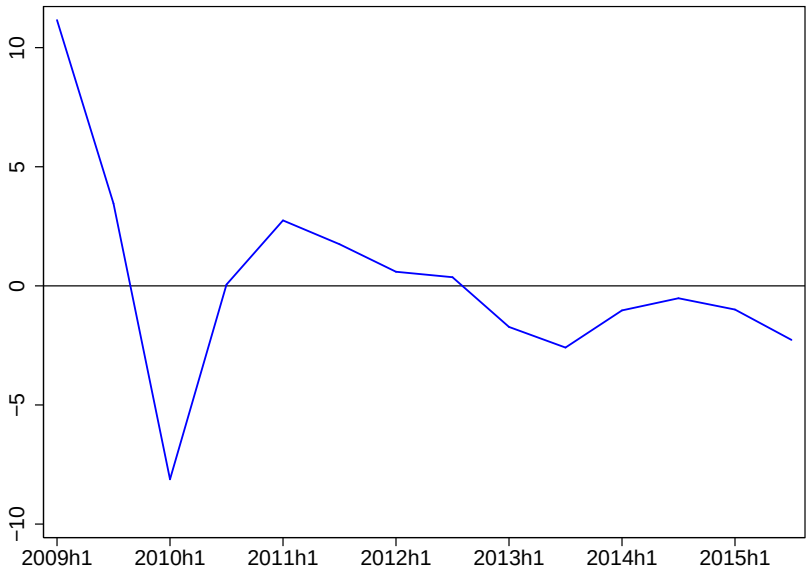
We identify unforeseen shifts in credit supply using survey data – the Bank of Italy's Regional Bank Lending Survey (RBLS) – on banks' actual and expected lending policy. Based on this information, we build an econometric model to construct a measure of supply shocks that abstracts from factors correlated with firms' demand such as loan officers' expectations, bank characteristics and economic conditions. Then, we map our measure to information on loans granted to firms by banks using Bank of Italy's credit register data.

To estimate the effects of credit supply changes during the financial crisis, economists adopt the methodology introduced by the seminal contribution of Khwaja and Mian (2008), where credit supply is identified by exploiting an exogenous shock to banks and any unobservable characteristics of the borrower is absorbed by using firm×time fixed effects. In these studies, the objective is documenting the relevance of a bank balance-sheet channel, while our scope is to quantify the importance of supply shocks for the entire banking sector during a longer span of time. This requires an alternative methodology because it is not always possible to find an exogenous shock for a prolonged period such as the Great Recession.

Italy has an under-performing economy with respect to the euro area peers. The financial fragility is one of the main obstacles for Italy to reach the pre-crisis level of

income. As shown in Figure1, Italy experienced a first decline in firm credit after 2009 – the begin of the subprime crisis – and a second, prolonged and deep slowdown from mid 2012 to 2015 following the sovereign debt crisis. Several papers tried to identify the role of supply factors in the dynamics of Italian credit market (Del Giovane et al., 2013; Bonaccorsi di Patti and Sette, 2016; Bofondi et al., 2018). All these paper are based on the Khwaja and Mian's methodology. Our proposed empirical strategy can help to draw a real anatomy of the Italian credit crunch as we estimate the impact for the entire crisis period and for different financial instruments. Moreover, the RBLS provide information on changes in credit supply for four Italian macro regions: north-east, north-west, center and south. This level of granularity allows us to precisely identify shifts in supply while accounting for the heterogeneity of financial development across Italian regions (Guiso et al., 2004).

Figure 1: Credit to Private Non-Financial Firms in Italy



Source: Bank for International Settlements. The series is the year over year percentage change in credit to private non-financial firms in Italy from 2009 to 2015. Data are converted from quarterly to half-year.

We document a firm that borrows revocable credit lines from a bank that experiences a one-unit tightening in lending standards suffers an additional reduction in credit growth of 0.43 percentage points with respect to borrowing from non-affected banks. By aggregating the credit volume at firm-level, we then explore the ability of firms to counteract these supply shocks by additional borrowing from other sources. We show that firms with multiple lenders are able to compensate single bank's shocks by relying on alternative sources of financing. If we divide the firms in our sample in quartile according to their size, the largest firms are those that suffered the most of this credit contraction. Furthermore, we analyze if there are different patterns in credit granted to firms across sectors and

geographical area. We find that those operating in the manufacturing sector and those located in the North-East are the most affected by a shift in lending standards. Finally, we explore the effect of our measure of credit supply change on the extensive margin, and we find that a negative shock has a significant impact on the probability for a bank of accepting new loan applications. This effect is stronger for term loans.

The rest of the paper is organized as follows. Section 2 briefly discusses the related literature. Section 3 describes the data. Section 4 presents the econometric strategy. Section 5 presents the results on the bank-lending and firm-borrowing channels. Section 6 concludes.

2 Literature Review

This paper is contributing to different strands of the literature in banking.

First, it contributes to the studies that identify the "bank-lending channel" using firm-bank transaction data. The most important paper in this field is Khwaja and Mian (2008). In their paper, they use the changes in bank liquidity induced by an unexpected nuclear test in Pakistan as en exogenous source of variation for Pakistani banks' credit supply. They document the transmission of a bank shock in terms of actual credit granted to firms and the heterogeneous effect among different firm size classes: large and connected firms are able to compensate financial shocks with other sources of financing, while small firms experience a reduction in their loans with consequences for their financial health. Gan (2007) exploits the drop in land prices in Japan during the 90s as a natural experiment for a negative shock to banks' balance sheets. In this paper, borrowers' investment decisions are significantly affected by the exposure to the real estate market of their top lender. Jiménez et al. (2012) study the impact of monetary policy changes and other macroeconomic conditions in Spain from 2002 to 2008. They focus on the extensive margin of the bank-firm relationship using loan applications data. They find that higher short-term interest rates or lower GDP growth reduce the probability of loan granting, and the negative effect of higher short-term interest rates or lower GDP growth on credit availability is stronger for banks with low capital or liquidity, meaning that monetary policy can potential amplify the bank lending channel.

Second, our study contributes to the literature that uses survey data at the bank-level to estimate the pass-through effects of a change in lending standards to businesses. Using information from the ECB's Bank Lending Survey (BLS) in Italy, Del Giovane et al. (2011) quantify the relative importance of credit supply and demand behind the slowdown in loan to non-financial corporations during the financial crisis of 2007-2009. In their paper, they estimate that supply factors induced a contraction in the annualized quarter-on-quarter rate of growth in loans to enterprises by the banks to be between 2.3

and 3.1 percentage points during the 2007-2009 financial crisis.[1] Ciccarelli et al. (2015) confirm that the predictive power for credit supply using as sample the entire euro area. Additionally, they provide a test of the bank lending channel as transmission mechanism for a monetary policy shock, amplifying its effects on real activities. van der Veer and Hoeberichts (2016) build from Del Giovane et al. (2011) and find that the level of lending standards, and not the changes, has an impact on credit cycles.

The use of survey data to analyze credit cycles is not only limited to the euro area. For the United States, Lown and Morgan (2006) and Bassett et al. (2014) show that a shock in lending standards induces a decline in output and the aggregate volume of credit to firms and households. Although our empirical methodology is built upon the empirical model of Bassett et al. (2014), in our paper we will focus more on the micro-level behavior of banks. Finally, the survey data are used to test the importance of the bank lending channel for the transmission of the monetary policy. Relative to these studies we have done several innovations: first, we propose a new methodology to the use of surveys to analyze credit supply with the use of credit-register data. Second, we use the depth of our dataset to extend the analysis of Del Giovane et al. (2011) to analyze the variation in the different credit facilities. Lastly, we are the first to combine elements of the state-of-the-art methodology to properly identify credit shocks.

3 Data description

For the empirical analysis, we retrieve information from three different databases: the Regional Bank Lending Survey (RBLS), the Italian Credit Register (CR) and the Supervisory Reports. The RBLS is conducted by the Bank of Italy to collect information about demand and supply of credit in Italy following the structure of the European Central Bank's Bank Lending Survey (BLS). Questions are divided into two blocks: the first is regarding the latest economic trends; the second concerns structural characteristics of financial intermediaries.[2]

Our sample starts in 2009 because since this year our survey follows the current structure, where banks are asked to provide information on economic trends for credit supply and demand. The RBLS has half-yearly frequency and it contains information for bank's credit policy in four different macro-regions in Italy: north-west, north-east, center and south. The geographical depth of the RBLS is a clear advantage with respect to the BLS survey. Furthermore, the RBLS involves a larger number of banks (346) than the

[1] By replicating a similar methodology, Nobili and Orame (2015) show the potential benefit of using RBLS vs. BLS in terms of reducing potential bias in estimating supply contractions, thanks to the larger sample of banks involved in the survey.

[2] The analysis has no supervisory purpose, since it is conceived as a statistical instrument ad disposal of the Bank of Italy's research department. Therefore, the incentives to misreport by the respondents are mitigated because the loan officer has no need to hide some information to the supervisory authority.

BLS (141) with the RBLS is covering a total of 87 percent firm credit granted by banks operating in Italy. As it will be shown in the empirical section, the span of the RBLS is key to estimate the impact of credit supply in Italy during the Great Recession.

The RBLS provides information about banks' lending standards for three credit categories: credit to firms, consumer credit and family mortgages. Each half-year, banks are asked to provide a qualitative measure of change in their credit demand and in their supply policy. The intensity range for the supply indicator has five possible values: *tightened considerably*, *somewhat tightened*, *essentially unchanged*, *somewhat eased*, *eased considerably*. A similar range is used for the demand indicator: *increased considerably*, *somewhat increased*, *essentially unchanged*, *somewhat decreased*, *decreased considerably*. Additionally, the financial intermediaries have to reveal their expectation on the evolution of demand and supply of bank credit in the next half-year, using the same intensity ranges described above. Banks' answers – expected and observed – are converted into numeric variables. Conventionally, a credit supply tightening is identified by positive values, while an easing is represented by negative numbers; conversely, a demand increase (decrease) is represented by positive (negative) values.

Table 1: Summary Statistics

	Mean	S.D.	Median	p25	p75
Panel A: Regional Bank Lending Survey indexes (426 Banks)					
Supply	.212	.245	.160	.0411	.334
Demand	-.059	.346	-.073	-.247	.113
Expected supply	.0396	.185	.001	-.046	.113
Expected demand	.123	.267	.112	-.019	.282
Panel B: Credit Register variables (1,831,490 bank-firm credit)					
LBR	240,825.5	2,287,809	92,153.85	44,000	201,645.5
Credit Lines	93,883.87	675,071.5	30,198.04	13,809.52	68,005
Term Loans	414,325.7	2,469,233	86,889.63	36,515.83	255,843.1
Total Credit	415,902.1	2,042,516	122,780.3	57,106.42	306,661.6
Panel C: Bank-level controls (426 banks)					
Size	20.891	1.553	20.578	19.896	21.732
Interbank deposits	12.147	12.849	8.981	5.616	13.254
Liquidity ratio	.491	.286	.448	.325	.612
Capital ratio	11.611	3.717	11.269	9.632	13.359
Nonperforming loan	11.109	5.716	10.537	7.299	14.057

Notes: The Information are collected from the Regional Bank Lending Survey, Credit Register and Supervisory report over the period 2009-2015. Three main loan facilities are considered: loans backed by account receivables (LBR), revocable credit Lines (Credit Lines), term loans (Term Loans). Size is the natural logarithm of total assets; interbank deposits is the ratio of bank's deposits over total assets; the liquidity ratio captured is the ratio of bank's cash over total assets; the capital ratio is given by book capital value over assets; Nonperforming loans is the ratio of the bank's non-performing loans by total assets. This bank-level controls are retrieved from the Bank of Italy's Supervisory Reports.

In the table 1, panel A reports summary statistics for the above-mentioned indexes of supply and demand and their expectations. Over the period 2009-2015 the average

expectations at the bank level were more optimistic compared to the actual indexes: the supply index was positive and larger than the expected supply, meaning that the average lending standards were tighter than what banks expected; the expected demand index was positive, but the observed indicator actually showed negative values on average.

The second source of information is the Italian Central Credit Register (CR). CR contains detailed information about all the loans granted to non-financial borrowers above 30,000 euros. In order to add firm-level information and explore firm heterogeneity in our sample, within the universe of non-financial firms we select those which also provide balance-sheet information through the Cerved database, provided by Cerved Group SpA. Firm credit is grouped in three main loan facilities: revocable credit lines, term loans and loans backed by account receivables (LBR). Our analysis involves half-yearly data on euro-denominated credit, grouped by type and over 14 periods between 2009 and 2015. CR provides data about granted and drawn amounts; nevertheless, we will consider only granted lending, as a better proxy of credit supply since it is less affected by demand.

In our study, we consider the change in logarithm of bank credit to firms as the dependent variable; variations are winsorized at the 5 percent level. Panel B of table 1 contains the descriptive statistics of both the amount of credit and its yearly log-change for each credit type. Our database consists of 601,880 firms and 450 banks that are present both in CR and the RBLS. The average log-change for term loans is much larger (in absolute values) than the other credit facilities, but the source of this heterogeneity lies in the very nature of term loans: at the individual level, a portion of the loan is reimbursed each month, hence at a given point in time it is very likely that the amount granted by the bank for term loans is smaller than it was the previous year at the same time; moreover, the majority of these loans are short term, therefore the reimbursement rate is normally quite large. Usually the terms of such contracts (such as the reimbursement plan) cannot be changed unilaterally by the bank, and this is one of the reason for which we will dedicate a greater deal of focus on other credit types in order to explore the effects of shifts in lending standards on firm credit, as it will be discussed later.

Lastly, we use their balance-sheet information collected through the Supervisory Reports to control for observable characteristics of our 450 banks, which the financial intermediaries submit to the Bank of Italy on a monthly basis. The bottom Panel C shows descriptive statistics for this set of control variables. Giving the RBLS is collected on a non-consolidated basis, in order to exploit all the information available we prefer to use individual financial data rather than consolidated, group-level information. Besides controlling for relationship characteristics, which are bank-firm specific, we add a control variable for bank size, measured as the natural logarithm of total assets; an interbank deposit variable, properly scaled by total assets; a liquidity ratio captured by the ratio between cash and total assets; a capital ratio given by book capital value over assets; and finally an indicator of non performing loans scaled by total assets. We also add the

share of firm loans over the bank's total loans in order to control for the specialization of financial intermediaries.

4 Empirical strategy

This section describes our approach to identify changes in credit standards to find evidence of both the bank-lending and firm-borrowing channels during the Great Recession in Italy.

First, we construct an indicator for a change in bank credit using the responses about the applied lending standard from the Regional Bank Lending Survey. From the row RBLS's answers, regarding three main client categories k (firm credit, consumer credit and family mortgages), we build a set of composite bank indexes that measure the expected and observed changes in overall lending standards and credit demand. Those indexes are built as following:

$$\Delta S_{b,t} = \sum_k \omega_{b,t-1}(k)\, I^S_{b,t}(k) \quad \text{and} \quad \Delta D_{b,t} = \sum_k \omega_{b,t-1}(k)\, I^D_{b,t}(k),$$

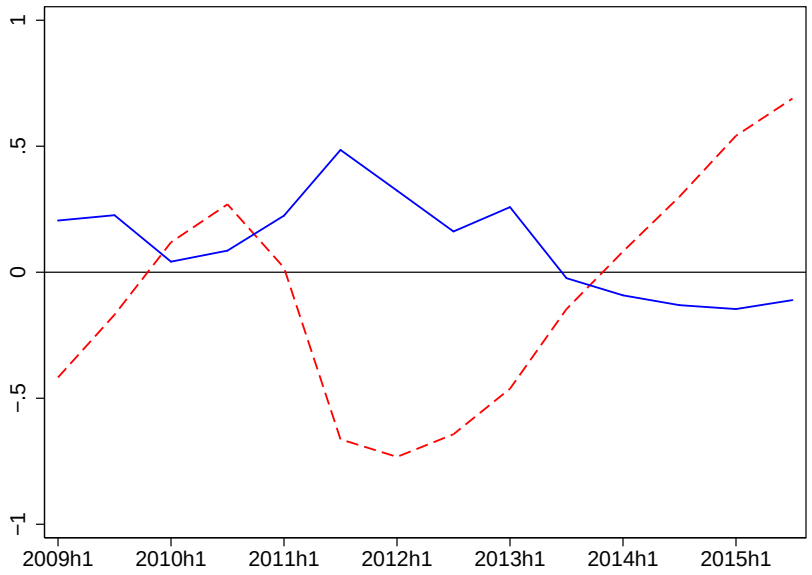
where the weight $\omega_{b,t-1}(k)$ is the ratio of credit granted to k at $t-1$ over the total outstanding credit of bank b, and $I^S_{b,t}(k)$ and $I^D_{b,t}(k)$ are respectively the supply and demand answers from the survey for category k. Therefore, supply indicator $I^S_{b,t}(k)$ is defined for bank b in the half-year t for the corresponding range goes from -1 for a considerable easing to $+1$ for a considerable tightening respect to the client category k (the demand indicator $I^D_{b,t}(k)$ follows a similar definition). Figure 2 depicts the half-yearly average of supply and demand indexes. The two indexes clearly reflect the dynamics of both business cycle and bank lending during the crisis. The demand decreased in 2009 and from the second half of 2011 up until 2013; the supply progressively tightened until the end of 2013. Demand grew steadily after 2014, while the supply began to slowly ease, although the intermediaries still show a certain degree of prudence.

The use of survey data to describe credit cycles leads to an endogeneity problem: there are demand factors that can influence the answer of the bankers about the credit supply. To identify the credit supply change from the answer to the RBLS, we take the part of the change in banks' lending standard that is orthogonal to demand factors. This empirical strategy is in line with previous studies using bank-level panel data (Bassett et al., 2014) or VAR-based (Lown and Morgan, 2006; Ciccarelli et al., 2015) identification strategies. Therefore, we first estimate the following regression by Ordinary least squares (OLS):

$$\begin{aligned}\Delta S_{b,t} = \beta_0 + \beta_1 \Delta S_{b,t-1} + \beta_2 \Delta D_{b,t} + \beta_3 E_{t-1}[\Delta S_{b,t}] + \\ + \beta_3 E_{t-1}[\Delta D_{b,t}] + \gamma X_{b,t} + \delta_b + \eta_t + \varepsilon_{b,t},\end{aligned} \tag{1}$$

where $\Delta S_{b,t}$ is the change in these lending standard for the bank b in year t; $\Delta D_{b,t}$ is

Figure 2: Average of Regional Bank Lending Survey's Credit Supply and Demand Indexes



Notes: The dashed line represent the average of demand index, while the solid line depict the measure of change in credit supply. Positive values of the indexes indicate a tightening of the supply (demand), while negative values indicate a decrease (see the text for details).

the change in the demand condition for bank b in year t; $E_{t-1}[\Delta S_{b,t}]$ is the change in expectations for the lending condition in the half-year t made in the half-year $t-1$ for bank b; and $E_{t-1}[\Delta D_{b,t}]$ is the change in expectations for credit demand in the half-year t made in the half-year $t-1$ for bank b. $X_{b,t}$ is a set of bank-level controls (see Table 1), δ_b is the bank fixed effects, η_t is the time fixed effects and $\varepsilon_{b,t}$ is the error term.[3]

Then, we use the residual of the previous regression $\Delta BankSupply_{b,t-1} = \hat{\varepsilon}_{b,t}$ as our measure of exogenous change in banks' credit supply. By construction, this is orthogonal to all the other variables included in the model so it represents the variation in credit standards attributable to a bank supply shock and not to demand or other confounding factors; neglecting to include such factors in the analysis leads to the creation of an omitted variable bias and to an underestimation of the true effect of supply shifts on firm credit.[4]

Estimating the bank-lending and firm-borrowing channel

Once we compute our supply shock indicator, we use it to estimate both the bank-lending and firm-borrowing channel through which these shocks may impact firm credit. There-

[3]In an alternative specification, we substitute the time fixed effects with macroeconomic variables, such as GDP and unemployment. We find no improvement in terms of the goodness of fit, hence we decided to stick to the most conservative model in terms of residual magnitude.

[4]This result is shown in the Appendix A.

fore, we will estimate the bank-lending channel through the following equation:

$$\Delta L_{i,b,t} = \beta_0 + \beta_1 \Delta BankSupply_{b,t-1} + \gamma X_{b,t-1} + \eta_{i,t} + \delta_b + \varepsilon_{i,b,t}, \tag{2}$$

where $\Delta L_{i,b,t}$ is the yearly log change in loans to firm i by bank b in period t and $\eta_{i,t}$ corresponds to the firms×time fixed effects. In this model, our coefficient β_1 is interpreted as the effect on loan growth rate of a tightening in credit supply of bank b to firm i relative to another bank with an unchanged lending policy.

To disentangle between the shift in lending supply and demand, we introduce the firm×time fixed effects to properly identify the coefficient β_1, which help us rule out the possible endogeneity stemming from demand shocks at the firm level. Furthermore, using information on different credit type helps alleviate the concern that a firm's credit demand is loan specific and shocks to loan demand are correlated with shifts in bank lending standards.

In the second part of this section, we turn to the analysis of the firm-borrowing channel to explore the ability of the firms to counteract an individual bank shock by smoothing credit needs over different intermediaries. We will do so by aggregating the bank-level shocks $\Delta BankSupply_{b,t-1}$ at the firm level through the formula:

$$\Delta BankSupply_{i,t} = \sum_{b \in B_i} \omega_{b,t} \times \Delta BankSupply_{b,t},$$

where B_i is the set of banks granting credit to firm i and $\omega_{b,t}$ is the share of bank b over total firm credit. The estimated equation then becomes:

$$\Delta L_{i,t} = \beta_0 + \beta_1 \Delta BankSupply_{i,t-1} + \gamma X_{i,t-1} + \eta_i + \phi_t + \varepsilon_{i,t}, \tag{3}$$

where $\gamma X_{i,t-1}$ are bank controls properly weighted at the firm level, η_i are the firm fixed effects and ϕ_t are the time fixed effects. In this case we cannot use the firm×time fixed effects to rule out firm-level demand shocks because of the firm-time panel dimension.

5 Results

5.1 Measuring shifts in bank lending standards

In this subsection, we present the results of the first step of our empirical methodology. We identify a supply-driven shift in bank lending standards as the orthogonal component to demand conditions in the answers to the RBLS. Therefore, we regress $\Delta S_{b,t}$, our qualitative indicator of banks' credit supply change, over $\Delta D_{b,t}$, our qualitative indicator of banks' credit demand change, the corresponding expectations for both variables, the lag of the dependent variable $\Delta S_{b,t-1}$, plus the controls for bank characteristics and the fixed

Table 2: Changes in lending standards

	(1) $\Delta S_{b,t}$	(2) $\Delta S_{b,t}$	(3) $\Delta S_{b,t}$
$\Delta D_{b,t}$	-0.157***	-0.161***	-0.127***
	(0.0139)	(0.0137)	(0.0137)
$\Delta S_{b,t-1}$	0.197***	0.150***	0.129***
	(0.0212)	(0.0207)	(0.0201)
$E_{t-1}[\Delta S_{b,t}]$	-0.0249**	-0.0117	-0.00640
	(0.0117)	(0.0119)	(0.0117)
$E_{t-1}[\Delta D_{b,t}]$	0.259***	0.220***	0.189***
	(0.0225)	(0.0231)	(0.0235)
Bank-level controls	No	Yes	Yes
Time fixed effects	No	No	Yes
Bank×area fixed effects	Yes	Yes	Yes
N	11,318	10,212	10,212
adj. R^2	0.339	0.342	0.374
F-stat	245.9	102.2	34.94

Notes: The standard errors, in parentheses, are clustered at the bank level. Significance levels: *: 10%; **: 5%; ***: 1%.

effects.

Table 2 shows the resulting coefficients from the estimation of Equation 1. The first specification reported in column (1) includes only the lagged change in credit supply, the change in loan demand and the lagged expected changes of both demand and supply indicators. In column (2), predetermined bank-levels controls are added such as total assets, inter-bank deposits, liquidity, capitalization, share of non-performing loans and share of credit allocated to firms. In column (3), we include time fixed-effects. In our model, we always control for bank fixed-effects, while the standard errors are clustered at the bank level.

In all the specifications, the RBLS indicators show the expected signs: a tightening of credit standards in the previous half-year corresponds to a further tightening in the current half-year; an increase in loan demand is associated to an easing in credit standards in the same period. A similar path is retrieved from the coefficients of the expected changes in supply and demand in the previous half-year, however the coefficient on the expected change in demand is not significant. The inclusion of bank-level controls and time fixed effects does not affect the magnitude and the significance of RBLS coefficients, except for the expected supply change, whose effect is absorbed by such controls.

Using the estimation in column (3) in Table 2 as our favorite specification, we extract the residual and use this measure, $\hat{\varepsilon}_{b,t}$, as the change in lending standards induced by bank's supply shock.

Table 3: Lending standards and bank credit to firms

	(1) ΔLBR$_{b,t}$	(2) ΔCredit Lines$_{b,t}$	(3) ΔTerm Loans$_{b,t}$	(4) ΔTotal Credit$_{b,t}$
$\Delta BankSupply_{b,t-1}$	-1.341**	-2.092***	-0.897	-1.203***
	(0.559)	(0.620)	(0.600)	(0.386)
N	8,388	8,471	8,471	8,477
adj. R^2	0.297	0.284	0.314	0.414
F-stat	17.19	11.62	11.73	17.13

Notes: All regressions include bank-level controls, and bank and time fixed effects. The standard errors, in parentheses, are clustered at the bank level. Significance levels: *: 10%; **: 5%; ***: 1%.

The results in Table 3 are presented as evidence of the correlation between our measure of supply shock and banks' credit policy: a shift in lending standards is associated to significant reductions of short-term self-liquidating (LBR) and revocable credit lines, while the coefficient on term loans is still negative but not significant; also, total credit seems significantly affected by our key regressor. This evidence leads us to focus mainly on the first two credit types (LBR and credit lines), although we will also investigate the possible effects on firms' total credit.

5.2 The bank-lending channel

In this section, we document how the bank-lending channel has influenced bank credit to firms during the Great Recession in Italy. To isolate the role of supply from any idiosyncratic time-varying shocks to the demand for credit, we focus on firms borrowing from multiple banks. Indeed, we follow the contribution by Khwaja and Mian (2008), identifying the role of supply factors by introducing firm×time fixed effects in our econometric model. This way, we compare how the same firm's credit growth from one bank changes relative to another more or less exposed bank depending on the variable $\hat{\varepsilon}_{b,t}$, i.e. our measure of supply shock to a bank's lending standards.

In all the specifications we introduce bank-level controls such as bank total assets, inter-bank deposits, liquidity, capitalization, and the share of non-performing loans. Furthermore, we include a control of the firm-bank relationship, represented by the share of credit lent by the bank b on total amount borrowed by the firm i from the banking system. This way, we control for all the possible confounding factors in our study of the role of banks' credit supply policy. Lastly, we allow for geographical differences within the same bank, by adding bank×time fixed effects.

The results are shown in Table 4. A significant impact of supply tightening is found on revocable credit lines: credit lent by banks exposed to a one-unit unforeseen supply tightening grows 0.43 percentage points slower than the credit lent by a non-exposed bank.

Table 4: The bank lending channel

	(1) ΔLBR$_{i,t}$	(2) ΔCredit Lines$_{i,t}$	(3) ΔTotal Credit$_{i,t}$
$\Delta BankSupply_{b,t-1}$	-0.035	-0.434***	0.016
	(0.210)	(0.095)	(0.229)
Bank-level controls	Yes	Yes	Yes
Firm×time fixed effects	Yes	Yes	Yes
Bank×area fixed effects	Yes	Yes	Yes
N	3,222,443	4,172,670	5,113,206
adj. R^2	0.111	0.095	0.113
F-stat	318.3	333.8	256.3

Notes: The standard errors, in parentheses, are double clustered at the firm and at the bank level. Significance levels: *: 10%; **: 5%; ***: 1%.

No significant effect is found on LBR nor on the total credit provided by each bank. This result is justified as a credit line is the most flexible financial contract among the ones considered in the study. Indeed, the amount granted to the firm in a credit line can be rapidly renegotiated by the bank from one period to another. Our results are consistent with the findings of Acharya and Mora (2015), who argue that when banks are exposed to unexpected market stress they may experience difficulties in meeting firms' liquidity needs.

According to our methodology, the only financial instrument influenced by short-term supply adjustments is credit lines. Thus, we focus on this tool to explore the role of firm size. The results are shown in table 5. Surprisingly, the negative effect of a tightening of the lending standards on the liquidity provision to the firms is larger for large firms. Indeed, the coefficient of credit supply increases by 34% in the fourth quartile respect to the first.

Table 5: Quartile Regressions (Credit Lines)

	(1) 1st Quartile	(2) 2nd Quartile	(3) 3rd Quartile	(4) 4th Quartile
$\Delta BankSupply_{b,t-1}$	-0.355**	-0.231**	-0.328***	-0.543***
	(0.139)	(0.107)	(0.101)	(0.122)
Bank-level controls	Yes	Yes	Yes	Yes
Bank×area fixed effects	Yes	Yes	Yes	Yes
Firm×bank fixed effects	Yes	Yes	Yes	Yes
N	262,028	628,051	1,046,033	2,139,496
adj. R^2	0.112	0.116	0.115	0.104
F-stat	305.3	349.0	355.4	301.2

Notes: Standard errors, in parentheses, are double clustered at the firm and at the bank level. Significance levels: *: 10%; **: 5%; ***: 1%.

In the paper, we explore other forms of heterogeneity than firm size such as the dynamics across sectors and geographical areas. The results of the analysis of geographical heterogeneity are presented in the Table 6, while in 7 we can study the different paths across industrial sectors. According to our analysis, manufacturing has been the most sensitive sector to our measure of supply shock as the coefficients with the coefficient for $\Delta BankSupply_{b,t-1}$ larger by 30.4% than the construction sector and by 90.2% than in service.

If we shift our attention to variation in the geographical location of the firms, the effect of lending standards shifts on credit lines are particularly strong in the north-east of Italy. This could be explained by the high concentration of cooperative banks in this area of the country (roughly 42% of the total number of cooperative banks in our sample are in the North-East) that were among the most hit by the crisis. Because of their social aim, cooperative banks can pursue objectives different from profit maximization and their lending policy is often view as a mean to support a territory. The fact that they suffered the most during the crisis might be a signal of the hard times that this kind of financial institutions has recently lived, and in general poses several questions on the sustainability of the cooperative model during a financial crisis.

Table 6: Geographical Heterogenity (Credit Lines)

	(1) North-west	(2) North-east	(3) Center	(4) South
$\Delta BankSupply_{b,t-1}$	-0.289***	-0.678***	-0.284*	-0.204
	(0.099)	(0.122)	(0.164)	(0.318)
Bank-level controls	Yes	Yes	Yes	Yes
Bank×area fixed effects	Yes	Yes	Yes	Yes
Firm×bank fixed effects	Yes	Yes	Yes	Yes
N	1,508,951	1,262,045	780,278	621,396
adj. R^2	0.091	0.103	0.088	0.093
F-stat	171.6	268.3	204.4	102.0

Notes: Standard errors, in parenthesis, are double clustered at the firm and at the bank level. Significance levels: *: 10%; **: 5%; ***: 1%.

Table 7: Industry Heterogenity (Credit Lines)

	(1) Manufactoring	(2) Construction	(3) Service
$\Delta BankSupply_{b,t-1}$	-0.586***	-0.445**	-0.308***
	(0.126)	(0.173)	(0.097)
Bank-level controls	Yes	Yes	Yes
Bank×area fixed effects	Yes	Yes	Yes
Firm×bank fixed effects	Yes	Yes	Yes
N	327,725	535,824	707,043
adj. R^2	0.109	0.094	0.104
F-stat	284.4	337.3	278.7

Notes: Standard errors, in parentheses, are double clustered at the firm and at the bank level. Significance levels: *: 10%; **: 5%; ***: 1%.

Finally, we complete the bank lending channel exercise by verifying the effect on loan prices. Data on firm interest rates involve the average interest rate on the stock of the three loan facilities; they are not observed on the universe of firms in the Credit Register but only on a sample of them, and they are collected quarterly. Empirically, we substitute the half-year average level of prices $P_{i,b,t}$, measured as the spread of prices in bank b with respect to the macro-area level of prices, to the log-change in quantities $\Delta L_{i,b,t}$ in 2. As shown in table 8, there is no significant effect on the interest rate for credit lines and term loans; while there is, however, a negative effect on prices for LBR. For credit lines, the significant effect on quantities and not on prices is consistent with theoretical literature on credit rationing and moral hazard (Freixas and Rochet, 2008). During a recession, banks prefer to reduce the supplied quantity rather than increase the interest rate to adjust to the riskier environment, as higher prices lead to exacerbate the moral hazard problem for the borrower and to expected future losses on the bank loans portfolio.

Table 8: Effects on prices

	(1) $P(\text{LBR})_{i,t}$	(2) $P(\text{Credit Lines})_{i,t}$	(3) $P(\text{Term Loans})_{i,t}$
$\Delta BankSupply_{b,t-1}$	-0.114**	-0.206	0.0157
	(0.0520)	(0.193)	(0.0131)
Bank-level controls	Yes	Yes	Yes
Bank×area fixed effects	Yes	Yes	Yes
Firm×bank fixed effects	Yes	Yes	Yes
N	1,911,622	2,219,877	1,096,084
adj. R^2	0.383	0.273	0.343
F-stat	297.1	162.3	73.84

Notes: Standard errors, in parentheses, are double clustered at the firm and at the bank level. Significance level: *: 10%; **: 5%; ***: 1%.

5.3 The firm borrowing channel

In this section, we try to address the following question: given that firm credit is sensitive to shocks in the lender's lending standards, are firms able to balance this effect by borrowing from other banks? To answer this question, we estimate equation 3 for credit lines, where the bank shocks are aggregated at the firm-level and weighted for their share of firm i's total bank exposure. Unlike the previous paragraph, we can no longer use firm×time fixed effects, since it would saturate the dataset variability. To overcome this issue, we follow Cingano et al. (2016) and we exploit the fixed effects estimates from the previous paragraph as a proxy for idiosyncratic demand shock $\hat{\eta_{i,t}}$ at the firm-level.

The estimates of equation 3 are shown in table 9. Since in our benchmark regression in table 4, the only significant effect of our supply measure is found to be on credit lines, in this section we are still focus on this type of financial contract. In column (1), the effect of restriction of credit supply of firm i's lenders is not statistically significant. Contrarily to Khwaja and Mian (2008), firms appear to compensate for the bank lending channel by increasing borrowing from non-affected banks. Columns (2) and (3) split the sample between single-lender and multiple-lender firms: as expected, the results of column(1) is explained mainly by firms that rely solely on one intermediary and, therefore, they cannot compensate reduction in revocable credit. In column (4), the fixed effects estimate from the bank-lending channel estimation are added, but even in this case no significant effect is found in the variable of interest.

In Table 10, we investigate if the results presented above are driven by difference size across firms. We split our sample in four categories. First we divide our firms with a single lender or with multiple lenders. Then in small versus large firms. A firm is defined

Table 9: The firm borrowing channel

	(1) Full sample	(2) Single lender	(3) Multiple lenders	(4) Multiple lenders
$\Delta BankSupply_{i,t-1}$	0.036	-0.281***	0.117	-0.104
	(0.066)	(0.074)	(0.118)	(0.09)
$\widehat{\eta_{i,t}}$				1.485***
				(0.003)
Bank-level controls	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
N	3,803,251	1,699,727	2,053,878	1,393,918
adj. R^2	0.093	0.181	0.142	0.455
F-stat	2042.2	653.2	563.2	40039.4

Notes: Standard errors, in parentheses, are clustered at the firm level. Significance levels: *: 10%; **: 5%; ***: 1%.)

to be small if it belongs to the first quartile of the size distribution. Consistently with the finding of Table 9, firms borrowing from multiple lenders are not affected by an average tightening of credit supply as shown in column (3) and (4) of Table 10. Nonetheless, it plays a role for the single-lender firms. If we compare the coefficient of $\Delta BankSupply_{i,t-1}$ between column (1) and (2), we observe that smaller firms experience a more intense drop in credit lines growth due to an aggregated shift in lending standards with the coefficient for the small firms significantly larger by 46.7% than the other firms.

Table 10: Firm borrowing by size

	(1) SL, small	(2) SL, non-small	(3) ML, small	(4) ML, non-small
$\Delta BankSupply_{b,t-1}$	-0.361**	-0.246***	-0.311	-0.0919
	(0.155)	(0.0848)	(0.209)	(0.0975)
$\widehat{\eta_{i,t}}$			1.400***	1.492***
			(0.00734)	(0.00283)
Bank-level controls	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
N	413,929	1,285,798	115,671	1,278,247
adj. R^2	0.169	0.185	0.595	0.448
F-stat	161.2	494.4	4893.0	36024.4

Notes: Standard errors, in parentheses, are clustered at the firm level. SL = single lender; ML = multiple lenders. Significance levels: *: 10%; **: 5%; ***: 1%.

5.4 The extensive margin

In this section, we examine to what extent shifts in lending standards affect the so-called extensive margin, i.e. the probability of entry or exit in the credit market for non-financial firms. Following previous studies (Jiménez et al., 2012; Bofondi et al., 2018), we retrieve information on the outcome of loan applications from the Bank of Italy's CR to analyze the probability that a firm receives new credit from a bank; with the usual CR data, instead, we compute the probability that a firm currently reported in the CR is eventually cut by the bank.

To the extent of the supervisory activity of the Bank of Italy, every time a new client submits a loan application to a bank, the latter requests information on this borrower and the query is recorded in the CR. For each application, we check whether the bank eventually granted any credit commitment to the loan applicant within the same or the following half-year of the application. Hence, a loan application submitted to a bank, say, in September 2011, is classified as accepted if we observe that the bank grants credit to the borrower either by 2011.II or by 2012.I.

We collect data on all the requests recorded as loan applications between January 2009 and December 2015. Our dependent variable $Accepted_{i,b,t}$ is a dummy equal to 1 if the application of firm i to bank b at time t is accepted, 0 otherwise. The acceptance is associated with the corresponding credit type. We estimate a linear probability model including firm×time and bank×area fixed effects, plus the usual bank-level controls. Including firm×time fixed effects is important to control for applicant unobservables, but

limits the sample to firms posting a loan application at least to two different banks within the same half-year: we check if a bank hit by a supply shift has a higher probability of rejecting an application compared to non-hit bank(s). Firms applying for more than one loan may be different, likely worse, than the average firm applying for a single loan. The effect on the probability of exit is computed similarly: we check whether a firm borrowing from at least two intermediaries has a higher probability of being cut by a bank who experiences a shift in its supply policy compared to a bank whose lending standards remain unchanged.

Table 11: Probability of acceptance

	(1) $Accepted_{i,b,t}$	(2) $Accepted_{i,b,t}$	(3) $Accepted_{i,b,t}$	(4) $Accepted_{i,b,t}$
$\Delta BankSupply_{b,t-1}$	-0.0106***	-0.00935***	-0.00713**	-0.00811***
	(0.00308)	(0.00299)	(0.00329)	(0.00294)
$\Delta BankSupply_{b,t-1}$ ×(LBR)		-0.0102		
		(0.0141)		
$\Delta BankSupply_{b,t-1}$ ×(Credit lines)			-0.0244	
			(0.0167)	
$\Delta BankSupply_{b,t-1}$ ×(Term Loans)				-0.0310*
				(0.0183)
Bank-level controls	Yes	Yes	Yes	Yes
Bank×area fixed effects	Yes	Yes	Yes	Yes
Firm×bank fixed effects	Yes	Yes	Yes	Yes
N	859,633	859,633	859,633	859,633
adj. R^2	0.261	0.261	0.261	0.261
F-stat	65.88	60.37	61.11	58.64

Notes: Standard errors, in parentheses, are double clustered at the firm and at the bank level. Significance levels: *: 10%; **: 5%; ***: 1%.

The results are depicted in table 11: we find a significant effect on the overall probability of acceptance; also, we find that the interaction of our measure of supply shift with the dummy for term loans has an additional impact on the frequency of acceptance. Contrarily, we find no significant effect on the probability of exit.[5] The results are in line with the findings of Schivardi et al. (2017) on the so-called "zombie-lending" in Italy: during a crisis, banks have incentives to keep lending money to otherwise insolvent borrowers not to declare such positions as non-performing loans, with higher costs in terms

[5]See table 13 in the Appendix.

of capital requirements (Caballero et al., 2008). Coherently with those studies, we find that banks are reluctant to cut existing relationships and rather prefer to reduce the rate of acceptance. Furthermore, it is interesting to notice that short-term supply shifts may not impact the equilibrium quantity of term loans at the firm level but they do have an impact on the probability that an application for a term loan is accepted: this is an additional piece of evidence that banks adjust to supply shocks operating on the intensive margin for the most flexible credit type, while intervening on the extensive margin for the least flexible one.

6 Conclusions

A large literature, starting from the seminal paper of Khwaja and Mian (2008), has tried to estimate the contribution of credit supply using credit register data. However, the prolonged nature of the Great Recession requires an update of this methodology providing reliable estimates without recurring to an external exogenous shock to the banks. Our proposed methodology innovates over previous literature by properly combining survey data from the Regional Bank Lending Survey to generate a measure of change in bank lending standards combined with firm×time fixed effects in order to isolate the credit supply channel from any firm-specific demand shocks. One strength of our methodology is that can be easily expendable to all the euro area countries through the ECB Bank Lending Survey, thus helping the research community and the policymakers to shed new light on the recent credit crunch that hit most countries in the continent.

We find that a negative bank supply shock induces a contraction in bank-intermediated credit to firms and this effect is especially relevant for the liquidity provisions to firms in the form of credit lines. According to our evidence, the firms that were the most involved by this mechanism are those in the top quartile of the size distribution; those operating in the manufacturing sector; and those located in the North-East of the country. However, we show that firms with multiple lending relationships manage to smooth the individual bank shock by borrowing more from other lenders. Looking at the extensive margin of the bank-firm relationship, we find that a negative shock has a significant impact on the probability of accepting new loan applications but it does not affect the probability of exit.

These results suggest that bank shocks during the last seven years in Italy must have caused aggregate negative effects in two directions: first by stifling existing businesses with a credit crunch and likely contributing to liquidity shortages within previously granted firms; second, by inducing a misallocation of resources in the economy, by cutting the new (extensive margin) or the already existing (intensive margin) potentially productive projects.

A Appendix: The shift in bank lending standards and the omitted-variable bias

Intuitively, one could think of plugging the survey measure of supply change, $\Delta S_{b,t}$, directly into the Khwaja and Mian's machinery, thus estimating

$$\Delta L_{i,b,t} = \beta_0 + \beta_1 \Delta S_{b,t-1} + \gamma X_{b,t-1} + \eta_{i,t} + \delta_b + \varepsilon_{i,b,t}, \tag{4}$$

The results are depicted in table 12: the coefficient for credit lines is still significant but its magnitude is halved. As mentioned in section 4, the procedure of netting out demand, expectations and other confounding factors is necessary to avoid such underestimation of the supply effect. By the Frisch-Waugh-Lovell theorem, it can be proven that by adding all the right-hand side observables of equation 1 to equation 4, the coefficients of $\Delta S_{b,t}$ and of $\Delta BankSupply_{b,t}$ do coincide. The procedure of Bassett et al. (2014) is useful to disentangle the *net* supply shifts and plug them into equation 2 with a straightforward interpretation.

Table 12: The omitted variable bias from using the survey supply change

	(1) ΔLBR$_{i,t}$	(2) ΔCredit Lines$_{i,t}$	(3) ΔTotal Credit$_{i,t}$
$\Delta S_{b,t-1}$	-0.0151	-0.256***	0.0664
	(0.194)	(0.0953)	(0.247)
Bank-level controls	Yes	Yes	Yes
Firm×time fixed effects	Yes	Yes	Yes
Bank×area fixed effects	Yes	Yes	Yes
N	3,648,682	4,747,000	5,807,809
adj. R^2	0.111	0.094	0.113
F-stat	484.2	287.1	251.9

Notes: The standard errors, in parentheses, are double clustered at the firm and at the bank level. Significance levels: *: 10%; **: 5%; ***: 1%.

B Appendix: The extensive margin

Table 13: Probability of exit

	(1) ΔLBR$_{i,t}$	(2) ΔCredit Lines$_{i,t}$	(3) ΔTerm Loans$_{i,t}$	(4) ΔTotal Credit$_{i,t}$
$\Delta BankSupply_{b,t-1}$	-0.001	-0.001	-0.001	-0.002
	(0.001)	(0.001)	(0.001)	(0.001)
Bank-level controls	Yes	Yes	Yes	Yes
Bank×area fixed effects	Yes	Yes	Yes	Yes
Firm×bank fixed effects	Yes	Yes	Yes	Yes
N	12,680,463	12,680,463	12,680,463	12,680,463
adj. R^2	0.079	0.107	0.033	0.129
F-stat	26.67	18.84	11.86	13.99

Notes: Standard errors, in parentheses, are double clustered at the firm and at the bank level. Significance levels: *: 10%; **: 5%; ***: 1%.

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