Assessing the Sources of Credit Supply Tightening: Was the Sovereign Debt Crisis Different from Lehman?*

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We estimate a structural econometric model for the credit market in Italy, using bank-level data on lending and interest rates and identifying shifts in demand and supply based on the responses of Italian banks to the Eurosystem's Bank Lending Survey. We distinguish supply restrictions due to increased borrowers' riskiness from those due to banks' balance sheet constraints, and test for the presence of credit rationing. We assess whether the effects of supply tightening differed during the sovereign debt crisis compared with the global financial crisis. We find that the effects of supply shocks transmit to loan quantities via an increase in lending rates and are larger

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when they reflect banks' funding difficulties as opposed to a deterioration of borrowers' riskiness. During phases of acute financial tensions, there is evidence of credit-rationing phenomena, related to banks' assessment of the constraints on their capital position. Based on a counterfactual exercise, the effects of the supply restriction on the cost and amount of credit were larger during the sovereign debt crisis than the global crisis, mostly reflecting the larger contribution of banks' funding conditions.

JEL Codes: E30, E32, E51.

1. Introduction

Understanding the role of supply factors in credit market developments has become a crucial issue since the onset of the great financial crisis. A growing body of literature uses indicators of banks' credit standards based on survey data to identify the relative contributions of demand and supply shocks.[1] An important limitation of these studies is that they have typically exploited only the overall supply indicators, and survey data have not been used to determine the *sources* of supply shocks. The literature on the credit channel of monetary policy (e.g., Bernanke and Gertler 1995) has instead emphasized how a restriction due to a deterioration in the creditworthiness of borrowers and one reflecting a worsening in banks' balance sheet conditions may have different implications and thus require different policy responses.

In this paper we study the effects of credit supply restrictions on the loan market and assess whether the effects of supply tightening differed during the sovereign debt crisis compared with the global financial crisis. To this end, we estimate a structural model of the Italian business loans market. The sources of supply restriction are likely to have been different in the two phases of the crisis: during the

[1]Works based on the Eurosystem's Bank Lending Survey include Hempell (2004), Berg et al. (2005), de Bondt et al. (2010), Hempell and Kok Sorensen (2010), Del Giovane, Eramo, and Nobili (2011), and Ciccarelli, Maddaloni, and Peydró (2015). Other analyses based on the Federal Reserve's Senior Loan Officer Opinion Survey are Lown, Morgan, and Rohatgi (2000), Cunningham (2006), Lown and Morgan (2006), Bayoumi and Melander (2008), Swiston (2008), and Basset et al. (2014).

global crisis, economic activity harshly contracted in all euro-area countries, borrowers' creditworthiness deteriorated, and banks' risk aversion sharply increased. In the sovereign debt crisis, banks' liquidity positions and access to wholesale funding were severely strained in the vulnerable euro-area countries, where the banks' creditworthiness was treated as equal to that of the respective governments. Italy is a well-suited case to conduct this analysis, as both phases of the crisis had important repercussions on its economy.

We use micro data and match individual banks' interest rates and loan amounts with the replies provided by the banks participating in the Eurosystem's quarterly Bank Lending Survey (BLS). We use the information in the BLS not only to disentangle supply and demand but also—crucially for the aim of our analysis—to disentangle the effect of the different *sources* of supply restrictions, by considering the individual factors that banks report behind changes in lending standards. In particular, we distinguish between (i) factors related to the banks' balance sheets (capital position, ability to access market financing, liquidity position) and (ii) factors related to perceived borrowers' riskiness (connected with the general economic conditions or with the specific industry or firm-specific outlook). In addition, we test for the presence of rationing, by estimating a "disequilibrium" relation in the spirit of Fair and Jaffee (1972) and Quandt (1978), which allows us to better capture the impact of the different supply factors.

As in other empirical works on lending demand and supply, a very important issue is the reliability of the identification strategy. In our case, a crucial challenge is the possibility that the indicators of demand and supply as reported by the banks in the BLS are not orthogonal to each other, which might reflect either common factors leading to changes in both demand and supply (e.g., the deterioration of macroeconomic and financial conditions) or a causal link from changes in supply to changes in demand (e.g., demand might be discouraged by higher borrowing costs).[2] We tackle this issue in various ways. First, we detect no or very low simultaneous correlation between bank-level indicators of demand and supply. Second, in our baseline regression we control for a number

[2]For example, Basset et al. (2014) showed that this is the case in the United States.

of bank-level characteristics and macro variables, which attenuates potential endogeneity concerns. Third, we replicate the methodology proposed by Basset et al. (2014; hereafter BCDZ), in which the (bank-specific) changes in demand are used to partial out, in a first-stage regression, changes in standards that are related to the reported changes in loan demand at the same bank. We find that the results are very similar to those obtained with the unadjusted supply indicators. All in all, this evidence is reassuring as to the possibility to identify supply and demand with reasonable confidence. Nonetheless, we acknowledge that we cannot exclude the possibility that our results are affected to some extent by some residual endogeneity.

We contribute to the existing literature along a number of dimensions. Differently from most previous studies, we use bank-level data as opposed to aggregate data both for survey information and credit developments. This type of information has been used before by Del Giovane, Eramo, and Nobili (2011; hereafter DEN) and by BCDZ (2014): DEN (2011) use micro data for Italy in reduced-form equations for lending quantities during the global crisis; BCDZ (2014) use data from the U.S. Senior Loan Officer Opinion Survey (SLOOS) to estimate the macroeconomic effects of exogenous changes in bank loan supply. Compared with these works, we use bank-level data also for the cost of credit and explicitly estimate a structural model for demand and supply; we investigate the effect of different sources of supply shocks, using the BLS factors rather than the overall indicator of credit standards; we allow for supply effects consistent with credit-rationing phenomena; and by including the sovereign debt crisis period, we are able to compare two phases with different sources of supply shocks.

The main results are the following. First, the effects of supply shocks are significantly larger when they reflect banks' balance sheet constraints as compared with a deterioration of borrowers' riskiness. We estimate that a tightening of lending standards due to funding constraints reported by all banks in the panel is associated with a widening of the loan spread by 70–80 basis points, depending on the specification. Considering the interest rate elasticity of credit demand, the consequent effect on quantities amounts to a reduction of 1.6–1.8 percentage points in the quarter-on-quarter lending growth rate. A comparable tightening due to an increase in risk perception is associated with a 15 basis point increase in the spread;

the impact is stronger when banks reported risk to have contributed "considerably" to the tightening, but this is a very rare occurrence in the sample. We also find evidence of episodes of credit rationing occurring when banks report capital constraints as a factor behind changes in credit standards:[3] in this case, we estimate that the effect of a tightening in banks' capital position is a 2 percentage point reduction in loan growth.

Second, a counterfactual exercise—assuming that supply indicators remained unchanged at their pre-crisis levels—suggests that the effects of credit tightening on loan rates were stronger in the sovereign debt crisis than in the global crisis: the cumulative effect is 190 basis points through the second quarter of 2012, of which one-third came during the global crisis and two-thirds during the sovereign debt crisis. Moreover, during the global crisis supply effects were mostly related to the banks' risk perception, while funding conditions became predominant during the sovereign crisis. In addition, we estimate that at the end of the sample period supply factors had a cumulative negative impact on the stock of loans of around 4 percent during the global crisis and 5 percent during the sovereign debt crisis. These effects can be attributed in about the same proportion to the adjustment of loan demand to the increase in the cost of credit and to credit rationing.

In addition to considering the endogeneity issue, we test for the robustness of our results by using alternative definitions of the loan spread, considering the level, rather than the variation, of the loan interest rate as one of the dependent variables, and including the sovereign spread as one of the regressors in our estimates.[4] In all these cases the estimated elasticity of both demand and supply curves remains broadly unchanged.

The rest of the paper is organized as follows. Section 2 describes the BLS data used in the estimation. Section 3 illustrates the methodology used for the identification of loan demand and supply curves. Section 4 discusses the empirical findings, for both the specification that assumes equilibrium in the credit market and the

[3]This result is in line with the classical findings on the role of capital constraints in contributing to "credit crunches" (Bernanke and Lown 1991; Peek and Rosengren 2005).

[4]During the sovereign debt crisis, the sovereign spread was often regarded as a sort of "sufficient statistic" to measure the intensity of tensions (see, e.g., Bofondi, Carpinelli, and Sette 2013; Albertazzi et al. 2014).

model with credit rationing. Section 5 illustrates the counterfactual exercises, comparing the importance of supply factors during the sovereign debt crisis with those during the global financial crisis. Section 6 provides a number of robustness checks, and section 7 concludes.

2. Data and Descriptive Evidence

The study is carried out on data for the panel of Italian banking groups (henceforth "banks") participating in the Eurosystem's quarterly Bank Lending Survey (BLS),[5] which represent roughly 60 percent of total outstanding amount of loans to enterprises in Italy. The number of banks changes somewhat over time, due to mergers and new survey participants. The data set consists of an unbalanced panel of eleven banks (with a maximum of eight per quarter) over thirty-nine quarters (2002:Q4 to 2012:Q2), providing a total of 287 observations.

As endogenous variables we use the bank-level quarter-on-quarter growth rate of loans to enterprises and the margin between the average interest rate on new bank loans to firms and the EONIA rate, which rules out the effects of monetary policy.[6] Loan data are computed using consolidated bank-level data from the Bank of Italy supervisory reports. They include repos and non-performing loans and are adjusted for the effects of securitization, for reclassifications, and for other variations not due to transactions, notably mergers and takeovers.[7]

[5]Detailed information on the BLS and the complete questionnaire can be found on the websites of the European Central Bank and Bank of Italy.

[6]Section 6 shows the estimates obtained with alternative measures of the cost of credit.

[7]Loan data include the drawn amount on credit lines. In principle, this may be a confounding factor; for example, during the early stages of the financial crisis in the United States, commercial and industrial (C&I) loans on banks' books grew rapidly as firms drew down their credit lines. In our analysis, however, this does not seem to be an important concern. First, considering the aggregate of all Italian banks, in our sample period credit lines account for less than one-third of total loans to non-financial corporations, and the share fell quite steadily during the crisis. Second, since 2009—the shorter time frame for which credit lines data for the panel of BLS banks are available—the dynamics of total loans to firms and that of an aggregate where drawn credit lines are excluded are very similar, except for the higher volatility of the latter series.

The sample is highly representative of the aggregate evolution of loan amount and interest rates. Figure 1 shows that—both for the entire banking system and for our sample—there were two phases of sharp slowdown in lending to firms: in 2008–09, coinciding with the "global crisis," and since the second half of 2011, when the sovereign debt crisis hit Italy severely. During both episodes the cost of credit also raised sharply.

Survey data are taken from the banks' responses to the BLS. For demand, we use the answers to the specific question on a bank's perception on loan demand from firms.[8] For supply, we use the question on the contribution of the different factors to lending standards.[9] For each question and supply factor, banks can indicate whether supply (demand) conditions have been tightened/eased (increased/decreased) considerably/somewhat or remained unchanged. As DEN (2011) show, in constructing indicators based on the BLS replies, it is important to take into account potential non-linear effects, which may be especially large in the case of supply conditions. We accordingly construct a set of dummy variables $\{BLS\_D_{it}^{c},\ BLS\_S_{it}^{f,c}\}$, where $\{D, S\}$ refer to demand and supply indicators, respectively; $c = \{$*increased/tightened*, *decreased/eased*$\}$ and $f = \{$*capital position*, *funding conditions*, *perception of risk*$\}$.[10] For risk perception, we construct separate dummy variables for the cases of *considerable* and *somewhat* easing/tightening.

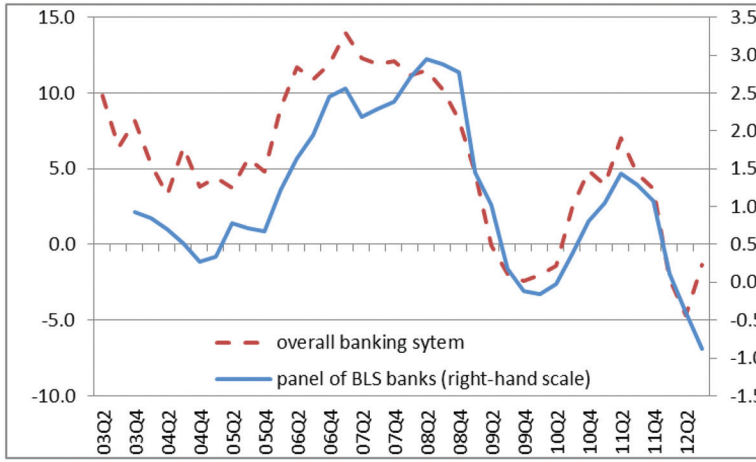
[8] The question is: "Over the past three months, how has the demand for loans or credit lines to enterprises changed at your bank, apart from normal seasonal fluctuations?"

[9] The question reads: "Over the past three months, how have the following factors affected your bank's credit standards as applied to the approval of loans or credit lines to enterprises?"

[10] *Capital position* takes a value of 1 if banks reported tightening/easing in the factor "costs related to bank's capital position." For the other supply factors, the replies are aggregated in order to avoid collinearity problems: *Funding conditions* takes a value of 1 if banks reported tightening/easing in at least one of the two factors "bank's ability to access market financing" or "bank's liquidity position"; *risk perception* takes a value of 1 if banks reported tightening/easing in at least one of the three factors "perception of risk related to expectations regarding general economic activity," "perception of risk related to industry or firm-specific outlook," or "risk on collateral demanded." In the questionnaire, possible replies also include factors related to competition; we ignore them because they have been reported very rarely in the sample period that we consider.

Figure 1. Representativeness of the BLS Panel

A. Quarter-on-Quarter Growth Rate of Loans to Enterprises
(quarterly data; percentage points)



B. Quarter-on-Quarter Change of Average Margin on Loans to Enterprises
(quarterly data; percentage points)

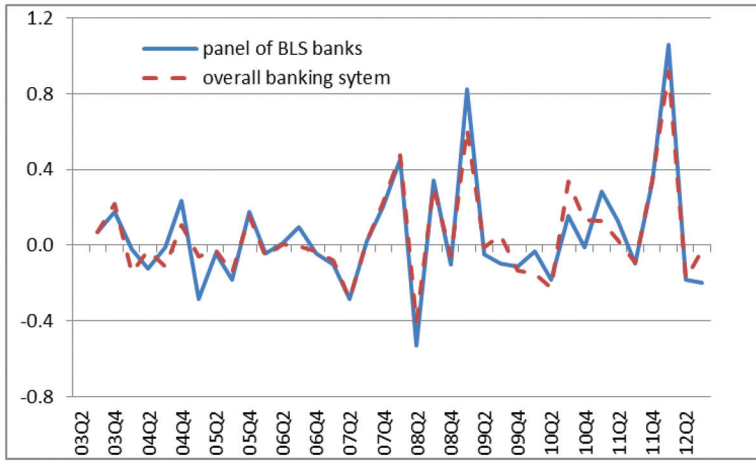
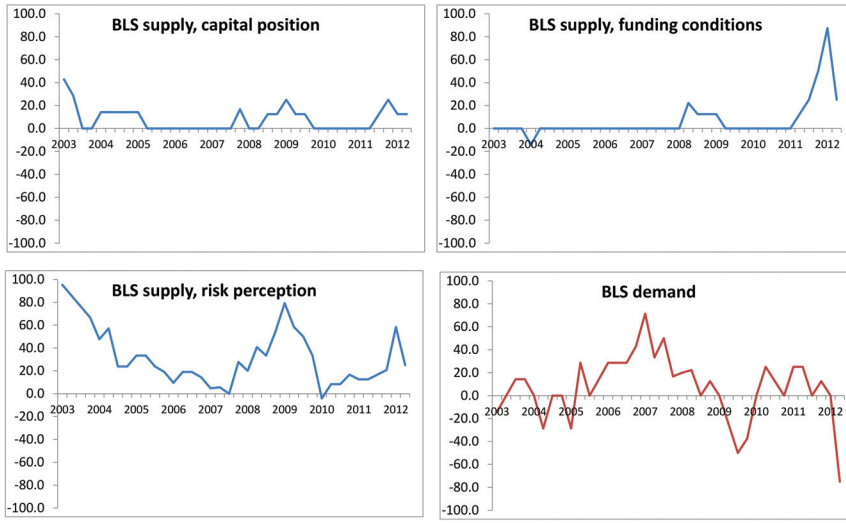


Table 1 reports descriptive statistics on the survey variables; figure 2 shows their evolution for the entire sample. First, the changes in lending standards are highly asymmetrical, with almost all the reported changes on the "tightening" side, whereas

Table 1. BLS Supply Factors and Demand Conditions for Loans to Enterprises: Descriptive Statistics (frequency of responses and, in parentheses, percentages with respect to total in each period)

	Factors Affecting Bank's Credit Standards				
	Bank's Capital Position	**Bank's Funding Conditions**	**Bank's Risk Perception**		**Bank's Demand Conditions**
1 = "contributed considerably to easing of credit standards"	0 (0.0)	0 (0.0)	0 (0.0)	1 = "decreased considerably"	0 (0.0)
2 = "contributed somewhat to easing of credit standards"	1 (0.3)	1 (0.3)	10 (3.5)	2 = "decreased somewhat	60 (20.9)
3 = "contributed to basically unchanged credit standards"	262 (91.3)	265 (92.3)	121 (42.2)	3 = "basically unchanged"	179 (62.4)
4 = "contributed somewhat to tightening of credit standards"	24 (8.4)	19 (6.6)	142 (49.5)	4 = "increased somewhat"	47 (16.4)
5 = "contributed considerably to tightening of credit standards"	0 (0.0)	2 (0.7)	14 (4.9)	5 = "increased considerably"	1 (0.3)
Total Observations	287 (100.0)	287 (100.0)	287 (100.0)	Total Observations	287 (100.0)

Figure 2. BLS Supply and Demand Indicators for Loans to Enterprises in Italy (quarterly data; "net percentages")



Source: Authors' calculation based on Bank of Italy data.

Notes: For BLS supply factors, "net percentages" are constructed as the difference between the share of banks reporting that the factor contributed to a tightening (considerably or somewhat) and the share of banks reporting that the factor contributed to an easing (considerably or somewhat). Positive (negative) values indicate a supply restriction (easing) compared with the previous quarter. Likewise, for BLS demand indicators, "net percentages" are constructed as the difference between the share of banks that reported an increase in demand (considerably or somewhat) and the share of banks that reported a decrease in demand (considerably or somewhat). Positive (negative) values indicate an increase (decrease) in loan demand compared with the previous quarter. In all cases, the range of variation of the indicator is from –100 to 100.

changes in demand are quite evenly balanced between "increase" and "decrease." Second, "considerable" tightening of standards is reported rarely, and only for risk related to firm-specific outlook. Third, the relative importance of the factors affecting credit standards differed in the two periods considered: in the aftermath of the Lehman Brothers collapse, the tightening mostly reflected increased perception of risk, with capital constraints also playing a role in some quarters; during the sovereign debt crisis, banks'

funding (and liquidity) conditions played a much larger role. The two waves of supply restriction went along with a reported fall in loan demand.

Overall, developments in demand and supply conditions mirror the behavior of lending growth and cost reported in figure 1. In both phases of the crisis, the slowdown in lending corresponded to a fall in the BLS demand indicator and a tightening of the supply factors.

The endogenous variables and the BLS indicators are combined with a set of bank-level and macroeconomic controls. In particular, we include the *quarter-on-quarter* percentage change in nominal GDP; firms' financing needs, measured by the absolute change in the ratio between the corporate sector's investments and gross operating profit; bank size, measured by the logarithm of total assets; the share of core loans, i.e., loans to the private sector over total assets, as a control for the bank's business model; the ratio of nonperforming to total loans as a proxy of bank loan quality; the bank funding gap, measured as customer loans less customer deposits over customer loans; the capital-to-asset ratio, i.e., the bank's equity over total assets; the marginal cost of funding, computed as the difference between the weighted average of the interest rates paid by the bank on its sources of funding (customer deposits and debt securities); and the EONIA rate, with the weights reflecting the relative importance of each type of liability.[11] Given that the sovereign spread has been considered as a sufficient statistic for the tensions in the banking sector (see Albertazzi et al. 2014, among others), in the robustness section we also include the change in the Italian ten-year sovereign spread with respect to the ten-year German bund as an additional control variable.

[11]The inclusion of this variable allows us to address the concern that the BLS indicator of funding conditions, as a dummy variable, may only partially capture the banks' funding difficulties and that the EONIA rate used to compute the bank markup may also depend on other bank-specific variables not included in the equation. Affinito (2011) and Angelini, Nobili, and Picillo (2011) showed that the interbank rates at longer maturities faced by Italian banks during the crisis depended significantly on some specific characteristics of borrowers and lenders and that some of the estimated relationships increased dramatically after the outbreak of the 2007–08 crisis. This might also be the case for overnight interbank rates.

3. Methodology and Identification

We estimate the following system of two simultaneous equations:

$$\Delta spread_{it} = \alpha_{1i} + \sum_{f,c} \beta_1^{f,c}(L) BLS\_S_{i,t}^{f,c} + \theta_1 \cdot \Delta loans_{it} + \gamma_1 X_{it}^1 + \mu_{it}^S \quad (1)$$

$$\Delta loans_{it} = \alpha_{2i} + \sum_{c} \beta_2^{c}(L) BLS\_D_{i,t}^{c} + \theta_2 \cdot \Delta spread_{it} + \gamma_2 X_{it}^2 + \mu_{it}^D, \quad (2)$$

where the endogenous variables $\Delta spread_{it}$ and $\Delta loans_{it}$ are, respectively, the first difference of the spread between bank i's average interest rate on new loans and EONIA in quarter t and the quarter-on-quarter rate of lending growth.[12] The variables $\{BLS\_D_{it}^{c},\ BLS\_S_{it}^{f,c}\}$ are the bank-level demand and supply factor indicators, as described in section 2, with $c = \{$*increased/tightened, decreased/eased*$\}$ and $f = \{$*capital position, funding conditions, perception of risk*$\}$.[13] These variables may enter contemporaneously and/or with lags. The lag order for each variable is selected by trying a range of lags from 0 to 4 and judging on the basis of the fit of the regression and the indications derived from standard information criteria. The vector $X_{it}^k (k = 1, 2)$ includes the bank-level and macroeconomic controls, as described above. We also add bank-specific fixed effects $(\alpha_{ki}, k = 1, 2)$ to control for unobserved bank-specific factors that might be correlated with the BLS variables and could result in inconsistent estimates. Moreover, in order to allow for possible non-linearity in the impact of the BLS indicators during specific periods of tension, we include a crisis-period dummy (taking a value of 1 from 2008:Q3 to the end of the sample period) and allow for interactions between this variable and the BLS indicators. Finally, we include lagged values of the dependent variable, if

[12] In what follows, we will sometimes loosely refer to the *spread* as *markup* or *margin*.

[13] As mentioned in section 2, in the case of *perception of risk* we construct separate dummy variables for the cases of *considerable* and *somewhat* easing/tightening, i.e., $c = \{$*tightened considerably, tightened somewhat, eased somewhat, eased considerably*$\}$.

statistically significant,[14] and dummies to capture seasonal effects. The system is consistently estimated using the two-step efficient generalized method of moments (GMM) estimator.[15] The selection of the model is based on a general-to-specific approach, where non-significant variables and/or lags are removed sequentially. Standard errors are clustered over time periods.

Our identification strategy for the system (1)–(2) relies on exclusion restrictions on the BLS indicators: the demand dummies $BLS\_D_{it}^{c}$ are excluded from equation (1) and the supply factor dummies $BLS\_S_{it}^{f,c}$ are excluded from equation (2). If θ_1 and θ_2 are, respectively, non-negative and non-positive, then equations (1) and (2) can be interpreted as, respectively, a credit supply and a credit demand curve.[16]

A crucial issue for the identification strategy is whether BLS replies are reliable indicators of changes in firm demand and/or bank lending standards. In this regard, BCDZ (2014) show that, in the United States, changes in credit standards as captured by bank-level responses to the Federal Reserve's SLOOS are negatively correlated with changes in the demand indicators. Therefore, as a proxy of loan supply shocks, they use the residual of a regression of

[14]The lagged dependent variables also act as instruments and are also reciprocally excluded. In a system of simultaneous equations, these variables are, by definition, predetermined. In principle, they can be used as regressors in both structural equations. In our system, the exclusion restrictions on predetermined variables are based upon the statistical significance of their coefficients and the indications provided by the Sargan test.

[15]The GMM estimator is more efficient than the traditional IV/2SLS estimator for over-identified systems of equations and when the residuals present heteroskedasticity and arbitrary intragroup correlation (see Hayashi 2000). BCDZ (2014) contrast ordinary least squares estimates of loan demand with instrumental-variables estimates and show that the latter is more (negatively) sloped, corroborating the validity of the changes in standards series as a potential loan supply shock measure. In a(n unreported) similar experiment we obtain similar results: the semi-elasticity of loan demand estimated with OLS is about –0.4 and statistically not significant.

[16]A special case of this structural model is $\theta_1 = 0$, i.e., credit supply is flat and the intermediaries set loan interest rates and fully accommodate credit demand, consistently with the standard imperfect competition framework of credit market (Freixas and Rochet 2008; Degryse, Kim, and Ongena 2009). It is also to be noted that, since in the sample period considered there are very few instances of easing of credit standards, only a portion of the demand curve can actually be estimated.

Table 2. Estimated Correlation between Demand Conditions and Supply Factors

	Demand Decrease	Demand Increase
BLS Capital Position, Tightening	0.20	−0.03
BLS Funding Conditions, Tightening	0.20	0.09
BLS Risk Perception, Tightening Considerably	−0.01	0.04
BLS Risk Perception, Tightening Somewhat	0.21	−0.05

changes in credit standards on the demand indicator and a number of macroeconomic and bank-specific controls.

It is important to check whether similar concerns apply to our case. Visual inspection of figure 2 provides preliminary evidence about the presence of unconditional correlation between changes of the BLS supply factors and those of the demand indicator. The contemporaneous correlation is very low for all supply factors over the entire sample period; for risk perception, it increases somewhat in the phase of most acute tensions of the global crisis. A more useful investigation assesses the empirical correlation in the panel data, rather than for the aggregate series over time, by considering separately the indicators of demand decreases and demand increases. The results, reported in table 2, confirm that the correlation is generally low, albeit not trivial. It is to be noted that these estimates do not control for any macroeconomic variables or bank-specific features, which are instead included, together with bank-fixed effects, in all our regressions. The inclusion of control variables further limits the potential endogeneity problems in the use of the BLS indicators.

As a further test for our identification strategy, we use statistical tools to assess the validity of our excluding restrictions. In particular, as we deal with *over-identified* supply and demand equations, we perform the Sargan-Hansen test for each structural equation separately, and separate tests for the exclusion of each individual instrument with the "difference-in-Sargan" statistic. We also report the Wald version of the Kleibergen-Paap statistic, which tests whether the excluded instruments are correlated with the endogenous regressors.[17]

[17]See Kleinbergen and Paap (2006).

Finally, as a further robustness check, in section 5 we rerun our main regressions using the same methodology as in BCDZ (2014). We find that all our results hold also in this case.

The system of equations (1) and (2) describes a framework in which the market for loans clears at every point in time. An important limitation of this approach is its inability to capture *credit rationing*, which may occur during episodes of severe restriction of loan supply and is typically related to specific factors.[18] Exploiting the BLS information on the factors behind the supply restriction, we can account for the presence of credit rationing in our estimates by using a variant of the "quantitative approach" by Fair and Jaffee (1972). According to that approach, the structural representation of a disequilibrium model consists of a demand equation, a supply equation, and an equation determining the level of excess demand. In this paper we test whether specific BLS supply indicators provide information on the existence of excess demand or supply, therefore capturing market disequilibrium phenomena. From a practical perspective, this approach boils down to testing whether any of the supply factors can be significantly added to equation (2). The complete description and derivation of the equations for this approach are provided in the appendix.

4. The Empirical Results

Table 3 reports the results of the econometric estimation. First, we discuss the equilibrium model (equations (1)–(2)). Columns (a)–(a') show the estimates of the supply and demand equations, including only the BLS indicators. The coefficient for the loan spread in the demand equation is highly significant and negative, suggesting a downward-sloping demand curve. The estimated elasticity is high: a 100 basis point increase in the markup is associated with a reduction of more than 2 percentage points in the quarter-on-quarter growth rate of loans. In the supply equation, the coefficient of loan growth

[18] Credit-rationing episodes occur when, at the prevailing interest rate, the demand for credit exceeds the supply and lenders will not supply additional credit even if the borrowers are ready to pay higher margins. Seminal work by Bernanke and Lown (1991) points to the role of banks' capital constraints; Stiglitz and Weiss (1981) focus on the role of asymmetric information. Additional causes of credit rationing relate to funding or liquidity constraints and risk aversion.

Table 3. Structural Equations for Loans to Enterprises

	Equilibrium Model				Disequilibrium Model	
	(a)	(a')	(b)	(b')	(c)	(c')
	Supply Curve	Demand Curve	Supply Curve	Demand Curve	Supply Curve	Demand Curve
	Δspread (t)	Δloan (t)	Δspread (t)	Δloan (t)	Δspread (t)	Δloan (t)
Endogenous Variables:						
Δloan (t)	0.067*		0.082*		0.081**	
Δspread (t)		−2.189***		−2.468***		−2.286***
Predetermined Variables:						
Δloan (t–2)		0.191***		0.129**		0.152**
Δspread (t–1)	−0.404***		−0.426***		−0.424***	
Δspread (t–2)	−0.204**		−0.252***		−0.252***	
Exogenous Variables:						
BLS Demand, Increase (t)		1.140***		1.067***		0.984**
BLS Demand, Decrease (t)		−0.964**		−0.538		−0.288
BLS Supply, Capital Position, Tightening (t)	−0.018		0.008			−2.001***
BLS Supply, Funding Conditions, Tightening (t)	0.472***		0.407***		0.407***	
BLS Supply, Funding Conditions, Tightening (t–1)	0.323**		0.290*		0.292*	
BLS Supply, Risk Perception, Tightening Considerably (t)	0.597**		0.487***		0.487***	
BLS Supply, Risk Perception, Tightening Somewhat (t) * Crisis Dummy	0.167**		0.124		0.124	
Crisis Dummy	0.101		0.030		0.029	

(*continued*)

Table 3. (Continued)

	Equilibrium Model				Disequilibrium Model	
	(a)	(a')	(b)	(b')	(c)	(c')
	Supply Curve	Demand Curve	Supply Curve	Demand Curve	Supply Curve	Demand Curve
	Δspread (t)	Δloan (t)	Δspread (t)	Δloan (t)	Δspread (t)	Δloan (t)
Other Control Variables:						
ΔNominal GDP (t)			−0.094**	0.427**	−0.095**	0.379**
ΔFinancing Needs (t)			−0.009	0.032	−0.009	0.031
Bank Size (t)			−0.047	−0.336	−0.047	−0.359
Bank Share of Core Loans (t)			−0.015	0.087*	−0.011	0.086*
Bank Loan Quality (t)			0.047*	−0.338***	0.046**	−0.403***
Bank Funding Gap (t)			−0.002	0.049	−0.001	0.054
Bank Capital-to-Asset Ratio (t)			0.021	−0.105	0.017	−0.007
ΔMarginal Cost of Funding (t)			0.081**	0.256	0.081**	0.330*
Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Seasonal Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Estimation Technique	2S-GMM	2S-GMM	2S-GMM	2S-GMM	2S-GMM	2S-GMM
Number of Observations (N)	247	247	245	245	245	245
Number of Regressors (K)	12	7	20	15	19	16
Number of Endogenous Regressors (K1)	1	1	1	1	1	1
Number of Instruments (L)	14	14	22	22	22	22
Number of Excluded Instruments (L1)	3	8	3	8	4	7
R-squared	0.162	0.136	0.195	0.196	0.169	0.251
Identification Diagnostics:						
Under-identification Test:						
Kleibergen-Paap rk LM Statistic	20.88	20.78	14.99	17.03	21.83	17.05
p-value	0.00	0.01	0.00	0.03	0.00	0.02
Weak-Identification Test:						
F-statistic of Excluded Instruments	7.48	9.56	4.51	6.12	5.12	6.98
Over-identification Test for All Variables:						
Hansen J Statistic	4.10	16.97	3.24	12.46	3.28	2.30
p-value	0.13	0.02	0.20	0.08	0.35	0.89

(*continued*)

Table 3. (Continued)

	Equilibrium Model				Disequilibrium Model	
	(a)	(a')	(b)	(b')	(c)	(c')
	Supply Curve	Demand Curve	Supply Curve	Demand Curve	Supply Curve	Demand Curve
	Δspread (t)	Δloan (t)	Δspread (t)	Δloan (t)	Δspread (t)	Δloan (t)
C-Statistics (p-value) for Each Single Variable:						
BLS Demand, Increase (t)	0.67		0.82		0.82	
BLS Demand, Decrease (t)	0.11		0.13		0.15	
BLS Supply, Capital Position, Tightening (t)		0.10		0.01	0.27	
BLS Supply, Funding Conditions, Tightening (t)		0.73		0.40		0.40
BLS Supply, Funding Conditions, Tightening (t–1)		0.30		0.74		0.74
BLS Supply, Risk Perception, Tightening Considerably (t)		0.95		0.91		0.91
BLS Supply, Risk Perception, Tightening Somewhat (t) * Crisis Dummy		0.88		0.47		0.47

Notes: The dependent variables, "Δspread" and "Δloan," are, respectively, the quarterly change in bank markup (computed as the difference between the average rate on new loans and the EONIA rate) and the quarter-on-quarter growth rate in loan quantity. "BLS Supply, Capital Position, Tightening," "BLS Supply, Funding Conditions, Tightening," and "BLS Supply, Risk Perception, Tightening" (also specifying whether the bank reported that this factor contributed considerably or somewhat to a tightening) are dummy variables taking the value of 1 if a bank reported that this factor contributed to a tightening in credit supply conditions. "BLS Demand, Decrease" and "BLS Demand, Increase" are dummy variables taking the value of 1 if the bank reported, respectively, decrease/increase in demand. *, **, and *** denote significance, respectively, at 10 percent, 5 percent, and 1 percent. The "Under-identification Test" is a Lagrange-Multiplier test of the null hypothesis that the equation is under-identified (i.e., the matrix of reduced-form coefficients on the $L1$ excluded instruments has rank $K1-1$), while the alternative hypothesis is that the equation is identified (i.e., the matrix has rank exactly equal to $K1$). Under the null hypothesis, the test statistic is distributed as chi-squared in $(L1-K1+1)$ degrees of freedom. The "Over-identification Test" is based on the Sargan-Hansen statistic: under the null hypothesis that the exclusion restrictions are valid; the test statistic is distributed as chi-squared in the $(L-K)$ number of tested over-identifying restrictions. The C-statistic (or "difference-in-Sargan" statistic) allows a test of the exogeneity of one single instrument. Under the null hypothesis that both the smaller set of instruments and the additional, suspect instruments are valid, the C-statistic is distributed as chi-squared in the number of instruments tested.

is positive but very small and only marginally significant, suggesting that the credit market supply curve is almost flat.

As to the other variables in the supply equation, none of the "easing" dummies is significant (and they are therefore not reported in the table). This is not unexpected, as it presumably reflects the marked asymmetry of the BLS supply indicators, which almost never report an easing. "Tightening" replies are associated with significant effects on the loan spread. Specifically, banks' funding conditions have a significant effect both on impact and with a one-quarter lag: the estimates indicate that if all banks in the sample reported a tightening related to this factor, the spread would be around 80 basis points higher than if no bank signaled such an effect. A tightening related to a worsening of banks' risk perception is also found to have a significant effect on loan rates: the impact effect is estimated at 60 basis points when banks reported that this factor contributed "considerably" to the tightening, and at 17 basis points during the crisis when it was reported to have contributed "somewhat."[19] Given the interest rate elasticity of credit demand, the resulting effects on quantities would amount to a reduction of 1.8 percentage points in the quarter-on-quarter lending growth for funding conditions and of between 0.4 and 1.3 points for risk perception. A tightening connected with the banks' capital position is not statistically significant. In the loan demand equation, the dummies of the BLS demand indicator are significant and have the expected signs in the case of both "increase" and "decrease." The coefficients suggest that the relationship is roughly linear: both an increase and a decrease in demand are related to a corresponding change in credit growth by about 1 percentage point.

Columns (b)–(b') report the results of the regression including bank-level and macroeconomic covariates. The results are similar to the previous regression, with minor differences in the magnitude of the coefficients. The elasticity of demand increases somewhat in absolute value while that of the supply curve remains broadly unchanged. In both equations, GDP and bank-level loan quality are significant and have the expected signs; higher marginal cost of funding is associated with a rise in the cost of credit. The inclusion of these controls crowds out the significance of the BLS indicator for

[19] In the latter case, it is significant only when interacted with the crisis dummy.

demand decrease in the demand equation and of the moderate risk perception indicator in the supply equation. The overall impact on the loan spread of a tightening due to funding conditions is around 70 basis points (after one quarter); that of a considerable tightening due to risk perception is 50 basis points. The corresponding effects on loan growth are 1.6 and 1.1 percentage points.

Overall, the fact that the results for the BLS indicators are very similar between the models reported in columns (a)–(a') and (b)–(b') provides further evidence that endogeneity is not a significant concern. An additional formal check of the quality of the identification strategy is the Sargan-Hansen test, which tests the null hypothesis that the instruments are correctly excluded from the structural equation to be identified. In the regressions just discussed (both with and without controls), the test suggests that the supply equation is correctly identified. For the demand equation, however, the null hypothesis cannot be accepted at a 10 percent confidence level. The "difference-in-Sargan" C-statistic—testing for the exclusion of each instrument separately—suggests that this failure is related to the restriction that the dummy for the tightening of banks' capital position is excluded from the quantity equation. The exclusion of all the other instruments, instead, is accepted with a generally high confidence level. This suggests that the BLS indicator of a bank's capital position could enter the demand equation, thus carrying information on possible credit rationing.

Columns (c)–(c') of table 2 show the results for the disequilibrium model, i.e., the system of equations (7)–(8) described in the appendix, in which the existence of excess loan demand is related to the BLS supply factor involving capital position.[20] The direct effect of the BLS capital position indicator on loan demand is negative and highly significant; a tightening of this factor is associated with a decline of 2 percentage points in the quarter-on-quarter growth rate of loans. The coefficients of the remaining variables are almost identical to the previous specification, including the estimated slopes of the demand and supply curves and the coefficients associated with the BLS demand and supply indicators.

[20]In unreported regressions, we tried to use the other BLS supply factors as rationing indicators; consistently with the difference-in-Sargan test mentioned above, none were significant.

The diagnostic tests appear to support our identification scheme. In particular, the overall Sargan-Hansen test p-value increases substantially for both the supply and demand equations, and the null hypothesis is now comfortably accepted also for the demand equation. All individual instruments—including the BLS capital position in the demand equation—also comfortably pass the C-test for single instrument exclusion. Overall, these results suggest that the credit supply curve is almost flat in normal times and becomes temporarily price inelastic when banks report a worsening in their capital position, consistent with the presence of credit rationing during a financial crisis.

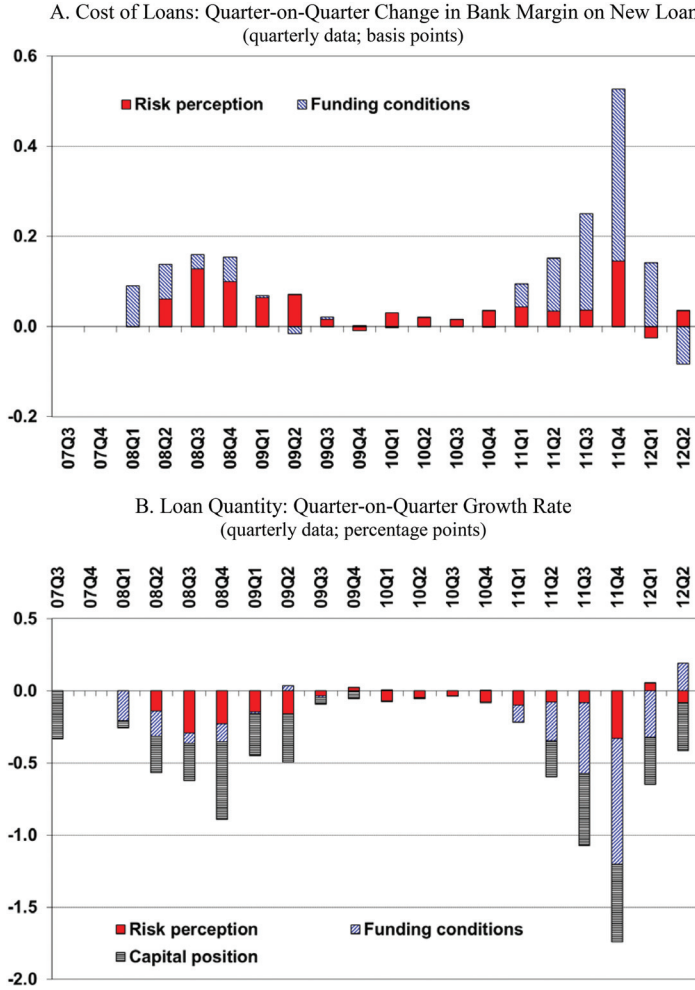
5. Was the Sovereign Debt Crisis Different from the Global Crisis?

In the previous sections we have used the BLS demand and supply indicators to identify and estimate structural demand and supply curves for business lending. Now we use these estimates to quantify the contribution of supply factors to changes in the cost and the volume of loans during the two phases of the financial crisis. To this end we perform a counterfactual exercise setting the supply indicators constant throughout the crisis at their pre-crisis (2007:Q2) levels.[21] Based on the estimated parameters, we can calculate the values of the interest rate spread and the loan growth rate in this counterfactual scenario and compare them with the fitted values based on actual supply indicators, thus obtaining an estimate of each factor's contribution.

We perform the counterfactual analysis using the specification presented in columns (c)–(c') of table 3. Figure 3 (panels A and B) shows the quarterly contribution of each factor to the change in the cost and the growth rate of loans to firms. Table 4 provides a more compact illustration of the effects of supply factors, in terms of their quantification and sources, by reporting the estimates of the cumulative effects in the two phases of the financial crisis.

[21] In the exercise, we assume that the BLS demand indicators and the control variables equal their realized values.

Figure 3. Counterfactual Exercise: Estimated Contribution of Supply Factors to the Cost and Growth Rate of Loans to Enterprises (based on columns (c)–(c') of table 3)



The results indicate that supply factors—as measured by the BLS indicators—had a substantial effect on both the cost and the availability of credit throughout the crisis. The magnitude of the effects was stronger on average during the sovereign debt crisis than during the global financial crisis.

Table 4. Counterfactual Exercise: Cumulative Contribution of Supply Factors to the Cost and Growth Rate of Loans to Enterprises (based on columns (c)–(c') of table 3)

	Global Crisis 2007:Q3–2010:Q1	**Sovereign Debt Crisis 2010:Q2–2012:Q2**	**Whole Period 2007:Q3–2012:Q2**
	Effect on the Cost of Credit (Basis Points)		
BLS Supply Factors:	25	82	107
BLS Funding Conditions	46	34	80
BLS Perception of Risk	71	116	187
Total Supply Indicators			
	Effect on the Stock of Loans (Percent)		
BLS Supply Factors:			
BLS Capital Position	−2.2	−2.0	−4.1
BLS Funding Conditions	−0.6	−1.9	−2.4
BLS Perception of Risk	−1.1	−0.8	−1.8
Total Supply Indicators	−3.8	−4.6	−8.4

As regards the cost of credit, the tightening of supply conditions is estimated to have determined a quarterly rise of 53 basis points at the peak of the sovereign debt crisis (2011:Q4), compared with about 15 basis points at the peak of the global crisis (2008:Q3 and Q4). The cumulative effect from the beginning of the crisis through 2012:Q2 is estimated at around 190 basis points, of which about one-third came during the global crisis and two-thirds during the sovereign debt crisis.

The two phases of the crisis were characterized by differing relative importance of the various supply factors. During the global crisis, risk perception played a predominant role in affecting the cost of lending, while the impact of funding conditions was smaller. By contrast, during the sovereign debt crisis, the factors relating to difficulties in access to funding became much more important, determining on average around 70 percent of the rise in interest rates due to all supply factors. The effects on the growth rate of loans via the elasticity of demand to cost differed correspondingly. The impact of supply factors was greatest in the last quarter of 2011, when it is estimated to have reduced the quarter-on-quarter growth rate of loans by almost 2 percentage points, compared with almost 1 point in 2008:Q4. The contributions of credit-rationing effects related to the banks' capital position were similar in the two phases of the crisis.[22]

At the end of the sample period (2012:Q2), supply factors are estimated to have determined a cumulative reduction of about 8 percent in the stock of loans. The part of this negative effect that can be ascribed to credit rationing is estimated to be about 4 percent, equally distributed in the two phases of the crisis.

6. Robustness Analysis

6.1 Assessing the Endogeneity of the BLS Supply Indicators

As discussed above, the use of the BLS demand and supply indicators to identify demand and supply may raise endogeneity concerns.

[22]It is worthwhile noting that these differences may reflect not only the relative importance of the various factors in the two periods but also changes in the way lending standards affect credit markets over time.

Adding to the evidence provided by the correlation analysis (in section 3) and that discussed in section 4, we further address this issue here by replicating the approach proposed by BCDZ (2014). First, we estimate logit regressions for each BLS supply factor, including, besides the standard control variables, the BLS demand indicators as explanatory variables. Results (reported in table 5) show that changes in the BLS demand conditions have marginal information content only for the supply indicator that reflects banks' funding conditions; they have no predictive power for the supply indicators related to the banks' assessment of their capital position or their perception of risk.

Using the estimated parameters of the logit regressions, we then derive the "adjusted" indicators of BLS supply factors.[23] Figure 4 shows these indicators together with the corresponding "unadjusted" measures. The dynamics of the two types of indicator are very similar. As expected, during the sovereign debt crisis, the BLS "adjusted" indicator for bank funding conditions is somewhat lower than the corresponding "adjusted" measure.

Next, we reestimate the model (with rationing), replacing all the BLS supply indicators with the corresponding "adjusted" measures. The coefficients for the supply and demand curves are reported in table 6 and are very similar to those obtained with the benchmark specification. In particular, the semi-elasticity of loan demand and the estimated effect of credit rationing, as captured by banks' assessments of their capital position, remain highly significant and of the same magnitude. We also replicate the counterfactual exercise described in section 5 using these estimated coefficients and the "adjusted" BLS supply indicators. The main results remain broadly unchanged.[24]

[23] In particular, these are the differences between the bank-specific reported outcome and the bank-specific predicted probabilities of a tightening at each point in time. As BCDZ (2014) observe, asymptotically these residuals share the zero-mean and orthogonality properties of the residuals from an OLS regression.

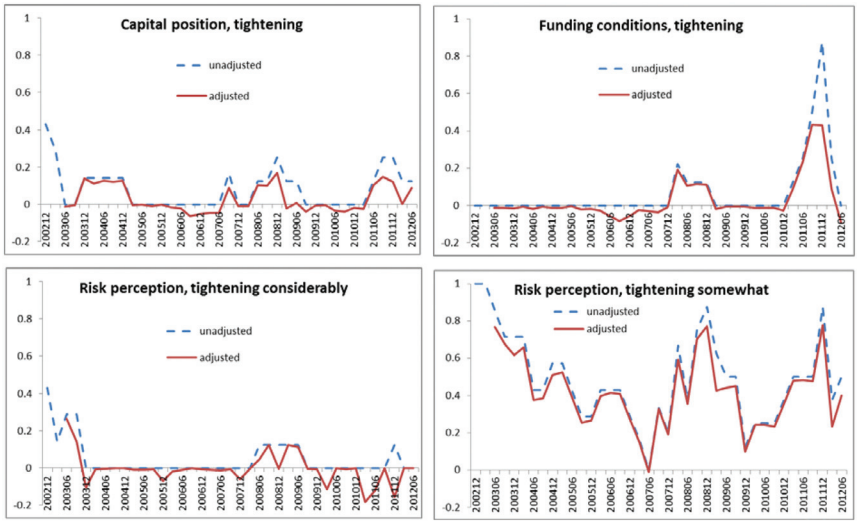
[24] Specifically, the cumulative effect of the supply factors on the cost and the stock of loans, from the beginning of the crisis through 2012:Q2, reduces somewhat to, respectively, 160 basis points and –6.8 percent. The results also confirm the predominant role of banks' funding conditions during the sovereign debt crisis, as well as the presence of a similar impact of credit-rationing effects in the two phases of the crisis.

Table 5. Logit Regressions for BLS Supply Factors

	Dependent Variable			
	BLS Supply, Capital Position, Tightening	**BLS Supply, Funding Conditions, Tightening**	**BLS Supply, Risk Perception, Tightening Considerably**	**BLS Supply, Risk Perception, Tightening Somewhat**
Lagged Dependent Variable	1.502**	1.458**	3.901**	1.881***
BLS Demand, Decrease (t)	1.237	1.658*	−0.331	−0.596
BLS Demand, Increase (t)	1.371	2.551**	−20.713	0.783
ΔNominal GDP (t)	−0.474	−0.019	0.740	−0.444**
ΔFinancing Needs (t)	−0.085	−0.005	0.128	0.021
Bank Size (t)	12.920**	4.721	9.303*	−0.986
Bank Loan Quality (t)	−0.683**	0.181	−0.846	0.063
Bank Share of Core Loans (t)	0.126	0.040	−0.412	−0.004
Bank Funding Gap (t)	0.081	0.137*	0.370*	0.000
Bank Capital-to-Asset Ratio (t)	−0.364	0.053	2.474	−0.101
ΔMarginal Cost of Funding (t)	0.342	0.476*	4.693*	0.447**
Bank-Specific Fixed Effects	Yes	Yes	Yes	Yes

Notes: "BLS Supply, Capital Position, Tightening," "BLS Supply, Funding Conditions, Tightening," and "BLS Supply, Risk Perception, Tightening" (also specifying whether the bank reported that this factor contributed considerably or somewhat to a tightening) are dummy variables taking the value of 1 if a bank reported that this factor contributed to a tightening in credit supply conditions. "BLS Demand, Decrease" and "BLS Demand, Increase" are dummy variables taking the value of 1 if the bank reported, respectively, decrease/increase in demand. *, **, and *** denote significance, respectively, at 10 percent, 5 percent, and 1 percent.

Figure 4. "Adjusted" vs. "Unadjusted" BLS Supply Indicators (quarterly data)



Source: Authors' calculation based on Bank of Italy data.

Notes: Each "unadjusted" BLS supply indicator is computed as the share of banks reporting that the indicated factor contributed to a tightening in credit supply conditions. Each "adjusted" indicator is computed as the difference between the corresponding "unadjusted" indicator and the predicted probability of a tightening related to the indicated factor, which is obtained by the logit regressions described in section 6.1.

All in all, the results reported here confirm that the correlation between the BLS supply and demand indicators is not a critical issue in our empirical investigation.

6.2 Using Alternative Measures for the Cost of Credit

As a second robustness check, we reestimate our structural model under three alternative definitions of the cost of credit, replacing the difference between the loan rate and the EONIA, which we used in our baseline regressions. First, practical considerations suggest that loan demand may simply depend on the cost of credit, rather than on the margin over some market rate; therefore, we rerun our regressions using simply the level of the loan rate. Second, since the use of an overnight rate could result in attributing an improper term

Table 6. Structural Equations for Loans to Enterprises: Removing Correlation between BLS Supply Factors and BLS Demand Indicators

	(a)	(a')
	Supply Curve	**Demand Curve**
	Δspread (t)	**Δloan (t)**
Endogenous Variables:		
Δloan (t)	0.092**	
Δspread (t)		−2.025**
Predetermined Variables:		
Δloan (t–2)		0.152**
Δspread (t–1)	−0.413***	
Δspread (t–2)	−0.268***	
Exogenous Variables:		
BLS Demand, Increase (t)		0.834**
BLS Demand, Decrease (t)		−0.451
BLS Supply, Capital Position, Tightening (t), Adjusted		−1.922***
BLS Supply, Funding Conditions, Tightening (t), Adjusted	0.430***	
BLS Supply, Funding Conditions, Tightening (t–1), Adjusted	0.432***	
BLS Supply, Risk Perception, Tightening Considerably (t), Adjusted	0.346**	
BLS Supply, Risk Perception, Tightening Somewhat (t), Adjusted * Crisis Dummy	0.096	
Crisis Dummy	0.062	
Other Control Variables:		
ΔNominal GDP (t)	−0.112*	0.438**
ΔFinancing Needs (t)	−0.011	0.041
Bank Size (t)	−0.016	−0.573
Bank Share of Core Loans (t)	−0.017*	0.080
Bank Loan Quality (t)	0.053**	−0.396***
Bank Funding Gap (t)	−0.003	0.054
Bank Capital-to-Asset Ratio (t)	0.029	−0.039
ΔMarginal Cost of Funding (t)	0.111***	0.267
Fixed Effects	Yes	Yes
Seasonal Dummies	Yes	Yes
Estimation Technique	2S-GMM	2S-GMM
Number of Observations (N)	245	245
Number of Regressors (K)	19	16
Number of Engodenous Regressors (K1)	1	1
Number of Instruments (L)	22	22
Number of Excluded Instruments (L1)	4	7
R-squared	0.095	0.264

(*continued*)

Table 6. (Continued)

	(a)	(a')
	Supply Curve	**Demand Curve**
	Δspread (t)	**Δloan (t)**
Identification Diagnostics:		
Under-identification Test:		
Kleibergen-Paap rk LM Statistic	19.41	17.31
p-value	0.00	0.02
Weak-Identification Test:		
F-statistic of Excluded Instruments	4.59	6.38
Over-identification Test for All Variables:		
Hansen J Statistic	1.99	1.84
p-value	0.57	0.93

Notes: "BLS Supply Funding Conditions, Tightening" and "BLS Supply, Risk Perception, Tightening" (also specifying whether the bank reported that this factor contributed considerably or somewhat to a tightening) are residuals from the logit regressions reported in table 3. For the definition of all other variables and the statistical tests, see the notes of table 3.

premium to our measure of loan cost, we replicated the analysis by computing the margin with respect to the three-month EURIBOR (to which 95 percent of business loans are indexed). One drawback of EURIBOR (which is quoted for unsecured transactions) is that it was not an appropriate measure of the monetary policy stance during the global crisis, when it abnormally jumped because of the increase in risk aversion in the interbank market (see Angelini, Nobili, and Picillo 2011). For this reason, we considered as a third measure the spread vis-à-vis the three-month EUREPO, which is based on secured interbank transactions and was basically unaffected by tensions in the interbank market during the crisis.

Table 7 reports the estimated coefficients for the alternative measures of the cost of credit. The results are very similar to those for the benchmark system.

6.3 Including the Sovereign Spread

During the sovereign debt crisis, analysts and policymakers paid considerable attention to the sovereign yield spreads between the euro-area countries hit by the tensions and Germany, which was often regarded as a sort of "sufficient statistic" to measure the

Table 7. Estimated Coefficients in Loan Demand and Supply Curves: Using Alternative Measures for the Cost of Credit

Semi-elasticity of Enterprises' Credit Demand to the Cost of Credit	
Memo: Spread between the Loan Rate and the EONIA	*–2.286***
Loan Rate	−2.914***
Spread between the Loan Rate and the Three-Month EURIBOR	−1.819*
Spread between the Loan Rate and the Three-Month EUREPO	−1.967***
Semi-elasticity of Credit Supply to a Change in Loans to Enterprises	
Memo: Spread between the Loan Rate and the EONIA	*0.081***
Loan Rate	0.066*
Spread between the Loan Rate and the Three-Month EURIBOR	0.012
Spread between the Loan Rate and the Three-Month EUREPO	0.072*

Notes: In the credit demand equation, the dependent variable is the quarter-on-quarter growth rate of the loan quantity. The loan rate is the average rate on new loans to enterprises. For each measure of the cost of credit, the quarterly change is considered in the regressions. *, **, and *** denote significance, respectively, at 10 percent, 5 percent, and 1 percent.

severity of the strains. Thus, we deemed it useful to investigate whether including the ten-year sovereign spread affects the estimated coefficients of the credit demand and supply curves and added the sovereign spread as a control variable. Results are reported in table 8.

The estimated semi-elasticity of credit demand remains unchanged at about 2 percent. The slope of the loan supply curve is also similar to that obtained with the benchmark specification. The coefficient of the sovereign spread is positive and highly significant: a 100 basis point increase in the spread is associated with a pass-through of around 60 basis points after one quarter, a magnitude similar to those found in other studies based on aggregate data (Neri 2013; Zoli 2013; Albertazzi et al. 2014).[25] The inclusion

[25]We also checked whether the effects of changes in the sovereign spread differed depending on whether they stem from changes in the yield on Italian or on German government bonds, by separately including the BTP and the bund yields in the regressions in the place of the sovereign spread. The results show that a rise in the BTP yield has a stronger effect on the cost of loans to enterprises than a reduction in the bund yield. The pass-through after one quarter is around 75 basis points in the former case and 50 basis points in the latter.

Table 8. Structural Equations for Loans to Enterprises: Including the Sovereign Spread

	(a)	(a')
	Supply Curve	**Demand Curve**
	Δspread (t)	**Δloan (t)**
Endogenous Variables:		
Δloan (t)	0.061*	
Δspread (t)		−2.020**
Predetermined Variables:		
Δloan (t–2)		0.143**
Δspread (t–1)	−0.462***	
Δspread (t–2)	−0.177**	
Exogenous Variables:		
BLS Demand, Increase (t)		0.904**
BLS Demand, Decrease (t)		−0.253
BLS Supply, Capital Position, Tightening (t)		−2.254***
BLS Supply, Funding Conditions, Tightening (t)	0.089	
BLS Supply, Funding Conditions, Tightening (t–1)	0.109	
BLS Supply, Risk Perception, Tightening Considerably (t)	0.376***	
BLS Supply, Risk Perception, Tightening Somewhat (t) * Crisis Dummy	0.083	
Crisis Dummy	0.030	
Other Control Variables:		
ΔNominal GDP (t)	−0.044	0.381**
ΔFinancing Needs (t)	−0.006	0.021
Bank Size (t)	−0.071	−0.449
Bank Share of Core Loans (t)	−0.013	0.089*
Bank Loan Quality (t)	0.032	−0.442***
Bank Funding Gap (t)	−0.005	0.050
Bank Capital-to-Asset Ratio (t)	0.010	−0.025
ΔMarginal Cost of Funding (t)	0.033	0.211
ΔSovereign Spread (t)	0.201***	0.682
ΔSovereign Spread (t–1)	0.416***	−0.194
Fixed Effects	Yes	Yes
Seasonal Dummies	Yes	Yes
Estimation Technique	2S-GMM	2S-GMM
Number of Observations (N)	245	245
Number of Regressors (K)	21	18
Number of Engodenous Regressors (K1)	1	1
Number of Instruments (L)	24	24
Number of Excluded Instruments (L1)	4	7
R-squared	0.327	0.274

(*continued*)

Table 8. (Continued)

	(a)	(a')
	Supply Curve	**Demand Curve**
	Δspread (t)	**Δloan (t)**
Identification Diagnostics:		
Under-identification Test:		
Kleibergen-Paap rk LM Statistic	22.48	24.64
p-value	0.00	0.00
Weak-Identification Test:		
F-statistic of Excluded Instruments	5.20	5.95
Over-identification Test for All Variables:		
Hansen J Statistic	4.94	4.44
p-value	0.17	0.62

Notes: "ΔSovereign Spread" is the quarterly change in the difference between the yield on the ten-year Italian government bond and the corresponding German one. For the definition of all other variables and the statistical tests, see the notes of table 3.

of the sovereign spread wipes out the significance of the BLS funding conditions indicator and the bank-specific marginal cost and lowers the coefficient of the BLS risk-perception indicators. These results suggest that during the sovereign debt crisis the correlation between banks' funding difficulties and credit developments largely reflected the common shock related to the sovereign debt markets. This common effect dominated the idiosyncratic components, potentially captured by the individual banks' cost of funding and their survey answers.

7. Conclusions

In this paper we used firm-level responses of Italian banks to the Eurosystem's quarterly Bank Lending Survey to estimate structural relationships in the credit market. Our aim was to assess the effect of credit supply tightening on the volume and cost of bank lending, distinguishing between restrictions connected to borrowers' riskiness and those due to worsening in banks' balance sheet conditions. We evaluated whether such effects differed during the sovereign debt crisis compared with the global financial crisis.

We find that the impact of supply shocks on loan rates and quantities is significantly larger when the restriction reflects banks' balance sheet constraints as compared with borrowers' riskiness. The data also indicate that credit rationing was present during the most acute phases of financial tension and was related to banks' capital constraints. In addition, a counterfactual exercise suggests that the effects of the supply restriction on both the cost and the availability of credit were, on average, stronger during the sovereign debt crisis than during the global crisis. And whereas throughout the global crisis supply effects on the cost of credit were mostly related to the banks' risk perception, during the sovereign crisis funding conditions became predominant. Credit-rationing effects related to the banks' capital position were similar in the two phases of the crisis.

A caveat common to all studies based on survey data is that the quality of the results depends on the truthfulness of the respondents' answers. On the one hand, banks may be inclined to report tighter credit standards than those actually applied because they fear that the information could be exploited for supervisory purposes. On the other hand, during the crisis public criticism and political pressure may have induced banks to portray their policies as less restrictive than they actually were. In the latter case, our estimates of the effects of supply restriction on credit conditions could be considered as a lower bound.

Our results suggest two policy considerations. First, well-capitalized banks are less likely to generate strong procyclical changes in credit supply conditions through rationing. In this regards, the recent structural reforms in the banking sector should help to stabilize the credit cycle. Second, the differences we found as regards the effects of supply restriction corroborate the mix of policy measures adopted by the European Central Bank's Governing Council to counteract the effects of the crisis on lending, which attenuated the negative spiral between tightening credit conditions and the deterioration of the real economy. An interesting development for future research would be to extend our model to include bank-level data on recourse to the longer-term refinancing operations or sales of financial assets to central banks in the context of the Extended Asset Purchase Programme. This would contribute to the growing empirical literature on the effects of unconventional monetary policy on credit conditions and the real economy.

Appendix. Description of the Credit-Rationing Model

The system of equations (1) and (2) describes a framework in which the changes in the interest rate always ensure that the quantity of credit supplied equals the amount demanded at each point in time, so that the market clears. An important limitation of this approach is its inability to capture credit rationing, namely episodes of excess demand over supply.[26] To make the model tractable and suitable for empirical analysis, we follow the "quantitative approach" by Fair and Jaffee (1972), according to which the structural representation of a disequilibrium model consists in a demand equation, a supply equation, and a "short-side" rule assuming that the traded quantity is the lower between supply and demand. The system of equations is, therefore, modified as follows:

$$\Delta spread_{it} = a_{1i} + \sum_{f,c} \beta_1^{f,c}(L) BLS\_S_{i,t}^{f,c} + \theta_1 \cdot \Delta loans_{it}^{S} + \gamma_1 X_{it}^{1} + \mu_{it}^{S} \tag{3}$$

$$\Delta loans_{it}^{D} = a_{2i} + \sum_{c} \beta_2^{c}(L) BLS\_D_{i,t}^{c} + \theta_2 \cdot \Delta spread_{it} + \gamma_2 X_{it}^{2} + \mu_{it}^{D} \tag{4}$$

$$\Delta loans_{it} = min(\Delta loans_{it}^{S}, \Delta loans_{it}^{D}). \tag{5}$$

To close the model, the seminal approach also included additional equations where excess demand and excess supply are related to positive and negative changes in the price level. This approach may be questionable in an empirical analysis of the credit market insofar as the interest rate is an endogenous variable. In this paper we instead assume that the information on the existence of excess

[26]Credit-rationing episodes occur when, at the prevailing interest rate, the demand for credit exceeds the supply and lenders will not supply additional credit even if the borrowers are ready to pay higher margins. The possible causes include banks' balance sheet constraints, risk aversion, and asymmetric information. As for the latter, banks may not want to raise lending rates above a certain level in order to avoid financing riskier borrowers (adverse selection) or to discourage firms from taking on additional risk (moral hazard), as in the seminal work by Stiglitz and Weiss (1981).

demand or supply is provided by the BLS supply indicators rather than changes in the loan interest rate, as follows:

$$\Delta loans_{it}^{D} - \Delta loans_{it}^{S} = \begin{cases} \sum_f \sigma_1^f(L) BLS\_S_{i,t}^{f,tightening} \text{ if } \Delta loans_{it}^{D} - \Delta loans_{it}^{S} > 0 \\ -\sum_f \sigma_2^f(L) BLS\_S_{i,t}^{f,easing} \text{ if } \Delta loans_{it}^{D} - \Delta loans_{it}^{S} \leq 0. \end{cases} \quad (6)$$

Equation (6) relates excess demand and excess supply, respectively, to the banks reporting a tightening and an easing of the various BLS supply factors. This assumption is more in line with the literature of credit rationing, which typically occurs in the form of non-price allocation of credit. Following the discussion in Fair and Jaffee (1972), the system of equations (3)–(6) can be expressed in closed form as follows:

$$\Delta spread_{it} = a_{1i} + \sum_{f,c} \beta_1^{f,c}(L) BLS\_S_{i,t}^{f,c} + \theta_1 \Delta loans_{it} + \gamma_1 X_{it}^1 - \sum_f \sigma_2^{f,easing}(L) BLS\_S_{i,t}^{f,easing} + \mu_{it}^S \quad (7)$$

$$\Delta loans_{it} = a_{2i} + \theta_2 \Delta spread_{it} + \sum_c \beta_2^c(L) BLS\_D_{i,t}^c + \gamma_2 X_{it}^2 - \sum_f \sigma_1^{f,tightening}(L) BLS\_S_{i,t}^{f,tightening} + \mu_{it}^S. \quad (8)$$

We allow all the BLS supply factors to potentially capture a disequilibrium in the credit market and test which ones actually do so by looking at the statistical significance of the coefficients $\sigma_1(L)$ and $\sigma_2(L)$. In practice, since banks very rarely reported that some factors had contributed to an easing of credit standards (see table 1), it is impossible to estimate the coefficients $\sigma_2(L)$. Therefore, our analysis is accordingly confined to assess which (if any) of the coefficients $\sigma_1^{f,tightening}(L)$ is significantly different from zero. Model (7)–(8) is estimated with the same GMM estimator as model (1)–(2).[27]

[27] Another approach to estimating disequilibrium models relies on maximum-likelihood methods (Amemiya 1974; Maddala and Nelson 1974), which have been

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used extensively in studies of credit-rationing episodes during financial crises (e.g., Kim 1999; Barajas and Steiner 2002; Allain and Oulidi 2009). However, maximum likelihood requires stronger distributional assumptions than GMM; maximizing the likelihood function in a disequilibrium model may be difficult (Goldfeld and Quandt 1975), and the complexity of the likelihood function in the presence of autocorrelation is high (Laffont and Monfort 1977).

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