ESSAYS ON BANK LENDING

Ph.D Dissertation

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Summary

This dissertation focuses on the development of bank credit to the non-financial corporations. Broadly speaking, I investigate how shocks to the banking sector, i.e. sovereign shocks, are transmitted to the bank lending policies.

Chapter 1 provides a review of a part of the ample literature on the sovereign-bank nexus; specifically, the focus is on research that investigates the transmission of sovereign debt market on the banking system and answers to the following three questions: (i) why did banks increase their holdings of public portfolios during sovereign distress? (ii) why banks' funding conditions deteriorate following a rise in sovereign risk? and (iii) how are sovereign tensions transmitted to bank credit supply granted to the real sector? On the first question, research explains the phenomenon by looking to both moral suasion by government and to risk-shifting behavior of banks. On the second question, the deterioration of the bank funding conditions is the consequence of several channels, as the worsening in investors' evaluations. On the third question, the tightening of credit supply is also the result of several factors, among which the prominent seems to be the rise in cost of funding.

In chapter 2, I analyze the role of banks' holdings of public portfolios in the transmission of sovereign tensions to bank lending supply. Banks' direct exposures to government debt can affect the quantity of credit supply via two direct channels: the balance sheet channel and the liquidity channel. The former is a reduction of banks' capital following the depreciation of public portfolios, the latter is the impairment in banks' ability to raise funds in the wholesale markets using public bonds as collateral. I exploit credit development observed in Italy in the second half of 2018 after the sudden rise in government yields and disentangle these two channels. Results suggest that the reduction in credit granted associated of the direct channels entirely reflects the shock to the capital, while the shock to the liquidity position does not play a role. The economic significance of idiosyncratic banks' direct holdings of public bonds is however relatively small compared to that connected to the generalized increase in the cost of funding.

Chapter 3, which is a joint work with Massimiliano Affinito and Massimiliano Stacchini, analyze the determinants of loan collateralization; specifically, we study which lender and borrower determinants are associated to the incidence of collateral over loans granted. The dataset covers the period between the years 2007-2013 and we are therefore able to control for the effect of the global financial and sovereign debt crisis. Results indicate that for the same borrower, more capitalized banks apply tighter collateral policies than less capitalized banks, therefore suggesting a negative link between bank soundness and risk-taking.

Sovereign tensions and euro-area banks: a review

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Abstract

This article reviews part of the large literature on the sovereign-bank nexus. The focus is on research investigating the transmission of sovereign debt market on the banking system and, specifically, answering to the following three questions: (i) why did banks increase their holdings of public portfolios during sovereign distress? (ii) why banks' funding conditions deteriorate following a rise in sovereign risk? and (iii) how are sovereign tensions transmitted to bank credit supply to the real sector? On the first question, the two main explanations behind the increase in banks' public portfolios are the moral suasion by government and the risk-shifting behaviour of banks. On the second question, the deterioration of the bank funding conditions is the result of several channels, like the worsening in investors' evaluations or the freezing of wholesale markets. On the third question, the tightening of credit supply is the result of several factors, among which the prominent seems to be the rise in cost of funding.

Keywords: credit supply, banks' sovereign holding, bank lending channel
JEL Codes: G01, G21, E5, E51

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Contents

1 Introduction

Since the burst of the sovereign debt crisis, a very large body of research has extensively investigated the sovereign-bank nexus and its implications for the real sector. This article focuses on the literature that investigated the transmission from sovereign debt market to the banking sector; specifically, it aims at summarizing the empirical research on the following questions:

1. why banks increased the holdings of public bonds during the sovereign debt crisis?
2. why banks' funding conditions deteriorate following a rise in sovereign risk?
3. how are sovereign tensions transmitted to the supply of bank credit to the real sector?

In summary, research answered to the first question mainly indicating two explanations. According to the first, the expansion in the purchases of public bonds during the sovereign crisis was not a voluntary choice of banks but rather a consequence of the pressure of governments under stress (moral suasion); for the second explanation, instead, the behaviour of credit institutions was voluntary and reflected the incentive of banks, especially of weaker banks, to invest in riskier and more profitable assets (risk-shifting). Although very different, these motives are not mutually exclusive and some work found evidence for both.
On the second topic, most of the research indicated that the generalized increase in the cost of funding reflects the worsening on market evaluations of the whole banking system - and its subsequent transmission to other sources of funding. Sovereign downgrades also have an adverse impact on the cost at which banks can borrow, while the presence of a government guarantee on banks' deposits, either implicit or explicit, has uncertain effects. Finally, depreciation in government bonds might reduce the ability of credit institutions to borrow on the wholesale markets as sovereign bonds are normally used as collateral.
On the third point, research largely documents sovereign tensions exert a negative impact on supply of loans to households and firms, both in terms of quantities and prices. According to a large body of research, the prominent channel behind this development is the generalized increase in the cost of funding faced by banks operating in the countries most affected by the crisis - while the idiosyncratic component at the bank level have played a minor role. Other studies, instead, find that this phenomenon is to be conducted with the concomitant expansion of banks' public portfolios during the crises that caused a crowding-out effect on lending.

2 Why banks increased the holdings of public bonds during the sovereign debt crisis

Public debt portfolios have largely expanded during the sovereign debt crisis, especially in the countries most affected by the crisis (Fig.1). Since then, an ample area of research

aimed at analysing the reasons behind the expansion in banks' exposures to government. A first strand of the literature explains this phenomenon as a consequence of a government "moral suasion", as sovereigns under financial stress coerce banks to expand the purchases of domestic public bonds in order to sustain their weak demand; the increase in sovereign home bias in banks' public portfolios observed in some countries between 2010 and 2013 would be in line with this hypothesis. According to this theory the expansion of banks' public portfolios is therefore not a voluntary behaviour; moreover, it is stronger for those credit institutions more likely to be swayed by the government. The literature has tried to identify these likely-to-be-swayed institutions by looking at the type of ownership: State-owned banks would be indeed more likely to be under government influence than private ones; in addition to this, many works also focused on the behaviour of domestic banks (as opposed to foreign branches) or recently bailed-out banks.
By means of a dataset comprising information on 226 banks located in 18 euro-countries, Altavilla et al. (2015) find evidence for the moral suasion hypothesis; specifically, they find that State-owned and recently bailed-out banks increased their purchases of domestic bonds more than private and non-bailed out banks between 2011 and 2012. De Marco and Macchiavelli (2016) identify banks more swayed by sovereigns by looking at the political connection of a bank in terms of the number of politicians sitting in the board of directors; they use a bank-level dataset that is a merge of different sources such as the information on EBA's stress test, Bankscope and BoardEx, and find that a higher degree of politically connection is associated with larger increases of domestic bonds over total assets during the sovereign debt crisis for banks located in most affected countries. This result suggests that government pressure had a role in the expansion of banks' public portfolios. Becker and Ivashina (2018) further contribute to this theory as they find evidence that the negative correlation between government bonds and loans to enterprises is stronger for banks more likely to be influenced by governments.

Another large strand of the literature aims at explaining the expansion in banks' public portfolios during the sovereign debt crisis with risk-shifting models (see, for instance, Jensen and Meckling (1976)). In particular, Diamond and Rajan (2011) develop a model in which banks that are more likely to default have a stronger incentive to invest in risky assets that are positively correlated with their portfolios: indeed, risky assets would generate payoff in the good states of the world and losses in those states of the world in which the banks would default anyway. Crosignani (2021) further contributes to this literature and develops a model in which (i) undercapitalized banks have a strong incentive to risk-shifting when sovereign risk increases and (ii) if the sovereign risk is high enough, they will also reduce lending to further increase the holding of public debt (crowding-out effect).
According to this theory, during the sovereign debt crisis, European banks might have been characterized by strong incentives to risk-shift; in particular, this applies to the banks operating in the most affected countries (Greece, Ireland, Portugal, Spain, Italy, GIPSI) whereas credit institutions held high amounts of domestic public debt when government

conditions sharply deteriorated. Acharya and Steffen (2015) find evidence that the accumulation of risky government bonds in banks' balance-sheet can be explained by a carry trade behaviour: that is, banks in both GIPSI and no GIPSI countries increased the holdings of high-yield peripheral sovereign debt to pocket high returns while taking short positions on safer public bonds, i.e. German bunds. They also find that the incentive for this behaviour is stronger for weakly capitalized banks, consistently with the risk-shifting hypothesis. Acharya et al. (2018) further provide suggestive evidence that the accumulation of domestic sovereign holdings in GIPSI countries is mainly due to risk-shifting motives. Drechsler et al. (2016) also test the risk-shifting hypothesis: they use weekly information on banks' borrowing from the European Central Bank covering the period going from August 2007 to December 2011 and merge it with bank level data obtained by BankScope and European Bank Authority stress tests dataset.They find that lower capitalized banks pledged riskier collateral than highly capitalized banks; importantly, they also find that the pledging of riskier collateral is associated with an increase of the amount in risky assets, consistently with a risk-shifting behaviour. Using Italian monthly data at the bank level covering the period from March 2007 to December 2013, Affinito et al. (2019) investigate which bank balance-sheet variables are associated with purchases of domestic bonds. They find that during the European debt crisis, lower profitable and less capitalized banks are those that accumulate more public debt, in line with profitability and risk-shifting motives. Instead, they do not find evidence for the moral suasion hypothesis.

The moral suasion channel and risk-shifting motives can also coexist, and several works find evidence of a role for each of them in explaining banks' purchases of government bonds. Governments may be compliant with banks' risk-shifting behaviour and also encourage it in several ways; for instance, governments may agree preferential treatments for sovereign debt issued in euro countries (as the one established in the Capital Requirements Directive[1], see Acharya et al. (2018) and Popov and Van Horen (2014)) or may allow banks to accumulate large amounts of risky sovereign bonds and let them use it as collateral in operations with a common central bank (Uhlig (2013). Ongena et al. (2019) exploit the monthly information of the amount of sovereign debt maturing to proxy the periods during which government pressure on the banking sector is more likely to be stronger (high need periods). Using the ECB's monthly dataset comprising information on individual balance-sheet (IBSI), they focus on 60 MFIs located in GIPSI countries to test whether domestic banks, that are more susceptible to government pressure, purchase more public bonds than foreign banks during periods of high need periods. On the one hand, they find that domestic banks increase the purchases of public bonds more than foreign banks during high need periods, confirming the moral suasion hypothesis; on the other hand, they document that domestic banks also invest more when the sovereign is riskier, and interpret this result as evidence of the risk-shifting channel. Also Horváth et al. (2015) find evidence of both the moral suasion and risk-taking channels: exploiting a bank-level dataset of 91

[1]For more details, see Directive 2013/36/EU.

banks belonging to the European countries, they first find evidence that, in case of risky sovereigns, home bias in public portfolios is higher for State-owned banks, confirming the moral suasion hypothesis. They then build a variable that measures the degree of banks' "shareholder-friendship" by valuating different attributes of the governance. They find that banks characterized by governances more "shareholder-friendly" also display a larger home bias: this confirms that home bias is, to some extent, a voluntary phenomenon and this result is consistent with the risk-shifting channel.

In addition to the two main strands just described, several papers also indicated other reasons behind the accumulation of domestic public debt. Using a dataset with monthly observations for ten eurozone countries from 2007 to 2013, Battistini et al. (2014) decompose the sovereign risk into a country and systemic component and investigate how sovereign exposures respond to each factor by means a vector error-correction model; they find that (i) holdings of domestic public debt by banks in the periphery countries is positively correlated to the country-risk factor and (ii) for almost every eurozone country, banks increased their exposure to sovereign debt when common risk rose: while this does not rule out the moral suasion and/or carry trade hypothesis for peripheral countries, it suggests that home bias in most eurozone countries may be associated to the fact that banks hedge against a redenomination risk. Saka (2020) proposes an alternative explanation for the home bias observed for eurozone countries during the crisis: the informational channel. According to this hypothesis, the reallocation of sovereign debt from foreign to domestic banks is associated with the informational advantage of local banks; this behaviour is benign as it can mitigate the bank-sovereign nexus. In order to test this hypothesis, he uses a bank-level dataset built from stress-tests performed by the European Banking Authority and finds that, when sovereign risk rises, government holdings of foreign banks increases for those branches that are informationally closer to the country in which they are located, as expected. Finally, precautionary motive could also be the reason behind the increase in government portfolios (see Angelini et al. (2014) and Affinito et al. (2019)): banks could invest in government bonds to recur more intensively to the Eurosystem operations, especially for periods characterized by a high cost of issuing new debt or by high rate on the wholesale market.

3 Why banks' funding conditions deteriorate following a rise in sovereign risk

During the sovereign debt crisis banks' funding conditions in the euro area sharply deteriorated, especially in most affected countries: in the second half of 2011, the most severe phase of the crisis, CDS and interbank euro spreads rose abruptly, as did the cost of bank capital. Issues of bank bonds in the euro area remarkably declined as a consequence of

the rise in the cost of issuing new bonds, while the freezing of private wholesale markets required a strong intervention by the ECB to mitigate institutions' difficulties in raising short and medium term funds.

Deterioration in governments' creditworthiness has immediate repercussions on banks' market evaluations (see Fig. 2 for the Italian case). The reason behind this phenomenon is that country risk normally acts as a floor for banks' borrowing cost: although this specifically affects the issuance of new debt on capital markets, the rise in the borrowing cost is normally transmitted to other sources of funding. By means of a bank-level dataset with daily observations between 1st January, 2007 and 31st July, 2012, Zoli (2013) finds that the spread between the Italian and the German government bonds (BTP-Bund spread) is positively associated with both the CDS and the bank bond yields for the five largest Italian banks; specifically, she finds that a rise in sovereign spread of 100 basis points is associated with a widening in the bond yields spread of Italian banks with respect to the average of the euro-area of around 20 basis points. Albertazzi et al. (2014) use an ARDL methodology on a bank-level dataset covering the horizon 1991:Q1-2011:Q4 to study the effect the BTP-Bund spread (minus the difference between the yields of swap rates) on the borrowing rate of different sources of bank funding, specifically: (i) households overnight deposits, (ii) household deposits with agreed maturity, (iii) repurchase agreements and (iv) newly issued bonds. They find a positive association between the sovereign spread and the cost of each of these instruments (but overnight deposits) over the entire period; moreover, the effect is strengthened over the horizon 2010:Q2-2011:Q4 and, among the funding sources analysed, is stronger for newly issued bonds. The results are in line with Bofondi et al. (2017), that document a significant increase in the cost of deposits for Italian domestic banks (with respect to foreign branches operating in Italy) in the second half of 2011. Remarkably, the increase in the cost of funding following a rise in sovereign risk is generalized to the whole banking system; however, it might be amplified depending on specific bank variables (such as low capitalization or high non-performing loans share, see Zoli (2013)).

The sovereign-bank transmission is also influenced by the presence of a government guarantee on banks' deposits(Angelini et al. (2014)); however, the overall impact found by the literature is uncertain. On the one hand, works preceding the sovereign debt crisis indicate that the adoption of government guarantees schemes is associated to a reduction in the risk premia of banks' and improvements in the ability of raising funds (see, for instance, Grande et al. (2012)). Angelini et al. (2011) use a dataset containing all the transactions executed on the e-Mid market over 2005 and 2008; they find that the spread on the interbank market loans decreases with the size of the borrower: this result suggests that there is an implicit guarantee for "too-big-to-fail" banks. On the other hand, other research indicates that a deterioration in sovereign creditworthiness adversely impacts on those institutions that are more likely to benefit of a government intervention. Correa et al. (2014) perform an event

study using a dataset covering information for 259 banks from 1995 and 2011, and find that sovereign rating downgrades have a negative effect on the returns of the banking system; this effect is stronger for banks that are more likely to benefit of government support in case of distress. The impact is higher for advanced economies, as their governments' intervention to bail-out financial institutions is *ex ante* considered more credible. Makinen et al. (2020) also find evidence for the government guarantee channel but, differently from Correa et al. (2014), they find a role for banks' idiosyncratic components: specifically, they develop and test a model predicting that banks' risk premia increase with the probability that the institution may benefit of government support in case of distress; they proxy the expected government support with the market share of bank's deposit over GDP. Intuitively, the reason behind this result is that implicit government support makes banks more likely to benefit from it also more exposed to a common sovereign risk: specifically, with a deterioration in government conditions, the probability of intervention decreases as a consequence of the reduced ability of the sovereign to intervene; this in turn decreases the value associated to the implicit government guarantee, and investors will require an increase in the premia to be compensated for it.

The impact of a sovereign deterioration on the cost of funding can be further strengthened as a consequence of a sovereign downgrade since public ratings represent a ceiling for those assigned to private borrowers. Adelino and Ferreira (2016) study the effects of rating downgrades on banks' funding by comparing several measures of cost of funding for two sets of banks: the first group comprise banks that had the same rating of their sovereign before the downgrade (treatment group), while the second group comprise banks that instead had a lower rating (control group). The banks in the treatment group are therefore affected by a ceiling effect, while those in the control group are not. They find that in the six months following a sovereign downgrade, interbank funding for banks belonging to the treatment group reduces 3 percentage points more than for banks in the control group; retail deposits are instead not affected. Finally, the CDS spread between treated and controlled banks increases by around 15 basis points.
Finally, depreciations of public portfolios not only increase the cost of funding but also the ability to raise funds on the wholesale market, as government bonds are generally used as collateral. Several works found that an adverse shock to banks' funding conditions has an impact on credit supplied to firms, both in terms of quantity and quality(De Jonghe et al. (2020), Iyer et al. (2014)).

4 How are sovereign tensions transmitted to the supply of bank credit to the real sector

A large body of the literature focused on the consequences for credit supply to firms and households following a rise in government yields, both in terms of quantity and cost of

lending. Neri (2013) focuses on a group of euro-area countries (Italy, Germany, Spain, France, Netherlands, Belgium, Austria, Greece, Portugal, Finland) to study the transmission of strains in sovereign debt markets to the cost of new loans to non-financial corporations and households for house purchase. By estimating a seemingly unrelated regression model (SUR model) in which each equation follows an autoregressive distributed lags model (ARDL model), he finds that sovereign risk (measured as the spread between 10-year government bonds and swap contracts) is transmitted to the cost of credit to firms and households in periphery countries. Specifically for the Italian case, if the sovereign spread would have remained at the level of April 2010, at the end of 2011 the cost on new loans would have been about 130 basis points lower for firms; also cost on loans for house purchase would have been 120 basis points lower. The estimated effect is in line with the findings of other studies, such as Albertazzi et al. (2014) and Del Giovane et al. (2017). Turning to the amount of credit supply, Acharya et al. (2018) use a dataset at bank-firm level covering the period from 2006-2012 and obtained from Thomson Reuters LPC's DealScan and merged with several dataset at firm and bank level; they find that firms with a high dependence on banks located in most affected countries increase the holdings of cash, a behaviour which is typical of financial constrained firms. The result is interpreted as evidence that banks more affected from the sovereign debt crisis decreased credit supply. Albertazzi et al. (2014) focus on the Italian case by setting up an ARDL model and find that the BTP-Bund spread impacted on credit supply to firms and households: if the sovereign spread would have remained at the level observed in 2010:Q1, then in 2011:Q4 lending rates on loans to NFCs and households would have been lower by about 170 and 120 basis points, respectively. Also, they find that a 100 basis points increase in the BTP-Bund spread implies a reduction in the annual growth of credit to firms and households of 0.7 and 1.0 percentage points, respectively. Bottero et al. (2020) also focus on the Italian case and, by means of a bank-firm dataset on Italian data, are able to properly control for the demand of credit and investigate whether the supply of bank credit reduced for banks with larger holding of public debt. They focus on the exogenous shock on bank sovereign portfolios following the 2010 Greek bailout and find that, in the four quarters following the shock, banks with higher holdings of sovereign debt reduced credit supply more than less exposed banks.

Sovereign tensions can be transmitted on bank lending policies via several channels. Some papers investigated if the reduction of credit supply is associated to the increased purchases of government bonds. Popov and Van Horen (2014) use a dataset comprising syndicated loan-level information for 34 banks located in no-GIPSI countries and find that banks that expanded their expositions toward GIPSI sovereign debt between March and December 2010 granted, on average, less credit than banks that did not increase their holding of GIPSI government debt. Acharya et al. (2018) not only document a crowding-out effect of lending during the sovereign debt crisis but also interpret it as evidence of a risk-shifting behaviour of banks, as lower-capitalized credit institutions reduced lending more

than higher-capitalized ones. Becker and Ivashina (2018) confirm, on the one hand, that bank credit supply reduce as a consequence of an increase in government bond purchases; on the other hand, they indicate moral suasion as the reason behind this development. Differently from works previously described, the analysis carried by Angelini et al. (2014) suggests that for Italian banks no crowding-out effect was at work during the horizon 2012-2013.

A large strand of research explains the development of credit supply with the deterioration in funding conditions: in particular, many papers put the accent on the worsening in the funding conditions for the whole banking system more than on role played by idiosyncratic bank characteristics. Del Giovane et al. (2017) exploit a bank-level dataset containing individual responses of bank to the Bank Lending Survey (BLS) and identify demand and supply factors of lending dynamics; they then analyse their role on credit developments during the global and the sovereign debt crises. They first document a positive (negative) relation between the interest rates (the credit growth) and the supply factor indicating banks' funding difficulties; then, they document that the deterioration in banks' funding is associated with a common shock hitting the whole banking system, as captured by the changes in the sovereign debt spread, while idiosyncratic components proxied by the individual banks answers did not play a role. Altavilla et al. (2015) also find evidence that during turmoil on sovereign bond markets, larger exposures to government debt are associated with lower growth of credit to firms for domestic banks, but have no impact on credit development for foreign branches; this suggests that the reduction in credit supply following sovereign tensions is not associated with the specific exposure of a bank, but reflects the country-specific effect hitting the whole banking system. Both results are in line with Bofondi et al. (2017) that, using data from the Italian Credit Registry (CR), disentangle demand and supply of credit in the second half of 2011 and compare lending of Italian domestic banks and that of foreign branches operating in Italy but headquartered in countries not affected by the sovereign debt crisis. They find that, for the same firm, growth of credit by Italian domestic banks was around 3 percentage points lower than that of foreign branches; as their results are robust even when including a large set of variable accounting for bank heterogeneity, they interpret this country-specific component as evidence that, following sovereign tensions, the generalized increase in the cost of funding faced by the banking system has a strong negative effect on credit supply.
Adelino and Ferreira (2016) also find evidence that credit developments are impacted by a generalized deterioration in funding conditions but, differently from previous research, they specifically focus on the channel of sovereign downgrades. Specifically, they compare credit developments of banks affected by a sovereign downgrade (control group) to that of banks less affected (treatment group) and find that the growth of loans to firms of the control group is lower by around 25 per cent than that observed for banks in the treatment group. This result entirely reflects the deterioration in the funding conditions hitting the whole control group, as none of the bank variables has a significant effect on the dependent

variable.

Finally, several works focused on the effect of direct exposures of sovereign debt on lending. Specifically, the deterioration of public portfolios worsen both the capital position of a bank (bank-balance sheet channel) and its ability to raise funds on the wholesale market, whereas government bonds are generally used as collateral (liquidity channel). De Marco (2018) finds that sovereign losses exert a stronger negative effect on credit supply for banks with a higher share of short-term funding; low-capitalized banks, instead, do not seem more affected than higher capitalized bank: this result is interpreted as evidence that in the period considered a cost of funding/liquidity channel was at work while a bank balance-sheet channel was not. On the contrary, in the next chapter I study credit developments for Italian banks in 2018 and I find evidence of an adverse effect associated with banks direct exposures; this negative association entirely owes to the impact on banks' capitalization rather than on the impact on their ability to raise collateral funds. However, the overall effect connected to the direct exposures is smaller than the effect of the generalized increase in the cost of funding faced by the whole banking system.

5 Conclusions

This article briefly reviews the empirical research on the transmission from a deterioration in sovereign debt markets to the banking system focusing on different aspects. The main results are the following: (i) several works documented that banks expanded their holding of government bonds between 2010 and 2012, but there are concomitant explanations behind this behaviour; (ii) banks' funding conditions worsen after sovereign tensions because of several reasons, as a worsening in the evaluation of markets' participant and its transmission to the cost of other sources of funding; (iii) following sovereign tensions, bank credit supply to firms and households tighten, mainly reflecting the generalized rise in the cost of funding for banks.

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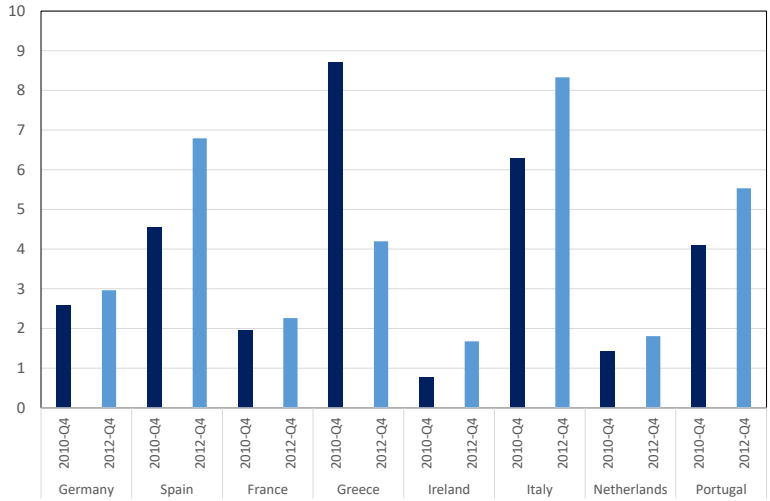
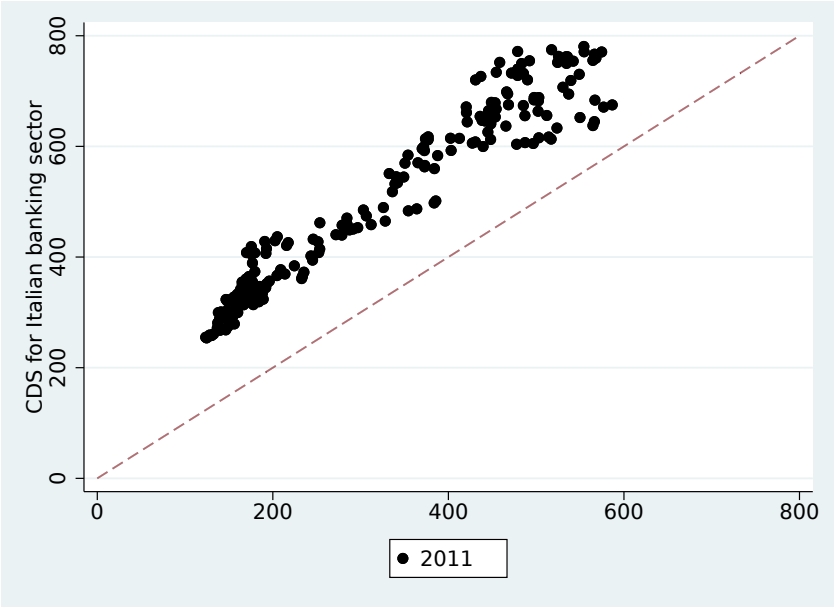
Tables and figures

Figure 1: Domestic public bonds by country
(per cent)



Histograms are computed using ECB SDW dataset; plot the percentage of the outstanding amount of domestic public bonds held by banks in terms of the outstanding amount of total assets; light blue and dark blue histograms refer to December 2010 and December 2012, respectively.

Figure 2: Italian sovereign and banks CDS
(per cent)



Each point corresponds to the daily of the sovereign 5-year CDS for Italy (x-axis) and 5-year CDS for the Italian banking sector (y-axis) during 2011. The 5-year CDS for the banking sector is computed as the unweighted mean of the CDS for the Italian credit institutions with a CDS. Daily data from Refinitiv.

The impact of sovereign tensions on bank lending: identifying the channels at work

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Abstract

Banks' holdings of sovereign bonds, which are particularly large in Italy, are an important component of the multi-faceted bank-sovereign nexus. By exploiting the sharp - and unexpected - increase in sovereign yields in Italy in May 2018, this paper quantifies the impact of a drop in the value of banks' government bonds portfolios on their supply of loans (direct channels). Importantly, it disentangles the effect stemming from the worsening in banks' capitalization (balance-sheet channel) from that associated with a reduced ability to raise funds in wholesale markets using public bonds' holdings as a collateral (liquidity channel). Results show that banks with large government bonds portfolios reduced credit supply mainly as a consequence of the balance-sheet channel; the liquidity channel did not activate, also thanks to the ample availability of Eurosystem funds held by the banking system when the shock occurred. I then control for the channels at work for the whole banking system regardless of the amount of government bonds held (indirect channels) and find that the generalized increase in banks' cost of financing (cost of funding channel) has a negative impact on the supply of credit; moreover, the magnitude associated with this indirect channel is slightly larger than that associated with the balance-sheet channel, consistently with the results typically found for the 2011 sovereign debt crisis.

Keywords: credit supply, banks' sovereign holding, bank lending channel
JEL Codes: G01, G21, E5, E51

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Contents

1 Introduction

A deterioration of sovereign creditworthiness may negatively affect the supply of bank lending in several ways[1]. Two important channels are directly related to the amount of sovereign bonds that banks hold on their balance sheets (*direct channels.*). The first is activated by the impact on bank capitalization exerted by a reduction in the value of sovereign bonds: indeed, the unrealized losses on sovereign portfolio at market values dent capital position (bank balance-sheet channel, see Albertazzi et al. (2014)). The second is triggered by the reduction in the amount of funds that banks can raise in collateralized wholesale markets or through Eurosystem operations, since government bonds are largely used as collateral on wholesale markets (liquidity channel, see Angelini et al. (2014)). In addition to these two mechanisms, sovereign risk may deteriorate bank's funding conditions - and in turn impairs the supply of loans to the private sector - via a number of *indirect channels*, which are at work for all banks and whose activation and intensity does not depend on the amount of sovereign bond held by a given institution. Among these: an increase in sovereign yields determines a rise in the cost of bank funding as country risk normally acts as a floor for the cost of issuing bonds (cost of funding channel, see pan); the reduction in the benefits of implicit and -if present- explicit government guarantees can increase banks risk premiums (government guarantee channel; see Mäkinen et al. (2020) and Correa et al. (2014)); sovereign downgrades often lead to downgrades of banking institutions as sovereign ratings are normally a ceiling for the private borrowers (rating downgrade channel, see Adelino and Ferreira (2016)). Finally, the reduction in lending supply may be due to other factors rather than the deterioration in credit institutions' conditions; for example, a large strand of the literature document that public debt portfolios held by banks expanded after the sovereign debt crisis, reflecting either government pressure or risk-shifting motives (see Popov and Van Horen (2014) and Becker and Ivashina (2018)): whatever the reason behind it, the increase in sovereign bond holdings may be conducted at the expense of loan granting, causing a decline in the amount of credit supply (crowding-out effect of loans).

The aim of this paper is to provide a quantitative estimation of the relative importance of the balance-sheet *versus* the liquidity channel within the direct channels. While the literature has established a significant positive relation between the overall amount of government bonds held by banks and the reduction in credit supply following an increase in sovereign risk (Popov and Van Horen (2014), Bottero et al. (2020)), a quantitative assessment of the impact of each of the two aforementioned channels is still lacking - to the best of my knowledge.

The key intuition that allows me to disentangle the two mechanisms is the possibility to exploit the information on how banks allocate government bonds under different accounting portfolios. In particular, according to the International Financial Reporting Standard 9 (IFRS 9), a financial asset can be classified into the following portfolios: (i) *held to col-*

[1]For a more detailed description of the cannels see pan

lect, (ii) *fair value through other comprehensive income* and (iii) *fair value through profit and loss*. Financial assets not intended to be sold can be allocated in portfolio (i) and are held at the amortised cost: this means that changes in their value will not affect capital position and the balance-sheet channel won't be activated for these bonds; assets classified under (ii) and (iii) are instead held at market values, implying that changes in their price impact capital position. On the contrary, in case of a price variation, the liquidity channel is triggered for all bonds as their valuation as collateral is independent of the portfolio under which they are allocated. Summarizing, the amount of securities held at market value will affect the intensity of both channels, while the amount of securities at amortised cost will determine the intensity of the liquidity channel only. A direct consequence is that the growth of loans after the outbreak of sovereign tensions can be associated with the pre-shock share of sovereign debt under each portfolio in order to disentangle the impact of each channel on lending policies. Specifically, when included in a regression having loan growth as the dependent variable, incidence on total assets of (i) sovereign exposures and (ii) sovereign exposures held in the fair value portfolios will provide an estimate of the relevance of, respectively, the liquidity channel and the bank balance-sheet channel.

A number of conditions are required for these estimates to measure the impact of sovereign tensions on lending supply. First, the increase in sovereign risk should be exogenous to the banking system - i.e., it should not be caused by a deterioration in banks' health. To this end, I exploit the episode of sharp rise in the Italian sovereign yields observed in the Spring of 2018 and connected with the sudden increase in the political uncertainty. In the second half of May, after the failure of several attempts to form a new government, yields on sovereign bonds increased by around 200, 175 and 110 basis points on the two-, five- and ten-year horizons respectively. Given that this rise was unexpected and mainly reflected the high uncertainty over the formation of the new executive, the shock can be regarded as exogenous, making this event an ideal setting to study the impact of sovereign tensions on the supply of credit. Its exogenous nature is confirmed by the fact that, in the period preceding the rise in sovereign yields, indicators for the Italian banking system were pointing to sound and improving conditions: during 2017 and in the first months of 2018 banks' profitability grew markedly (for significant groups, annualized return on equity rose to 8.4 per cent in the first quarter of 2018 from 5.1 per cent in the first three months of 2017[2]); non-performing loans ratio declined to the pre-sovereign crisis levels; banks' capital ratio strengthened and the gap with other European banks narrowed.[3]. The shock exploited in this paper presents two advantages with respect to the one observed during the sovereign debt crisis and largely used from the literature to estimate the impact of sovereign tensions on credit supply. A first advantage is that the rise in government yields in 2018 was unanticipated, as it was connected to the sudden rise in the uncertainty of the political background; on the contrary, international sovereign debt markets were under stress since the Greek bailout in 2010, well before yields on Italian sovereign securities markedly rose

[2]See Economic Bulletin, 2018, 3.

[3]See Economic Bulletin, 2018, 3 and Financial Stability Report, 2019, 1.

in July 2011. Another advantage is that the development in the government debt markets observed in 2018 did not involve other countries apart from Italy: this allows to study the effect of sovereign tensions originated in a country on the credit supply from the banks operating in that specific country, ruling out the possibility that the estimates are affected by macro-financial shocks originated outside the national borders and transmitted to domestic financial institutions.

A second condition required to the aim of this study is that loan supply must be isolated from loan demand: in order to do this, I follow the methodology pioneered by Khwaja and Mian (2008) by means of a granular dataset comprising 1,049,367 observations at bank-firm level: the proper identification of credit supply is possible by adding in the regressions firm-time fixed effects that control for observed and unobserved firm heterogeneity - and thus for the demand of credit. Third, a potential identification issue is that banks' investment and lending policies may be commonly influenced by non-observables characteristics, i.e. the bank business model. This identification issue is dealt with by including bank fixed effects: controlling for time-invariant unobserved characteristics of banks on such a short horizon, bank business model is reasonably controlled for because this feature does not change frequently over time.

The results show that, as a consequence of the outburst of sovereign tensions in the Spring of 2018, Italian banks with large government bonds portfolios reduced credit supply more than banks with smaller portfolios. In addition the drop in credit supply was triggered by the *balance-sheet channel*, while I find no evidence of an activation of the *liquidity channel*. Overall, the magnitude of the effect was relatively small: a one-standard deviation (7.5 percentage points) increase in the share of government bonds at fair value over total assets was associated with a 0.8 percentage points reduction in the growth rate of credit to a given firm. As for comparison, Bottero et al. (2020) study the effects of the Greek bailout and find that for two hypothetical banks that are one standard deviation apart in term of sovereign exposure, the growth of credit to the same borrower is 10 per cent lower for the more exposed bank.

After estimating the baseline model, I extend the analysis along two dimensions. First, I add variables measuring the impact of the indirect channels, which might have also affected lending supply during the horizon considered. In particular, I include the following variables: (i) the ratio of maturing bonds over total assets, that proxies the cost of funding channel, (ii) the ratio of household deposits over GDP that proxies the (implicit or explicit) public guarantees on the credit institution and (iii) the growth of sovereign bonds net purchases, that proxies the possible crowding-out effect of loans.[4] The results show that the cost of funding channel was an important driver of the reduction in lending supply and had significant economic effects: an increase of a one standard deviation (1.2 percentage points) in the variable measuring this channel was associated with a 1.0 percentage points

[4] I deliberately disregard the rating channel, which is unlikely to have had any role in the period considered: in 2018 only Moody's - among the most important credit rating agencies - downgraded the Italian sovereign rating, only by one notch and within the investment-grade class (to Baa3).

reduction in the growth rate of loan supply. This result is broadly in line with the findings of Bofondi et al. (2017) that focused on the development of credit supply in Italy in the second half of 2011 (just after the yields of sovereign securities abruptly rose) and find that domestic banks cut lending by more than 3 percentage points than foreign branches as a consequence of the rise in the cost of funding. The crowding-out effect is also statistically significant but with a negligible economic magnitude. At the same time, results are unchanged for the balance-sheet and the liquidity channels, though the coefficient measuring the impact of the balance-sheet channel reduces somewhat.

Second, I check whether the abundant liquidity provided by the ECB to the euro area banking system may explain the finding that the liquidity channel did not activate following the 2018 sovereign shock. This hypothesis would reconcile this result with those found by studies on the sovereign debt crisis, according to which the strains on liquidity wholesale markets for banks was arguably the main factor behind the tightening of loan supply conditions since the end of 2011. In order to do so, I first estimate for each bank the share of government portfolio used as collateral to raise funds on market. Then, I add the interaction between this variable and the government bond holdings in the baseline equation: the coefficient on the interaction term is negative and significant, suggesting that larger recourse to the market (with respect to the Eurosystem operations) is associated with an activation of the liquidity channel. As about the magnitude, the results indicate that for the same borrower, the growth of credit from a hypothetical bank raising funds on the market only was 0.3 percentage points lower than that of a hypothetical bank recurring only to the Eurosystem operations.

Summing up, the analysis suggests that the size of banks' sovereign portfolios matters in the transmission of sovereign shocks and affects credit supply via an adverse impact on both capitalization and funding conditions on wholesale markets. At the same time, when controlling for the other indirect channels of the multifaceted bank-sovereign nexus, the contribution of banks' direct exposure is not the most important mechanism, as the economic significance associated with the cost of funding channel is larger.

This paper is related to at least two strands of literature. First, the paper fits into the literature pioneered by Bernanke and Gertler (1995) that studies the relation between banks' balance-sheet conditions and credit supply: in particular, Khwaja and Mian (2008), Jimenèz et al. (2012), Jiménez et al. (2014), Acharya et al. (2019) and Schivardi et al. (2017) find that lower levels of bank capital and liquidity ratios impact on lending policies. Second, the paper contributes to the literature on the effects of sovereign tensions and the sovereign-bank nexus: Popov and Van Horen (2014), Becker and Ivashina (2018), Bottero et al. (2020) find that, after the European sovereign debt crisis, most exposed banks to sovereign securities experienced a reduction in credit supply; other works document that the different impact on lending policies can be attributable to the rise in the cost of funding for banks (Bofondi et al. (2017) and De Marco (2018)). The main contribution of this paper to both strands of literature is to disentangle the two mechanisms at work in transmitting sovereign tensions to credit supply arising by the direct exposures to public

debt. Moreover, and differently from most works analysing the transmission of sovereign tensions to bank credit supply, I investigate an episode of sharp sovereign tensions that is not related to the 2011 European sovereign debt crisis, therefore enlarging the scope of analysis of the transmission of sovereign tensions to credit supply.
The rest of the paper is structured as follows: Section 2 reviews the related literature; Section 3 describes the data, Section 4 addresses the identification issues and describes the empirical strategy. Section 5 presents the results of the baseline and some robustness checks, while Section 6 presents the extensions. Section 7 briefly discusses the evidence presented and concludes.

2 Related Literature

This paper relates to two strands of literature. First, it is connected to the studies analysing the relationship between banks' balance-sheet strength and credit availability (the so called *bank lending channel*; see Bernanke and Gertler (1995)). A number of studies have documented how lending supply is crucially affected by the degree of bank capitalization. In their seminal work Bernanke and Lown (1991) document that the credit crunch observed in the United States in the early nineties may be partly attributed to the shortage of capital suffered by credit institutions. Other studies have also highlighted the role of funding conditions and liquidity of bank balance-sheets in determining the effects of monetary policy and other shocks on credit supply (Kashyap and Stein, 1995; Stein and Kashyap, 2000). In recent years, after the pioneering work by Khwaja and Mian (2008), the use of large bank-firm matched datasets to study adverse shocks to credit supply has become more and more frequent. Among these, Jimenèz et al. (2012) find that the tightening in credit supply following a worsening in macroeconomic conditions, as higher interest rates or lower GDP, is stronger for banks with weaker capital and liquidity conditions; Jiménez et al. (2014), Schivardi et al. (2017), Acharya et al. (2019) find that low capitalized banks supply more credit to riskier (zombie) firms than better capitalized banks. Other works show that adverse shocks on bank funding are transmitted to credit supply to non-financial sector, either as a reduction in credit granted (Puri et al. (2011)) or as a reallocation of credit portfolio toward low-risk firms (Olivier et al. (2020)). This work contributes to this strand of literature by investigating the effects on credit supply of a sudden deterioration in banks' conditions; importantly, and differently from previous works, the methodology proposed aims at disentangling the effects of the shock on the liquidity position from those of the shock on the capital position.
The second strand of literature to which this paper contributes concerns the impact of sovereign tensions on bank credit supply. In a precursor work, Arteta and Hale (2008) study the effect of sovereign debt crises in emerging markets and find that these are associated with a reduction of foreign credit to domestic firms. Since then, a large number of works have focused on the impact of the European sovereign debt crisis of 2011-2012. Bofondi et al. (2017) find that during the sovereign debt crisis domestic banks in Italy

reduced credit supply by more than foreign banks, as a consequence of a rise in their cost of funding. Some studies focused on the impact of the direct holdings of government securities on credit supply: Becker and Ivashina (2018), using a dataset covering the period 1995-2015 identify the set of firms with a positive demand for funds; for these firms, they document that whenever the potential lender was a bank with a high exposure to sovereign domestic debt, than the firm was more likely to increase the debt issuance rather than bank credit: this result is interpreted as a consequence of the reduced credit supply by the banks most exposed to sovereign debt; Popov and Van Horen (2014), using a dataset on European syndicated loans, document that banks exposed to stressed euro-area public debt reduced lending to firms by more than less exposed banks; Bottero et al. (2020), using firm-bank matched data from the Italian Credit Register, find that during periods of distress on the sovereign debt markets higher direct exposures is associated with a stronger reduction in credit supply. De Marco (2018) is the closest work to this paper, as he analyses the mechanism whereby sovereign stress propagates to credit supply via public debt holdings: he finds that the negative effect on credit supply is stronger for banks with a higher share of short-term funding while the level of capitalization does not matter. This result is interpreted as evidence that in the period considered a cost of funding channel was at work while a bank balance-sheet channel was not. Differently from the previous studies, this paper proposes a method to disentangle the two main mechanisms connected with the direct public bond holdings (the bank balance-sheet and the liquidity channels), based on the accounting classification of bonds.

3 Data

I use a unique dataset at bank-firm level obtained by merging the information from the Italian Credit Register (CR) and the Supervisory Reports statistics. The CR contains information at loan level on credit granted in Italy by credit institutions to non-financial borrowers of outstanding amount above 30,000 euros (250 euros if at least part of the loan is a bad loan). The dataset distinguishes between three types of loans: revolving credit lines, term loans, loans backed by accounting receivables. Observations are collected at a quarterly frequency and we focus on credit granted, which is less affected by firms' decisions - as compared to drawn credit - and thus is better suited to capture the dynamics of loan supply (for more details on the dependent variable, see Section 3.2). Information on bank balance sheets are obtained by the Supervisor Reports statistics. Banks are required by law to report information on balance sheet quantities on a monthly basis (or quarterly for certain items). As it will be explained below in detail, I collect information on banks' capitalization, sovereign exposure, liquidity and funding structure, profitability and total assets. I collect data at four different dates in 2018: March, June, September and December. Banking information before January 2018 cannot be used because the implementation of the International Financial Reporting Standard 9 (IFRS 9) caused statistical discontinuity in several bank characteristics, notably in the accounting classification of sovereign

bond portfolios (see Section 3.1 for more details). The dataset includes all firms borrowing from at least 2 banks and active in each of the 4 periods; overall, the sample comprises 141,749 firms borrowing from 181 banks, for a total of 469,046 bank-firm relationship.

3.1 The classification of bonds under the IFRS 9

The International Financial Reporting Standard 9 (IFRS 9) came into force in January 2018 and replaced the earlier International Accounting Standard 39 (IAS 39). According to the new standard, a financial asset can be allocated in one of the following portfolios: (i) *Held to collect*, (ii) *Fair value through other comprehensive income*, or (iii) *Fair value through profit and loss*. Assets under portfolio (i) are valued at the amortized cost, while assets under portfolios (ii) and (iii) are valued at fair value.

IFRS 9 aims at reducing banks' discretion in the allocation of financial assets in different portfolios. For this purpose, it requires to carry-out two tests: (i) the *solely payments of principal and interests test* (SPPI test), which requires that the asset gives rise to cash flows that are solely payments of principal and interest on the principal amounts outstanding; (ii) the *business models test*, which evaluates the purpose for which the asset is held.

Government bonds always satisfy the SPPI test, so their allocation reflects only the result of the business model test. Specifically, if the bank holds the government bond with the only purpose of collecting cash flows over the life on the instrument, then the government bond will be assigned to the *Held to collect* portfolio. Instead, if the bank pursues both the collection of contractual cash flows and the sale of financial assets, the asset will be recorded under the *Fair value through other comprehensive income* portfolio. Finally, in case of other businesses models (i.e., trading models), the security will be recorded under the *Fair value through profit and loss* portfolio.

It is important to stress the following points. First, the result of the business model test, that identifies the first allocation of the asset, is conducted by taking into account objective elements of the investment and not a simple assertion by the bank: the entity must consider all relevant evidence that is available at the date of the assessment (as for instance, it is necessary to consider the frequency, value and timing of sales in prior periods, the reasons for those sales and expectations about future sales activity[5]). This prevents that banks use discretion in the allocation of bonds to portfolios. Second, subsequent movements of assets across portfolios are very difficult, as reclassification into other categories is possible just by changing the business model behind the assets[6].

Under the assumption that the direct channels comprise only the balance sheet and the liquidity channel, the classification of government bonds held by banks provides a crucial information for disentangling the relative role of each direct channel, which is the main contribution of this paper. The intuition behind this approach is that for bonds classified at amortized cost just the liquidity channel is activated: therefore, the impact on credit

[5]See Regulation (EU) 2016/2067 of 22 November 2016.

[6]Reclassification of assets up to a 10 per cent of the value without a change in the business model is also possible, but just under strict conditions and limitations, ibidem.

supply associated with the direct exposures for a hypothetical bank holding bonds only under portfolio (i) estimates the liquidity channel. Similarly, for a bank that allocates the government bond holding under portfolios (ii) and (iii), the development of credit granted associated with its sovereign exposures will be the sum of both the bank-balance sheet and liquidity channel. Comparing the growth of credit to the same borrower by two banks, differing only in the allocation of government bonds in each portfolio, allows estimating the magnitude of each channel at work.

Information on the portfolios is reported on a monthly basis and I can compute the relative share of government bonds held at amortised cost or at market values by each bank at every point of time. Figure 1 graphically reports the incidence of government bonds over total assets and government bonds held at fair value over total assets by bank size.

3.2 Variables used in the regression

Table 1 reports the names and descriptions of the variables used in the regressions and Table 2 reports the summary statistics before the shock, in March 2018 (panel A) and after the shock, for the second half of 2018 (panel B).

The dependent variable is the growth of credit at the bank-firm level on a 3-month horizon; in line with the literature, the variable is built using credit granted, as opposed to drawn credit, as the variations of the latter depend also on firms' decisions and liquidity needs - and therefore might reflect demand side factors. Credit supply fell in the second half of 2018: average and median lending dynamics are -0.9 and -0.1 per cent respectively, from -0.6 and 0 observed in the pre-shock period.

The key regressors are the ratio of Italian government bonds over total assets (*GovBonds*) and Italian government bonds held at fair value over total assets (*FVGovBonds*): as showed in the next section, they estimate respectively the liquidity and balance sheet channel. Domestic public bonds portfolio is an important fraction of banks assets, representing around 10.3 per cent of total assets for the average credit institution in the pre-shock period; the share of public bonds held at fair value, is lower and equal to 6 per cent in the pre-shock period. In the post-shock period the share over total assets of total public bonds increased to 11.2 per cent while that of public bonds held at fair value slightly diminished to 5.6 per cent. The difference in the dynamics of *FVGovBonds* and *GovBonds* in the post-shock period may partly reflects the different impact that a soaring in government bonds yields has on these variables: indeed, a rise in sovereign yields reduces the value of government bonds held at fair value but leaves unchanged the value of those held at amortised cost. To take into account the mechanical reduction of *FVGovBonds* with respect to *GovBonds* in the post-shock period, these variables are measured at the pre-shock period only (March 2018) and are time-invariant: therefore, only the interaction with the dummy *Post* is estimated because *FVGovBonds* and *GovBonds* are absorbed by bank fixed effects. Figure 1 shows that both *GovBonds* and *FVGovBonds* are differently distributed across bank size; the share of government bonds over total assets held by small banks is higher

than 20 percentage points while other large banks hold around 10 per cent and largest 5 groups around 6 per cent. Small banks also display the higher incidence of domestic bonds held at fair value; largest 5 groups hold around 5 per cent and, finally, other large banks with around 3 per cent. The differences of the distributions across banks might reflect that both the choices on the dimension of public portfolio and on the allocation of bonds under different portfolios may be associated with different bank characteristics, i.e. business models; in order to address this issue, it is important to include bank fixed effects that control for the time-constant features of credit institutions.

Other time variant bank characteristics may be associated with lending policies and the allocation of bonds over different portfolios. To tackle this issue and in line with the literature, I add in each regression the following standard bank variables: *capital ratio* (the ratio of regulatory capital to risk weighted assets), *size* (log of total assets), *ROA* (bank profit t to total assets), *liquidity ratio* (the ratio of cash plus non-domestic government securities to total assets), *interbank funding ratio* (wholesale deposits to total assets). To take into account that the in post-shock period the capitalization of banks with a higher incidence of government bonds held at fair value reduces mechanically more than that of banks with a lower incidence, I measure *capital ratio* at the pre-shock period only and, as for *GovBonds* and textitFVGovBonds, only the interaction with *Post* is estimated.

Finally, to control for the features of a single lending relations, the following variables at bank-firm time level are also included: $share\ of\ credit_{ijt} = \frac{credit_{ijt}}{\sum_i credit_{ijt}}$ is the ratio between the size of the credit granted at bank-firm level over the total bank credit that the firm obtains; it measures how much the firm is dependent from the bank and, when equal to 1, the bank is the only source of bank credit for the firm. $bind_{ijt} = \frac{granted_{ijt}\text{-}drawn_{ijt}}{granted_{ijt}}$ is computed as the difference between granted and drawn credit over credit granted: when zero, it signals that if the firm needs a new loan than it must apply for it.

4 Empirical strategy

4.1 Identification issues

Identifying the direct channels through which sovereign tensions impact on credit supply to firms poses relevant identification issues. In this section I will argue that the empirical strategy chosen is well-suited to address them.

A first identification issue is that the increase in Italian yields must be exogenous with respect to health of Italian banking system and in particular it must not be caused by a deterioration in banks' conditions. The paper focuses on the sudden increase in the Italian sovereign yields recorded in the second half of May 2018 and observed against a political background that became increasingly unstable. In particular, when against the expectations in the second half of May several attempts to form a new government failed, the uncertainty over the formation of the executive suddenly rose. The increase in the uncertainty impacted on the Italian sovereign market: in less than two weeks, between

the 18th and the 30rd of May, yields on government bonds increased by around 200, 175 and 110 basis points on the two-, five- and ten-year horizons respectively (Fig.2). For the identification strategy it is important to stress that when the rise in sovereign yields occurred, the Italian banking system was sound and indicators were pointing to improving conditions: during 2017 and in the first months of 2018 banks' profitability grew markedly (for significant groups, annualized return on equity rose to 8.4 per cent in the first quarter of 2018 from 5.1 per cent in the first three months of 2017[7]); non-performing loans ratio declined to the pre-sovereign crisis levels; banks' capital ratio strengthened and the gap with other European banks narrowed.[8] Summarizing, the shock arose from the sharp rise in political instability and did not originate from a deterioration in the banking conditions system, and can therefore be regarded as exogenous to the banking system.

The event exploited in this paper is an ideal setting and presents two advantages with respect to previous studies analysing the impact of sovereign tensions on credit supply by exploiting the sovereign debt crisis. One is that the rise in government yields in 2018 was unanticipated, as it was connected to the sudden rise in the uncertainty of the political background; on the contrary, international sovereign debt markets were under stress since the Greek bailout in 2010, well before yields on Italian sovereign securities markedly rose in July 2011; when the Italian government securities yields abruptly rose, this increase partly incorporated fears over the conditions of the Italian banking system: this poses serious problems in estimating the causal effect of sovereign tensions on the banking credit supply. Another advantage is that the development in the government debt markets observed in 2018 did not involve other countries apart from Italy: therefore, I can study the effect of sovereign tensions originated in a country on the credit supply from the banks operating in that specific country, ruling out the possibility that the estimates are affected by macro-financial shocks originated outside the national borders and transmitted to domestic financial institutions[9].

A second identification issue is that the supply of credit needs to be properly isolated from the demand of credit. The whole dynamic of credit reflects firms' demand for funds and is, in turn, affected by macroeconomic conditions; in particular, in a context of high political uncertainty, non-financial corporations might temporally reduce the demand of funds for investment purposes. I deal with these aspects by following the methodology pioneered by Khwaja and Mian (2008). Firm-time fixed effects are included in the regressions and all time-varying unobserved heterogeneity at firm level is controlled for: thus, I control for any shock originated from firms. This approach allows for unbiased estimates as long as the demand shocks are not bank-specific: in other words in the post-shock period, firms' demand should not differ according to the amount of government securities held by banks

[7] See Economic Bulletin, 2018, 3.

[8] See Economic Bulletin, 2018, 3 and Financial Stability Report, 2019, 1.

[9] A large literature investigates the international transmission of financial shocks: Peek and Rosengren (1997) focus on cross-borders lending; Schnabl (2012), Baskaya et al. (2017) focus on the propagation via international funding of domestic banks; finally, Cetorelli and Goldberg (2011), Peek and Rosengren (2000) investigate the role played by global banks.

or to the relative share of each accounting portfolio, which is a plausible assumption.
A third issue for identification is that the lending policy of banks and the allocation of bonds under the different portfolios might be correlated and explained by bank characteristics. This aspect is addressed in two ways. First, in order to control for time-varying observable heterogeneity among credit institutions, the regression includes bank variables that, according to the literature, influence the amount of government bonds held by banks[10](Section 3.2 provide details on the variables used in the regressions). However, the correlation between lending policies and allocations of public bonds over different portfolios might still be explained by unobservable factors, namely the bank business model; in order to deal with this aspect, the inclusion of bank fixed effects would control for the non-observable constant heterogeneity at bank level and, on a short span of time, also for bank business model (since this is very persistent over time).

The final dataset covers the whole 2018 and comprises 1 pre-shock observation and 2 post-shock observations, and bank fixed effects can be included. Ideally, I would have included another pre-shock observation but going backward is not possible as the entry into force of the International Financial Reporting Standard 9 (IFRS 9) in January 2018 caused statistical discontinuities in the classification of government bonds among different accounting portfolios.[11] Another issue to deal with is the differences in the measurement for share of government bonds under the different portfolios in the post-shock period: indeed, the increase in yields on sovereign securities implies a mechanical reduction of the exposure of sovereign bonds held at fair value with respect to the exposures of sovereign bonds at amortised cost. This problem is solved by taking the sovereign exposures in the pre-shock period only.[12]
Finally, it is necessary that banks did not start to differentiate their lending policies with respect either to the share of government bonds over total assets or to the incidence of government bonds held at fair value before the shock (parallel trend assumption). Figure 3 and 4 graphically show that this is not the case. Figure 3 displays the mean of unconditional credit growth for banks with high (above median) and low (below median) share of government bonds. As the graph shows, the two groups behaved in a similar fashion until June 2018; after this period, the subset of banks more exposed to sovereign tensions displays a strong decrease in the credit supply to firms. Figure 4 is built in a similar fashion, but the banks are split according to the incidence of government bonds held at fair value (above or below the median). Again, the figure shows that the two groups behaved similarly until sovereign shocks occurred in the second quarter of 2018.

[10]See, for instance, Bottero et al. (2020) or Gennaioli et al. (2018).

[11]In January 2018 the IFRS 9 replaced the earlier International Accounting Standard 39 (IAS 39); the coming into force of the new principle was followed by a strong increase at the aggregate level of the share of Government bonds held in the portfolios measured at amortised cost; this likely reflected that it was no longer possible for less significant institutions (LSI) to neutralize the capital gain or capital losses of the financial assets classified as 'Available for sale' as under IAS 39 (i.e. to opt for the so called *prudential filter*. More details can be found at: 5th update of Circular No. 263, Bank of Italy (Italian only).

[12]See the next subsection for more details.

4.2 Model

In order to identify the direct channels through which sovereign tensions affect the total amount of bank credit supply, the paper estimates a model at bank-firm level; the sample period comprises 4 quarterly data over 2018 and the shock is at Q2. Bank variables are included in every regression in order to control for bank heterogeneity; all independent variables are lagged because decision, approval and grant of credit require sometimes to be taken by the bank. Specifically, I am assuming that the rise in government yields occurred at the end of May will take some time to affect credit supply, and its effect is not exerted already in June. Bank fixed effects control for time-invariant observed and unobserved characteristics, among which also the business model. The variables exploited to identify the channels are the ratio over total assets of total government bonds, $GovBonds_{i,t}$, and the ratio over total assets of total government bonds held at fair value, $FVGovBonds_{i,t}$. The model to be estimated is:

$$\begin{aligned}\Delta b_{ij,t+1} = \alpha \text{GovBonds}_{i,pre} \times \text{Post} + \\ \beta \text{FVGovBonds}_{i,pre} \times \text{Post} + \gamma_1 \text{X}_{i,t} + \gamma_2 \text{X}_{i,t} \times \text{Post} + \\ \delta_1 \text{R}_{ij,t} + \delta_2 \text{R}_{ij,t} \times \text{Post} + \mu_{j,t} + \eta_i + \epsilon_{ij,t} \quad (1)\end{aligned}$$

where $\Delta b_{ij,t+1}$ is the difference in log credit granted by bank i to firm j between period t+1 and period t; $X_{ij,t}$ are bank controls, $R_{ij,t}$ contains variables built using Credit Register (CR) information measuring the strength of firm-bank relation, such as *share of credit* and *bind* (see Section 3.2 for further details, or Table 1 for descriptions). Finally, $\mu_{j,t}$ and η_i are firm-time fixed effects and bank fixed effects. The variables $FVGovBonds_{i,pre}$ and $GovBonds_{i,pre}$ are absorbed by bank fixed effects because, as explained in the previous section, they are time-invariant in order to avoid the mechanical reduction of the ratio of government bonds held at fair value with respect to the ratio of government bonds in the post-shock period. The two variable of interest are $GovBonds_{i,pre} \times Post$ and $FVGovBonds_{i,pre} \times Post$: in particular, the coefficients α and β estimate respectively the contribution of the liquidity channel and the bank balance-sheet channel to the log-change in loans granted. To see why this is the case, consider first the ratio of government bonds held at amortised cost over total assets, $AmGovBonds_{i,pre}$; since changes in sovereign yields do not impact on the value of the bonds included in this portfolio, no decrease in the capital item is recorded and thus the bank balance sheet channel is not activated; on the contrary, the liquidity channel is triggered because when raising funds against collateral, the latter reflects market values despite the accounting method at which it is recorded in the bank's balance sheet. Therefore, $AmGovBonds_{i,pre}$ approximates the liquidity channel to which a bank is exposed to. Now consider eq.(1) and rearrange it as:

$$\Delta b_{ij,t+1} = \alpha \text{GovBonds}_{i,pre} \times \textit{Post} + \beta \text{FVGovBonds}_{i,pre} \times \textit{Post} + ... =$$

$$= \alpha(\text{FVGovBonds}_{i,pre} + \text{AmGovBonds}_{i,pre}) \times \textit{Post} + \beta \text{FVGovBonds}_{i,pre} \times \text{Post} + ... =$$

$$= \alpha \text{AmGovBonds}_{i,pre} \times \text{Post} + (\alpha + \beta) \text{FVGovBonds}_{i,pre} \times \text{Post} + ...$$

The coefficient on $GovBonds_{i,pre}$, α, is equal to the one that would be estimated if $AmGovBonds_{i,pre}$ were included in the regression and, as explained, $AmGovBonds_{i,pre}$ measures the liquidity channel. In the last equation, instead, the coefficient on $FVGovBonds_{i,pre}$ would estimate both the direct channels and it is equal to ($\alpha + \beta$): given that α measures the effect of the liquidity channel, then it easily follows that β estimates the impact of the bank balance sheet channel.

5 Results

Table 3 reports the estimates of the parameters of equation (1)[13]. As reference, Column 1 shows the results obtained with a specification without including the sovereign exposure held at fair value. Variables are lagged and the effect of sovereign tensions on the quarterly credit growth starts starting from Q3. The coefficient on $GovBonds_{i,pre} \times Post$ is found negative and significant, indicating that higher shares of public bond portfolios held before sovereign tensions are associated with larger reduction in bank credit supplied to firms in the crisis period. Starting from Column 2 also sovereign exposure held at fair value is included. Column 2 reports the results without including bank fixed effects, so that the incidence of government bonds held in the pre-shock period can also be estimated: both ($GovBonds_{i,pre}$ and $FVGovBonds_{i,pre}$) are associated with higher growth of credit to firms; however, during the post-shock period, $GovBonds_{i,pre} \times Post$ is no longer significant and $FVGovBonds_{i,pre} \times Post$ becomes negative and significant; this suggests that the balance-sheet channel played a role for Italian banks during the second half of 2018, while the liquidity channel did not affect credit supply. Identification concerns might arise for estimates reported in Column 2, as the relative allocation of government bonds across different portfolios and bank's lending policy might be influenced by unobservable banking features, i.e. bank business model. To tackle this issue, Column 3 reports the results for the complete specification of equation (1), i.e. including bank fixed effects. In this specification $GovBonds_{i,pre} \times Post$ is no longer significant while $FVGovBonds_{i,pre} \times Post$ is negative and highly significant. This confirms that, even controlling for time-unvarying banks' characteristics, during the second half of 2018 (i.e. the post-shock period) the balance-sheet channel played a role and determined a reduction in credit supplied by Italian banks. The economic magnitude of the balance-sheet channel can be appraised by comparing credit

[13]Tables showing the whole set of controls added in the regression model can be found in the Appendix.

supply for two banks differing in the share of government bonds held at fair value (before the shock) by a one-standard deviation (which corresponds to 4.56 pp). I find that a higher exposure to sovereign bonds at fair value determined a reduction in the growth rate of credit supply of 0.8 percentage points. This value does seems smaller if compared to findings of previous works: for example, Bottero et al. (2020) focus on Italian banks' credit dynamics after the Greek bailout and compare lending supply to a given firm by two banks differing in sovereign exposure by one standard deviation: their results suggest that the more exposed bank reduces its credit supply by 10 percentage points more than less exposed bank, a magnitude that is remarkably larger than the one estimated in this paper. The difference in the magnitude partly reflects the distinct nature of the event under study -as Bottero et al. (2020) focus on a period that radically changed the perception of government debt riskiness; however, such big gap suggests that during 2018 the effects of the *direct channels* was smaller than during 2011.

The coefficient on overall exposure to sovereign bonds - which measures the liquidity channel - is instead not statistically significant, suggesting that this channel did not activate at the aggregate level in the episode considered. It is still possible that the channel activated for the banks that have a structurally higher recourse to this source of funding. To take this into account, I add to equation (1) interactions with the dummy $high\ interbk_i$, which takes value 1 if, in the pre-shock period, the bank is above the median of the bank-level distribution of the variable *Interbank funding ratio* (corresponding to 15.4 per cent). Results, reported in Column 4, show that the liquidity channel did not activate also for this subset of banks, as $FVGovBonds_{i,pre} \times high\ interbk_t \times Post$ is also not statistically significant ($GovBonds_{i,pre} \times high\ interbk_i \times Post$ is also not significant). The remaining coefficients are unaffected and, in particular, the one on (the non-interacted) $FVGovBonds_{i,pre} \times Post$ remains negative and significant.

Results are robust to different way of clustering the standard errors: instead of double cluster at the bank and firm level, I cluster at the bank level. Results do not change, and for the episode considered only the bank balance-sheet channel is activated, while the liquidity channel is not (results are reported in Table A1 in the Appendix).

6 Extensions

In this section I extend the baseline model in two directions. First, I include controls for the other channels through which sovereign tensions transmit to the banking system. As mentioned, these are indirect channels and tend to activate - during periods of turbulence on the sovereign debt market - irrespective of a given bank's direct exposure to public debt. This analysis has the twofold objective of being a robustness check for the baseline results and of providing an assessment of the relative importance of the direct channels as compared to the other transmission channels of sovereign tensions.

Second, I dig deeper into the result on the (non-activation of the) liquidity channel and,

in particular, check whether this result may be explained by the very broad availability of funds raised via the Eurosystem's refinancing operations.. This hypothesis would reconcile the result of the irrelevance of the liquidity channel in 2018 with those of the studies on the sovereign debt crisis, according to which the dry-up of funding liquidity for banks was arguably the main factor behind the tightening of loan supply conditions since the end of 2011.

6.1 Taking into account the indirect channels of sovereign tensions

The baseline model presented in Section 4 focuses on the transmission channels - from sovereign tensions to bank balance sheets and thus bank lending - activated by the direct holding of government debt by credit institutions (*direct channels* of sovereign tensions). As mentioned, however, a rise in sovereign yields might impact banks and thus lending policies through several other indirect channels (for a detailed review of the transmission channels of sovereign tensions, see pan). First, a prominent indirect channel is the generalized increase in the cost of funding for banks that is typically associated with a rise in sovereign yields (which are the basis for the pricing of bank bonds,[14]) and which is transmitted to the private sector via a worsening of lending conditions (*cost of funding channel*; Angelini et al. (2014), Bofondi et al. (2017)). One way to assess the impact of sovereign tensions via this channel is to use a proxy of banks' refinancing needs in the post-shock period, as credit institutions will face an increased cost to roll-over debt expiring during the post-shock period. To this end, I include in the regression the amount of bonds issued that are due to expire in the second half of 2018 over total assets, that is *Maturing issued bonds ratio*.

Second, sovereign tensions may transmit to banks also via a deterioration of the implicit or explicit guarantees that governments provide to credit institutions, should they end up in financial distress (*government guarantee channel*). Banks with larger amounts of deposits held by households and firms tend to be more affected by this channel, as these institutions are *ex ante* regarded as more likely to be bailed-out by authorities in order to protect deposit holders. Following Mäkinen et al. (2020), I account for this transmission channel by including in the regressions the variable *Deposit retail ratio*, that is the share of deposits held by households over the GDP, which measures a given bank's market share of deposits and is positively correlated with the expected support of government in case of bank distress.

Third, following a rise in government yields the amount of credit granted might reduce as a consequence of banks' decision to modify the composition of their assets and increase the amount of public bonds (crowding-out effect of lending). This phenomenon is documented by several studies (see Battistini et al. (2014)) and, differently from the other channels described so far, is not associated with a deterioration of banks' balance sheet conditions. Some studies explain it as the result of pressure by the governments on credit institutions

[14]For more details, see the ECB website The compass of monetary policy: favourable financing conditions, Chart 4.

to buy domestic debt during periods of sovereign stress (*moral suasion* hypothesis, see Becker and Ivashina (2018) and Ongena et al. (2019)). For others this phenomenon is driven by profitability and risk-shifting motives(see Acharya and Steffen (2015)). In order to control for this effect, I augment equation (1) with the variable *Government bonds purchases*, which measures the growth of sovereign bonds net purchases at the bank level. Notice that - in order to capture potential crowding out effects - this variable is included with the same timing of the dependent variable (and not with a 1-period lag).

Two additional indirect channels, which are often mentioned as important in the sovereign-bank nexus, are not included in this analysis because they most likely did not play a relevant role in the episode considered. First, I do not consider the *sovereign downgrade channel*, which arises as sovereign ratings typically represent a ceiling for those assigned to private borrowers: a sovereign downgrade is often followed by downgrades of credit institutions, which increases the cost and reduces availability of funding on financial markets. In the period object of this study this channel is unlikely to have played any role, as only Moody's - among the main credit rating agencies - downgraded the Italian sovereign rating in the course of 2018 by one single notch, to Baa3, without affecting its investment-grade class. Moreover, the downgrading occurred at the end of October 2018, which is almost at the very end of the post-shock period included in the regression, also considering the lags with which credit supply is typically affected. Second, sovereign tensions can be transmitted via international spillovers, for example through cross-border interbank exposure or through direct claims vis-à-vis the non-financial sector of countries in distress. As the episode of sovereign tensions in 2018 was entirely driven by the uncertainty related to the Italian political situation and other countries were not affected, international spillovers hardly played any role.

Results for the extended regressions are presented in Table 4. The first 3 columns include the three variables capturing the indirect channels one at the time: *Maturing issued bonds ratio*, *Deposit retail ratio* and *Government bond purchases*; the last column includes all of them. For the direct channels, results are always consistent with those of the baseline regression: in each specification the coefficient on the balance-sheet channel is negative and significant and implies a lower growth rate for highly-exposed banks by about 0.8 percentage points (1.0 for the specification in column 2). Similarly, the coefficient on the liquidity channel is not statistically different from zero.

The Table shows that sovereign tensions affected credit supply also through all the indirect channels, as the coefficients on all the three proxies of these indirect channels are negative and significant when they are included one at the time; in Column 4, instead, *Deposit retail* $\times$ *Post* is no longer significant, signalling that in 2018 the government guarantee channel did not play a role. In terms of magnitude, the impact of the cost of funding is sizeable and larger than that of the balance-sheet channel: the difference in credit supply growth for two banks differing by a one-standard deviation of the *Maturing issues bonds ratio* $\times$ *Post*, is 1.1pp. This result is broadly in line with previous research conducted on the sovereign debt crisis: Bofondi et al. (2017) found that in the semester following the

abrupt rise in Italian government yields at the beginning of July 2011, domestic banks cut lending by more than 3 percentage points than foreign branches as a consequence of the rise in the cost of funding. Finally, as about *Government bond purchases* they are also found negative and significant, but the economic magnitude is negligible.

6.2 Private markets and Eurosystem operations

The baseline results indicates that the deterioration in banks' liquidity positions following the sovereign shock did not contribute to reduce lending supply. This finding is somewhat at odds with those obtained in the literature on the sovereign debt crisis, which identified in the dry-up of liquidity one of the main channels of transmission of sovereign tensions to banks (see, for instance, Angelini et al. (2014)).The exercise carried out in the previous section partly reconciles this apparently divergent results as it documents that the *cost of funding channel* plays a role in explaining the reduction in credit supply - and, moreover, its economic magnitude is higher than that associated with the *balance-sheet channel*.
In this section I focus instead on the direct channels and investigate whether a potential explanation behind the difference in the results compared to the studies analysing the sovereign debt crisis could be related to stronger the overall liquidity position of the banking system in 2018 following several years of expansionary monetary policy by the ECB. In particular, since the 3-year long term refinancing operations (LTRO) launched in December 2011, the recourse to Eurosystem refinancing markedly increased - and, consequently, there was a decline in the relative share of collateralized funds raised on the private markets. In April 2018, just before the abrupt increase in the Italian government yields, the share of Eurosystem funds over total collateralized funds was 23.4 per cent, compared to less than 6 per cent in June 2011, just before the sovereign debt crisis hit the Italian banking system (Fig.5). I conjecture that the increase in the share of funds raised via Eurosystem operations played a role in neutralizing the liquidity channel in 2018.
Banks that normally raise funds more extensively on the wholesale markets rather than via Eurosystem operations might have experienced a stronger deterioration in the ability of raising funds: indeed, private counterparts can trigger margin calls or apply larger haircuts following an increase in sovereign risk; on the contrary, haircuts applied on refinancing operations by Eurosystem national central banks depend only on the residual maturity and the rating of the government bond posted as collateral.[15] Therefore, during sovereign tensions, the larger the recourse to the private markets (with respect to the Eurosystem operations) the stronger the liquidity shock hitting credit institutions.
To test this hypothesis, I proceed in the following way: first, for each bank I compute the share of total funds raised on private collateralized markets (with either euro area private banks or central counterparties) over the total collateralized funding (which comprises also the liquidity raised via Eurosystem operations):

[15]For details, see on the ECB website Financial Risk Management of Eurosystem Monetary Policy Operations, July 2015.

$$share\_mkt = \left(\frac{Privatewholesalefunding_{i,pre}}{Totalwholesalefunding_{i,pre}} \right)$$

I then interact *share_ mkt* with *GovBonds* in eq. (1) and estimate the following regression:

$$\Delta b_{ij,t+1} = \theta(\text{GovBonds}_{i,pre} \times share_mkt \times \text{Post}) + \alpha \text{GovBonds}_{i,pre} \times \text{Post} + \beta \text{FVGovBonds}_{i,pre} \times \text{Post} + \quad (2)$$

The hypothesis being tested here is that larger recourse to private collateralized markets with respect to Eurosystem operations are associated with an activation of the *liquidity channel*, *ceteris paribus*; larger *share_ mkt* are supposed to have a negative impact on credit supply and as a consequence, the coefficient on the triple interaction term in the brackets is expected to be negative ($\theta < 0$).

Results for equation (3) are shown in Table 5. The specification of Column 1 does not include *FVGovBonds*, similarly to Table 3. The coefficient on the triple interaction term is negative and significant, suggesting that the liquidity channel is activated as the recourse to the private collateralized markets increases. The coefficient on *GovBonds* is negative, even though is not significant. Column 2 includes the share of government bonds held at fair value among the independent variables: consistently with the findings of Section 5, *FVGovBonds* is found negative and significant. Remarkably, also the coefficient on the triple interaction remains negative and significant, suggesting that the *liquidity channel* plays a role for the more exposed banks on the private markets even when controlling for the *bank balance-sheet channel* . Turning to the economic magnitude, for the same borrower the growth of credit granted by a hypothetical bank that raises funds on the private markets only (*share* = 1) is lower by 0.3 percentage points than the growth of credit granted by a bank that raises funds only via Eurosystem operations (*share_ mkt* = 0). This result partly reconciles the findings of Table 3 with previous studies on the sovereign debt crisis, documenting that the *liquidity channel* plays a role even outside periods of severe financial strains as in 2018. Finally, for completeness Column 3 reports the estimates of the regression when adding also the proxies for the indirect channels described in the previous subsection (*Maturing issued bonds ratio* × *Post*, *Deposit retail ratio* × *Post* and *Government bonds purchases* × *Post*): the evidence is in line with Table 3, and indicates an activation of both the balance-sheet and the cost of funding channels.

7 Concluding Remarks

This paper has provided a quantitative estimation of the relative importance of the two direct channels through which a reduction in the market value of bonds held in banks' sovereign portfolios may lead to a deterioration of bank lending supply: the *balance-sheet channel*, which follows from a reduction in bank capitalization; and the *liquidity channel*, which relates to the reduced availability of collateral to obtain funding on collateralized

markets. The key intuition for disentangling the two channels is to exploit the accounting classification of sovereign bonds and, in particular, the fact that the amount of securities held at market value will affect the intensity of both channels, while the amount of securities held at amortised cost will determine the intensity of the liquidity channel only. To the best of my knowledge this is the first paper to disentangle the impact of these two channels. The exercise exploits the episode of sharp increase in the Italian sovereign yields observed in the second half of May 2018 and connected to the high uncertainty over the formation of the new executive: in less than 2 weeks government yields increased by around 200, 175 and 110 basis points on the two-, five- and ten-year horizons, respectively. This shock originated from the unstable political background and occurred in a context in which profitability, capitalization and overall financial conditions of banks had been improving for a number of years: for this reason, it can be regarded as exogenous to banks' conditions and thus is particularly well suited for the purpose of this paper. The shock here exploited also presents two advantages with respect to the one observed during the sovereign debt crisis and largely used from the literature to estimate the impact of sovereign tensions on credit supply: first, the episode in 2018 was largely unanticipated, while international sovereign debt markets were under stress already in 2010, since the Greek bailout; second, the rise in government yields observed in 2018 involved Italy only, ruling out the possibility that the estimates are affected by macro-financial shocks originated outside the national borders and transmitted to domestic financial institutions.

The results suggest that banks' direct holdings of sovereign bonds had a role in transmitting the sovereign shock to credit supply in the second half of 2018. In particular, the reduction in lending supply was the consequence of the adverse shock to banks' capital position (i.e. the balance-sheet channel activated), while the liquidity channel did not contribute.

The size of the effect associated with the balance sheet channel is economically significant (a reduction in loan growth of 0.8 percentage points for a one standard deviation increase in the exposure to sovereign bonds) but remarkably smaller when compared to previous studies. Bottero et al. (2020) focus on the effects of the Greek bailout on Italian bank credit dynamics by comparing lending supply to a given firm by two banks differing in sovereign exposure by one standard deviation and find that the more exposed banks reduces its credit supply by 10 percentage points more than less exposed bank. Even if the difference in the magnitude partly reflects to the distinct event under study - as they focus on an event that radically changed the perception of government debt riskiness -, such big differences suggest that during 2018 the effects of the *direct channels* was smaller than during 2011.

When I include in the regression proxies for the indirect channels of the sovereign bank nexus, I find that the increase in banks' funding cost associated with the rise in sovereign yields (*cost of funding channel*) also contributed to the reduction in credit supply. Turning to the magnitude of this effect, when comparing the growth of credit to the same firm by two banks that are a one standard deviation apart in terms of the amount of bonds issued and almost to expiry, I find a reduction for the more exposed bank equal to 1 percentage points: the economic significance of this indirect channel is therefore larger than what

estimated for the balance-sheet channel. I also find evidence of a possible crowding-out effect of lending by government bond purchases which, however, was negligible in terms of economic magnitude.

Finally, I document that the lack of an activation of the liquidity channel is consistent with the availability of funds that characterized the Italian banking system in the horizon considered: in particular, I find that banks with a systematically larger recourse to the collateralized interbank market (with respect to the Eurosystem operations) cut lending supply by more during the period considered. This result partly reconciles the findings of the baseline with the studies for the period of the sovereign debt crisis that generally consider the dry-up of funding liquidity for banks as arguably the main factor behind the tightening of loan supply conditions during that episode.

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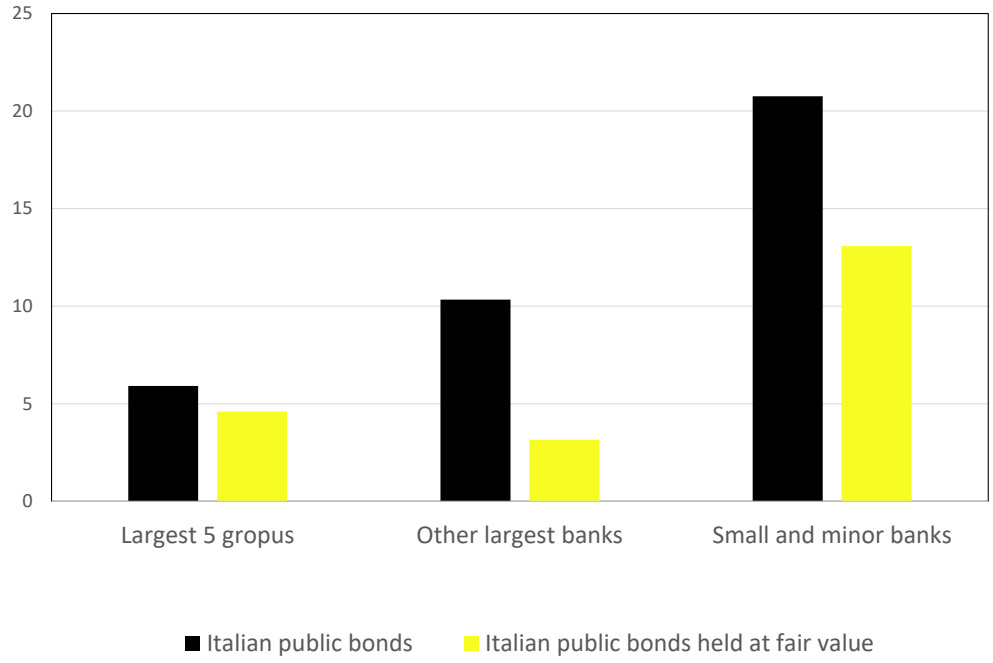
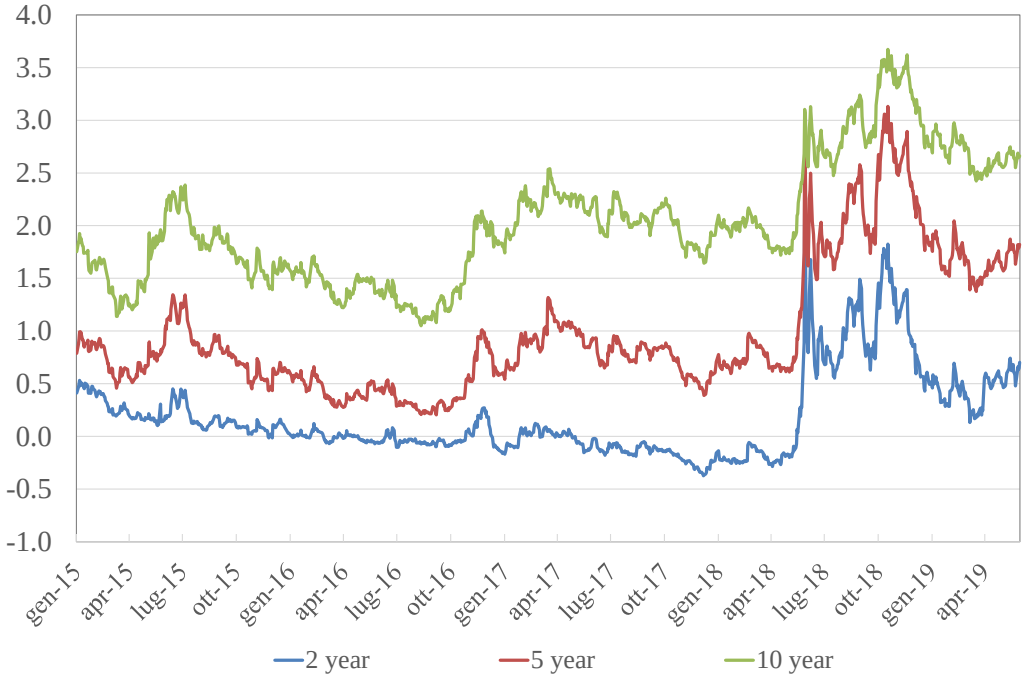
Tables and figures

Figure 1: Government bonds, by bank type



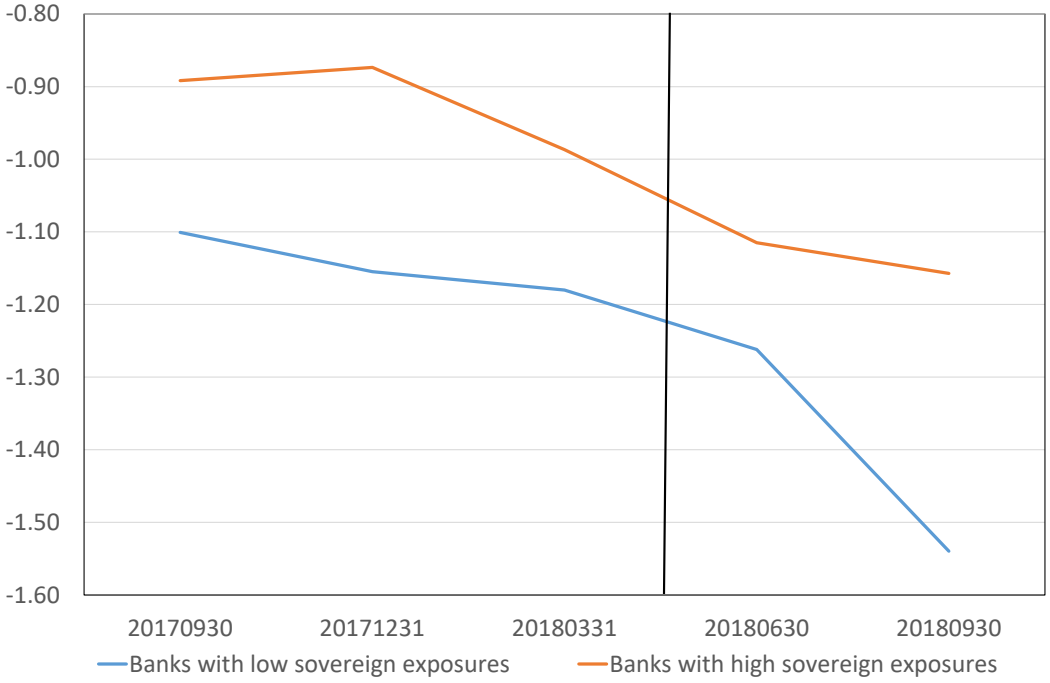
The figure shows the incidence, over total assets, of Italian public bonds (black histogram) of which held at fair value (yellow histogram) as reported in Supervisory Reports statistics for March 2018.

Figure 2: Yields on Italian government bonds



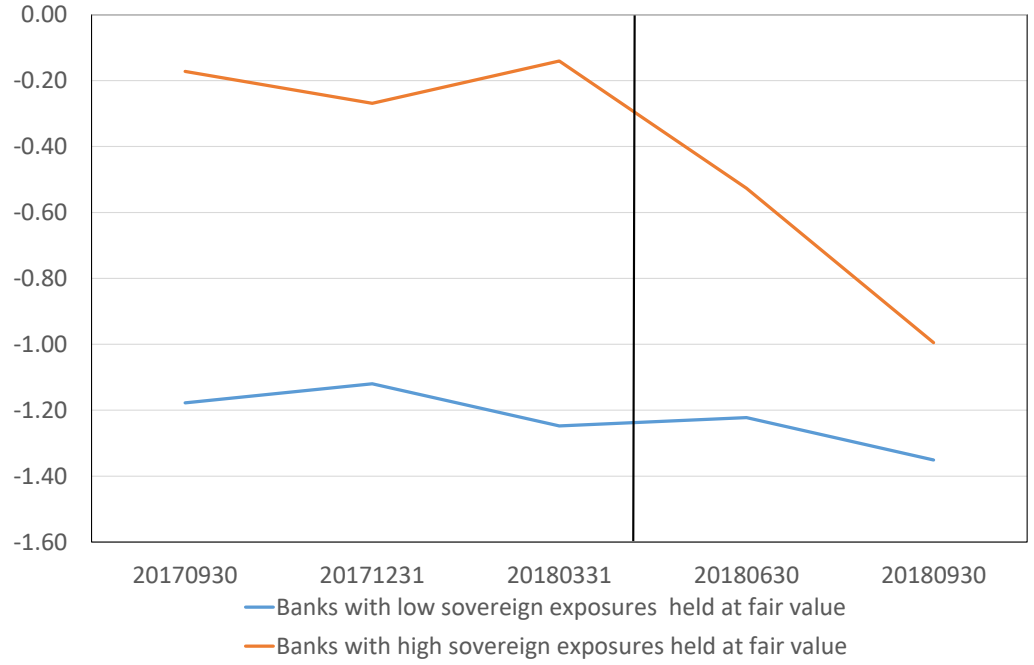
Source: Refinitiv.

Figure 3: Growth rate of bank credit to firms, for exposures of sovereign bonds



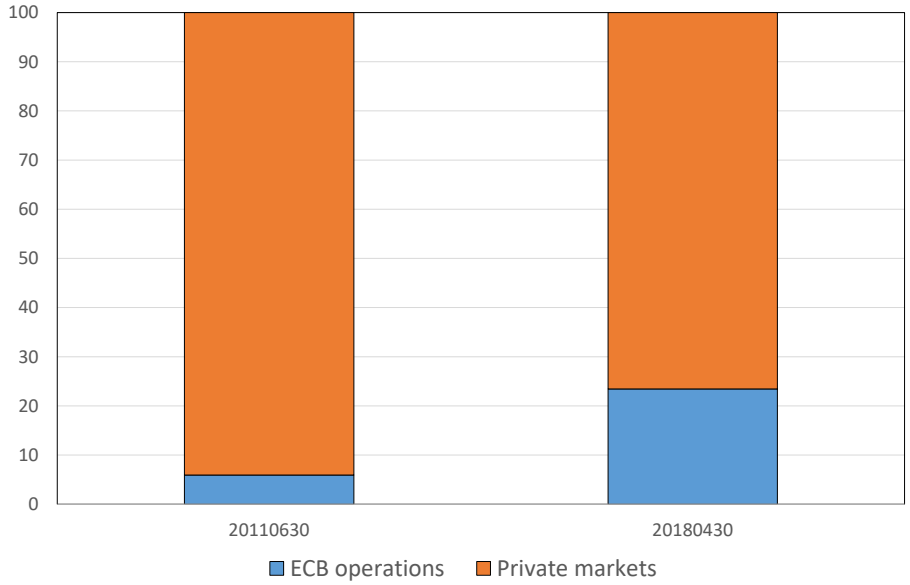
Source: CR and Supervisory Reports statistics

Figure 4: Growth rate of bank credit to firms, for exposures of sovereign bonds held at fair value



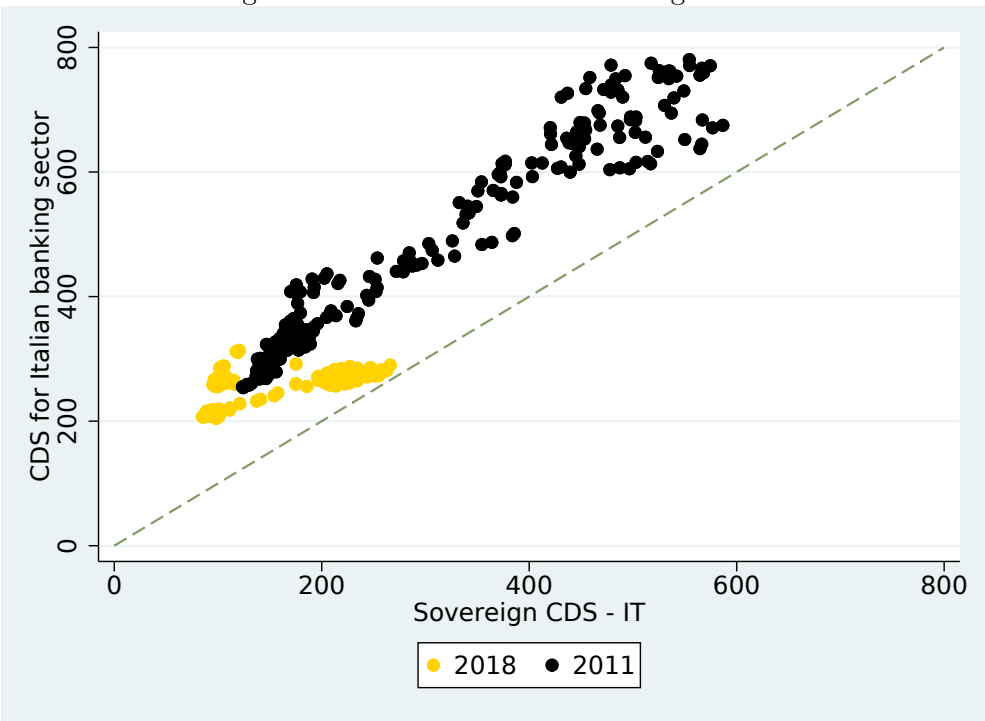
Source: CR and Supervisory Reports statistics

Figure 5: Funding on collateralized markets by Italian banks



The figure splits the total of collateralized funds into (i) funds raised toward ECB operations (blu area) and (ii) funds raised on private markets (orange area), as observed in two points in time just preceding the sharp increase in Italian government yields related to the sovereign debt crisis occurred (June 2011) and that occurred in 2018 related to the political uncertainty in Italy at the time (April 2011). Both histogram sum to 100 per cent. Data are from Supervisory Reports statistics.

Figure 6: Italian banks and sovereign CDS



Each point corresponds to the daily of the sovereign 5-year CDS for Italy (x-axis) and 5-year CDS for the Italian banking sector (y-axis). The 5-year CDS for the banking sector is computed as the unweighted mean of the CDS for the Italian credit institutions with a CDS. Daily data from Refinitiv.

Table 1 - Description of variables

Variable	Descriprion
Growth of credit	Log diff of credit granted from bank to firm on a horizon of 3 months
Capital ratio	Tier 1 ratio (for the post shock period, amended for the changes due to sovereign tensions)
Liquidity ratio	Cash and foreign sovereign bonds over total asstets
Interbank funding ratio	Funds raised on wholesale markets, with either private counterparties or with European Central Bank, over total assets
ROA	Profit and lossess over total assets
Size	Log of total assets
Maturing bonds ratio	Issued bonds with residual maturity up to December 2018 over total assets
Government Bonds ratio	Italian sovereign bonds over total assets
Government Bonds at fair value ratio	Italian sovereign bonds held in the fair value portfolios over total assets
Government bonds purchases	Growth of purchases of government bonds over the period
Retail deposits to GDP	Deposits held by household over to nominal annual GDP
Government bonds purchases	Quarter growth of Italian public bonds
Share of credit	Credit obtained by firm j from bank i over total banking loans obtained by firm i
Bind	The difference between credit granted and credit drawn over the total credit granted

Table 2 - Descriptive statistics

Variable	Mean	Median	25pct	75pct	Std.Dev.
Panel A : Pre-shock					
Growth of credit	-0.6	0	-3.89	0–index4	21.92
Capital ratio	16.14	15.12	14.08	17.8	2.66
Liquidity ratio	1.62	1.84	0.51	2.42	1.17
Interbank funding ratio	13.65	12.13	10.35	15.97	6.72
Roa	0.28	0.17	0.12	0.49	0.44
Log. assets	10.97	11.32	9.673	12.29	2.21
Maturing issued bonds ratio	1.6	1.5	0.65	2.65	1.19
Government bonds ratio	10.33	7.78	5.47	14.03	7.51
Government bonds at fair value ratio	5.97	4.21	2.4	7.28	4.56
Retail deposits to GDP ratio	2.67	1.44	0.21	2.92	3.14
Government bonds purchases	6.96	8.11	-9.7	21.91	67.88
Share of credit	32	26	14	46	22
Bind	41	36	8	73	46

Variable	Mean	Median	25pct	75pct	Std.Dev.
Panel B: Post-shock					
Growth of credit	-0.9	-0.1	-4.3	0	22.26
Capital ratio	16.53	15.36	13.41	18.38	3.92
Liquidity ratio	1.9	1.5	0.65	2.9	1.27
Interbank funding ratio	15.3	15.74	10.31	18.31	7.43
Roa	0.27	0.36	0.21	0.48	0.43
Log. assets	11.22	11.83	10.27	13.11	2.17
Maturing issued bonds ratio	1.19	1.04	0.44	1.65	0.91
Government bonds ratio	11.27	9.03	5.67	14.33	8.05
Government bonds at fair value ratio	5.61	3.99	2.16	8.26	4.07
Retail deposits to GDP ratio	3.27	1.86	0.32	7.14	3.31
Government bonds purchases	0.03	-0.5	-6.9	1.95	21.35
Share of credit	32	27	14	46	22
Bind	42	37	9	75	55

The table shows descriptive statistics of the variables used in the regressions, relative to the estimating sample and thus taken over the distribution of firm-bank-quarter observations. Data for Growth of credit, Share of credit and Bind are from the Italian Credit Register. Data on bank characteristics are from the Supervisory Reports. The sample period includes bank-firm relationships observed in March, June, September and December 2018. Growth of credit is the difference in the quarterly log credit granted. Capital ratio is the ratio of regulatory capital to risk

weighted assets; liquidity ratio is the ratio of cash plus non-domestic government securities to total assets; interbank funding ratio is the ratio of wholesale deposits to total assets; ROA is the ratio of bank profit t to total assets; bank size is the log of total assets; maturing issued bonds is the ratio of bonds issued and with residual maturity up to December 2018; government bonds ratio is the ratio between the amount of Italian public bonds over total assets; government bonds held at fair value ratio is the ratio between the amount of Italian public bonds allocated under either the fair value through profit and loss portfolio or the fair value through other comprehensive income portfolio over total assets; retail deposits to GDP ratio is the ratio between deposits held by households over the annual nominal GDP; government bonds purchases is the quarter growth of purchases in Italian public bonds; share of credit is credit obtained by a firm from the bank over total banking loans held by the firm; Bind is the ratio between the difference of credit granted and credit drawn over the total credit granted.

Table 3 - The channels of sovereign tensions on credit supply: disentangling the direct channels

VARIABLES	(1)	(2)	(3)	(4)
GovBonds		0.14***		
		(4.65)		
FVGovBonds		0.13***		
		(2.93)		
GovBonds x Post	-0.12**	-0.03	-0.06	0.02
	(-2.02)	(-0.58)	(-1.09)	(0.32)
FVGovBonds x Post		-0.25***	-0.18**	-0.15*
		(-4.01)	(-2.42)	(-1.85)
GovBonds x HighInterbk x Post				-0.11
				(-1.05)
FVGovBonds x HighInterbk x Post				-0.15
				(-1.29)
Observations	1047378	1047379	1047378	1047378
R^2	0.39	0.39	0.39	0.39
Bank controls	yes	yes	yes	yes
Bank fixed effects	yes	no	yes	yes
Firm*quarter fixed effects	yes	yes	yes	yes

The table shows regressions of the change in the log of credit granted over a 3-month horizon on the interaction between (i) the share of Italian government bonds over total assets (GovBonds) and the dummy crisis, (ii) the share of Italian government bonds held at fair value (FVGovBonds) and the dummy crisis. Bank controls and variables at firm-bank level and all their interactions with the dummy crisis are added in every regression. To avoid measurement errors arising by the different impact of a rise in sovereign yields on GovBonds and FVGovBonds, these two variables are measured at March 2018 and are therefore time-invariant. The dependent variable is computed as the change in the log of credit granted by the bank to the firm in period t and period t+1. Firm and bank level controls are measured at the end of period t. All independent variables are lagged with respect to the dependent variable. The dummy crisis is equal to one if the period t is Jun-2018 or later. The regression includes one pre-shock period and two post-shock period. The last column also include the interaction of a dummy equal to one if the bank is in the first 25 percentile in terms of total interbank funding over total assets. Standard errors are double clustered at the bank and firm level. Robust t-statistics in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 4 - The channels of sovereign tensions on credit supply: controlling for other indirect channels

VARIABLES	(1)	(2)	(3)	(4)
GovBonds x Post	-0.07	-0.07	-0.05	-0.09
	(-1.48)	(-1.35)	(-0.94)	(-1.63)
FVGovBonds x Post	-0.15*	-0.21***	-0.18**	-0.15*
	(-1.82)	(-3.35)	(-2.38)	(-1.85)
Maturing issued bonds ratio x Post	-0.57*			-0.83**
	(-1.96)			(-2.48)
Deposit retail x Post		-0.46*		-0.24
		(-1.82)		(-1.03)
Government bonds purchases x Post			-0.02**	-0.02**
			(-2.31)	(-2.30)
Observations	1047378	1047378	1042759	1042759
R^2	0.39	0.39	0.39	0.39
Bank controls	yes	yes	yes	yes
Bank fixed effects	yes	yes	yes	yes
Firm*quarter fixed effects	yes	yes	yes	yes

The table shows regressions of the change in the log of credit granted over a 3-month horizon on the interaction between (i) the share of Italian government bonds over total assets (GovBonds) and the dummy crisis, (ii) the share of Italian government bonds held at fair value (FVGovBonds) and the dummy crisis. Bank controls and variables at firm-bank level and all their interactions with the dummy crisis are added in every regression. To avoid measurement errors arising by the different impact of a rise in sovereign yields on GovBonds and FVGovBonds, these two variables are measured at March 2018 and are therefore time-invariant. The dependent variable is computed as the change in the log of credit granted by the bank to the firm in period t and period t+1. Firm and bank level controls are measured at the end of period t. The dummy crisis is equal to one if the period t is Jun-2018 or later. The regression includes one pre-shock period and two post-shock period. Maturing issued bonds ratio is the ratio, over total assets, of bonds issued with maturity up to December 2018 and proxies the cost of funding channel. Deposit retail ratio is computed as bank deposit held by households and firms over GDP and controls for the government guarantee channel. Government bonds purchases is the growth in the domestic public bonds purchases, controlling for the crowding-out effect of lending, is the only variable contemporaneous (not lagged) with respect to the dependent variable. Standard errors are double clustered at the bank and firm level. Robust t-statistics in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 5 - The role of recourse to Eurosystem funds on the activation of the liquidity channel

VARIABLES	(1)	(2)	(3)
GovBonds x Share_mkt x Post	-0.26*	-0.29**	-0.37***
	(-1.91)	(-2.15)	(-2.77)
Share_mkt x Post	0.03	0.03	0.06**
	(1.12)	(1.21)	(2.08)
GovBonds x Post	-0.03	0.05	0.03
	(-0.35)	(0.75)	(0.39)
FVGovBonds x Post		-0.21***	-0.17**
		(-3.04)	(-2.31)
Deposit retail x Post			-0.30
			(-1.12)
Maturing issued bonds ratio x Post			-0.84***
			(-2.72)
Government bonds purchases x Post			-0.01**
			(-2.28)
Observations	1046945	1046945	1042468
R^2	0.39	0.39	0.39
Bank controls	yes	yes	yes
Bank fixed effects	yes	yes	yes
Firm*quarter fixed effects	yes	yes	yes

The table shows regressions of the change in the log of credit granted over a 3-month horizon on the interaction between (i) the share of Italian government bonds over total assets and the dummy crisis, (i) the share of Italian government bonds over total assets scaled on the relative recourse to funds raised on private collateralized markets over total wholesale funding (GovBonds_mkt) and the dummy crisis and (iii) the share of Italian government bonds held at fair value (FVGovBonds) and the dummy crisis. Bank controls and variables at firm-bank level and all their interactions with the dummy crisis are added in every regression. GovBonds_mkt is computed as GovBonds by the share of funds raised on the private collateralized markets over the total funds raised on the collateralized markets. To avoid measurement errors arising by the different impact of a rise in sovereign yields on GovBonds and FVGovBonds, these two variables are measured at March 2018 and are therefore time-invariant. The dependent variable is computed as the change in the log of credit granted by the bank to the firm in period t and period t+1. Firm and bank level controls are measured at the end of period t. The dummy crisis is equal to one if the period t is Jun-2018 or later. The regression includes one pre-shock period and two post-shock period. Maturing issued bonds ratio is the ratio, over total assets, of bonds issued with maturity up to December 2018 and proxies the cost of funding channel. Deposit retail ratio is computed as bank deposit held by households and firms over GDP and controls for the government guarantee channel.

Government bonds purchases is the growth in the domestic public bonds purchases, controlling for the crowding-out effect of lending, is the only variable contemporaneous (not lagged) with respect to the dependent variable. Standard errors are double clustered at the bank and firm level. Robust t-statistics in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

8 Appendix

Table A1 - The channels of sovereign tensions on credit supply: disentangling the direct channels

	(1)	(2)	(3)	(4)
	list	list		list
VARIABLES	acco_g_f	acco_g_f		acco_g_f
GovBonds		0.14***		
		(3.93)		
FVGovBonds		0.13**		
		(2.43)		
GovBonds x Post	-0.12	-0.03	-0.06	0.02
	(-1.64)	(-0.48)	(-0.90)	(0.27)
FVGovBonds x Post		-0.25***	-0.18**	-0.15
		(-3.29)	(-1.98)	(-1.56)
GovBonds x HighInterbk x Post				-0.11
				(-0.87)
FVGovBonds x HighInterbk x Post				-0.15
				(-1.07)
Observations	1047378	1047379	1047378	1047378
R^2	0.39	0.39	0.39	0.39
Bank controls	yes	yes	yes	yes
Bank fixed effects	yes	no	yes	yes
Firm*quarter fixed effects	yes	yes	yes	yes

The table resembles Table 4 but standard errors are clustered at the bank level. Robust t-statistics in parentheses. * p < 0.10, ** p < 0.05, *** p < 0.01.

Table A.2 - The channels of sovereign tensions on credit supply: disentangling the direct channels

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
GovBonds x Post	-0.02		0.04		-0.02		-0.12**		-0.03	-0.06	0.02
	(-1.32)		(1.63)		(-0.86)		(-2.02)		(-0.58)	(-1.09)	(0.32)
FVGovBonds x Post		-0.04*		0.01		-0.05*		-0.22***	-0.25***	-0.18**	-0.15*
		(-1.92)		(0.21)		(-1.68)		(-2.68)	(-4.01)	(-2.42)	(-1.85)
GovBonds									0.14***		
									(4.65)		
FVGovBonds									0.13***		
									(2.93)		
GovBonds x Hing Interbk x Post											-0.11
											(-1.05)
FVGovBonds x Hing Interbk x Post											-0.15
											(-1.29)
Capital ratio									0.14**		
									(2.15)		
Capital ratio x Post							0.00	0.02	0.01	0.01	-0.15
							(0.02)	(0.16)	(0.09)	(0.10)	(-1.18)
Share							-0.11***	-0.11***	-0.11***	-0.11***	-0.10***
							(-13.51)	(-13.49)	(-13.93)	(-13.47)	(-15.20)
Share x Post							0.01	0.01	0.01	0.01	-0.00
							(0.80)	(0.70)	(0.86)	(0.75)	(-0.05)
Bind							-0.00	-0.00	-0.00	-0.00	-0.00
							(-0.86)	(-0.79)	(-0.66)	(-0.88)	(-0.49)
Bind x Post							0.01	0.00	0.01*	0.01	0.00
							(1.54)	(1.47)	(1.69)	(1.57)	(0.15)

Liquidity ratio			-1.02*	-1.01*	0.03	-1.09*	-0.79
			(-1.75)	(-1.76)	(0.21)	(-1.94)	(-1.09)
Liquidity ratio x Post			0.10	0.11	0.08	0.17	0.38
			(0.50)	(0.50)	(0.40)	(0.77)	(1.39)
ROA			1.77**	1.77**	0.65*	1.70**	0.41
			(2.55)	(2.49)	(1.74)	(2.47)	(0.55)
ROA x Post			-0.83	-1.07	-0.02	-0.96	-1.47***
			(-1.10)	(-1.37)	(-0.03)	(-1.26)	(-2.82)
Bank size	0.08*	0.08*	0.16**	0.13*	0.01***	0.13*	0.10
	(1.87)	(1.82)	(2.49)	(1.76)	(5.46)	(1.76)	(1.56)
Bank size x Post	-0.00***	-0.00***	-0.01***	-0.01***	-0.01***	-0.01***	-0.01***
	(-3.29)	(-3.64)	(-2.80)	(-2.91)	(-4.49)	(-2.94)	(-3.19)
Capital ratio x Hing Interbk							-0.51*
							(-1.90)
Share x Hing Interbk							-0.04***
							(-3.46)
Bind x Hing Interbk							-0.00
							(-0.26)
Liquidity ratio x Hing Interbk							-1.63**
							(-2.52)
ROA x Hing Interbk							-5.51**
							(-2.08)
Bank size x Hing Interbk							0.01
							(1.55)
Tier 1 ratio x							0.35*

Hing Interbk x Post											
											(1.71)
Share x Hing Interbk x Post											0.02*
											(1.78)
Bind x Hing Interbk x Post											0.01
											(1.63)
Liquidity ratio x Hing Interbk x Post											-0.95
											(-1.50)
ROA x Hing Interbk x Post											4.04**
											(2.59)
Bank size x Hing Interbk x Post											0.00
											(0.74)
Interbank funding ratio							-0.22	-0.17	-0.07***	-0.19	0.07*
							(-1.33)	(-1.01)	(-8.01)	(-1.11)	(1.93)
Interbank funding ratio x Post							0.01	0.00	0.01	0.01	-0.07
							(0.48)	(0.03)	(0.41)	(0.42)	(-1.16)
Observations	2106129	2106129	1574416	1574416	1574416	1574416	1047378	1047378	1047379	1047378	1047378
R-squared	0.15	0.15	0.32	0.32	0.32	0.32	0.39	0.39	0.39	0.39	0.39
Bank controls	no	no	no	no	yes	yes	yes	yes	yes	yes	yes
Bank fixed effects	no	no	yes	yes	yes	yes	yes	yes	no	yes	yes
Firm fe	yes	yes	-	-	-	-	-	-	-	-	-
Firm*timefte	no	no	yes	yes	yes	yes	yes	yes	yes	yes	yes

Robust standard errors clustered at bank and firm level. Robust t-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table A.3 - The channels of sovereign tensions on credit supply: controlling for other indirect channels

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
GovBonds x Post	-0.13**		-0.07	-0.14**		-0.07	-0.11*		-0.05	-0.14**		-0.09
	(-2.26)		(-1.48)	(-2.57)		(-1.35)	(-1.76)		(-0.94)	(-2.32)		(-1.63)
FVGovBonds x Post		-0.20**	-0.15*		-0.25***	-0.21***		-0.21**	-0.18**		-0.20**	-0.15*
		(-2.32)	(-1.82)		(-3.83)	(-3.35)		(-2.55)	(-2.38)		(-2.44)	(-1.85)
Capital ratio x Post	0.00	0.02	0.01	-0.07	-0.05	-0.06	0.03	0.04	0.04	-0.04	-0.02	-0.04
	(0.01)	(0.15)	(0.08)	(-0.69)	(-0.56)	(-0.65)	(0.24)	(0.37)	(0.33)	(-0.40)	(-0.25)	(-0.37)
Share	-0.11***	-0.11***	-0.11***	-0.11***	-0.11***	-0.11***	-0.11***	-0.11***	-0.11***	-0.11***	-0.11***	-0.11***
	(-13.55)	(-13.52)	(-13.51)	(-13.84)	(-13.79)	(-13.82)	(-13.58)	(-13.56)	(-13.55)	(-13.88)	(-13.82)	(-13.88)
Share x Post	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	(0.81)	(0.71)	(0.77)	(1.09)	(1.00)	(1.06)	(0.87)	(0.79)	(0.82)	(1.12)	(1.02)	(1.09)
Bind	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
	(-1.02)	(-0.91)	(-1.02)	(-0.90)	(-0.83)	(-0.93)	(-0.87)	(-0.82)	(-0.90)	(-1.15)	(-1.02)	(-1.15)
Bind x Post	0.01*	0.01	0.01*	0.01	0.01	0.01	0.01	0.00	0.01	0.01*	0.01*	0.01*
	(1.70)	(1.58)	(1.70)	(1.59)	(1.51)	(1.62)	(1.52)	(1.47)	(1.56)	(1.81)	(1.66)	(1.81)
Interbank funding ratio	-0.20	-0.16	-0.18	-0.25	-0.19	-0.21	-0.27	-0.23	-0.24	-0.29*	-0.24	-0.26
	(-1.29)	(-0.97)	(-1.09)	(-1.59)	(-1.21)	(-1.33)	(-1.65)	(-1.31)	(-1.41)	(-1.89)	(-1.50)	(-1.64)
Interbank funding ratio x Post	0.01	-0.01	0.01	-0.00	-0.02	-0.01	-0.00	-0.01	-0.00	-0.01	-0.03	-0.01
	(0.26)	(-0.16)	(0.25)	(-0.14)	(-0.70)	(-0.23)	(-0.00)	(-0.37)	(-0.00)	(-0.31)	(-0.83)	(-0.34)
Liquidity ratio	-1.03**	-0.98**	-1.09**	-1.17*	-1.22**	-1.31**	-1.07*	-1.07*	-1.15**	-1.05**	-1.04**	-1.16**
	(-2.05)	(-1.98)	(-2.21)	(-1.81)	(-2.00)	(-2.14)	(-1.86)	(-1.89)	(-2.06)	(-2.07)	(-2.19)	(-2.39)
Liquidity ratio x Post	0.11	0.09	0.16	0.09	0.13	0.19	0.11	0.12	0.18	-0.00	-0.00	0.08
	(0.53)	(0.42)	(0.74)	(0.54)	(0.72)	(1.09)	(0.52)	(0.56)	(0.82)	(-0.02)	(-0.01)	(0.43)
ROA	2.72***	2.62***	2.58***	0.44	0.38	0.29	1.61**	1.59**	1.53**	1.75	1.63	1.53
	(3.59)	(3.28)	(3.35)	(0.33)	(0.29)	(0.22)	(2.07)	(2.01)	(1.98)	(1.31)	(1.22)	(1.16)

ROA x Post	-2.00**	-2.10**	-2.00**	0.50	0.24	0.40	-0.92	-1.16	-1.04	-1.21	-1.34	-1.16
	(-2.15)	(-2.25)	(-2.19)	(0.42)	(0.21)	(0.34)	(-1.18)	(-1.43)	(-1.32)	(-0.95)	(-1.06)	(-0.92)
Size	0.18***	0.15**	0.15**	0.18**	0.15*	0.15*	0.16**	0.13*	0.13*	0.19**	0.17**	0.17**
	(2.80)	(2.00)	(2.01)	(2.24)	(1.80)	(1.79)	(2.57)	(1.83)	(1.80)	(2.57)	(2.10)	(2.08)
Size x Post	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.01**	-0.01***	-0.01***	0.00	0.00	0.00
	(-1.48)	(-1.21)	(-1.64)	(-0.47)	(-0.18)	(-0.66)	(-2.49)	(-2.79)	(-2.66)	(0.45)	(0.69)	(0.18)
Maturing issue bonds ratio x Post	-0.62**	-0.54*	-0.57*							-0.90***	-0.79**	-0.83**
	(-2.27)	(-1.84)	(-1.96)							(-2.86)	(-2.36)	(-2.48)
Deposit retail				-3.71	-0.69	-1.13				-14.09	-10.45	-11.32
				(-0.36)	(-0.07)	(-0.11)				(-1.60)	(-1.18)	(-1.31)
Deposit retail x Post				-0.39	-0.46*	-0.46*				-0.18	-0.24	-0.24
				(-1.48)	(-1.83)	(-1.82)				(-0.73)	(-1.03)	(-1.03)
Gov. bonds purchases							-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
							(-1.52)	(-1.50)	(-1.11)	(-1.46)	(-1.60)	(-1.08)
Gov.bonds purchases x Post							-0.02**	-0.02**	-0.02**	-0.02**	-0.02**	-0.02**
							(-2.24)	(-2.28)	(-2.31)	(-2.24)	(-2.25)	(-2.30)
Observations	1047378	1047378	1047378	1047378	1047378	1047378	1042759	1042759	1042759	1042759	1042759	1042759
R-squared	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39
Bank controls	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Bank fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Firm*quarter fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes

Robust standard errors clustered at bank and firm level. Robust t-statistics in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table A.4 - The role of recourse to Eurosystem funds on the activation of the liquidity channel

VARIABLES	(1)	(2)	(3)	(4)	(5)
GovBonds x Share_mkt x Post	0.02	-0.26*	-0.29**	-0.35***	-0.37***
	(0.85)	(-1.91)	(-2.15)	(-2.65)	(-2.77)
Share_mkt x Post	-0.01*	0.03	0.03	0.06**	0.06**
	(-1.87)	(1.12)	(1.21)	(2.04)	(2.08)
GovBonds_pre x Post	0.03	-0.03	0.05	-0.03	0.03
	(0.95)	(-0.35)	(0.75)	(-0.48)	(0.39)
FVGovBonds_pre x Post			-0.21***		-0.17**
			(-3.04)		(-2.31)
Capital ratio x Post		0.05	0.07	-0.05	-0.04
		(0.46)	(0.63)	(-0.47)	(-0.40)
Share		-0.11***	-0.11***	-0.11***	-0.11***
		(-13.61)	(-13.59)	(-13.87)	(-13.87)
Share x Post		0.01	0.01	0.01	0.01
		(0.81)	(0.76)	(1.08)	(1.05)
Bind		-0.00	-0.00	-0.00	-0.00
		(-0.78)	(-0.80)	(-1.00)	(-0.99)
Bind x Post		0.00	0.00	0.01*	0.01*
		(1.48)	(1.50)	(1.68)	(1.68)
Interbank funding ratio		-0.26	-0.23	-0.42**	-0.39*
		(-1.36)	(-1.17)	(-2.10)	(-1.90)
Interbank funding ratio x Post		0.00	-0.00	-0.03	-0.04
		(0.04)	(-0.00)	(-0.82)	(-0.84)
Liquidity ratio		-1.03*	-1.11**	-1.05**	-1.18**
		(-1.81)	(-2.04)	(-2.00)	(-2.37)
Liquidity ratio x Post		0.07	0.15	-0.12	-0.03
		(0.35)	(0.64)	(-0.60)	(-0.13)
ROA		1.88**	1.80**	1.90	1.67
		(2.23)	(2.16)	(1.46)	(1.32)
ROA x Post		-1.39	-1.57	-2.05	-2.02
		(-1.36)	(-1.54)	(-1.50)	(-1.52)
Bank size		0.15**	0.11	0.18**	0.15*
		(2.45)	(1.59)	(2.48)	(1.95)
Bank size x Post		-0.01***	-0.01***	0.00	-0.00
		(-3.88)	(-4.18)	(0.23)	(-0.06)
Deposit retail				-20.46**	-17.49**
				(-2.47)	(-2.15)
Deposit retail x Post				-0.23	-0.30
				(-0.83)	(-1.12)
Maturing issued bonds ratio x Post				-0.92***	-0.84***
				(-3.07)	(-2.72)
Government bonds purchases				-0.00	-0.00
				(-1.40)	(-1.06)

Government bonds purchases x Post				-0.01**	-0.01**
				(-2.21)	(-2.28)
Observations	1571264	1046945	1046945	1042468	1042468
R-squared	0.32	0.39	0.39	0.39	0.39
Bank controls	no	yes	yes	yes	yes
Bank fixed effects	yes	yes	yes	yes	yes
Firm*quarter fixed effects	yes	yes	yes	yes	yes

Robust standard errors clustered at bank and firm level
Robust t-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Chapter 3

Collateral in bank lending during the financial crises: a borrower and a lender story

M. Affinito, F. Sabatini and M. Stacchini[1]

Abstract

We study which lender and borrower characteristics are associated with a higher incidence of collateral over loans granted to non-financial corporations before and during the global financial and the euro-area sovereign debt crises. By using a large dataset of 2 million of bank-firm level observations covering the years 2007-13, we find that the degree of collateralization is higher at financially stressed and lowly capitalized borrowers; it moreover increases further during downturns. In addition, we find that collateral policies are tighter at banks that are more capitalised and have a lower stock of bad loans. This result is consistent with the existence of a negative link between bank soundness and risk-taking in bank lending.

[1] Bank of Italy. The authors would like to thank for their comments, without implicating them in responsibility, two anonymous referees, Giorgio Albareto, Andrea Brandolini, Riccardo De Bonis, Antonio De Socio, Matteo Piazza, Alfonso Rosolia, the participants at the Bank of Italy's 4th Banking Research Network Workshop (Rome, 25-26 September 2018) and at the internal seminars of our Directorates. All remaining errors are the authors' responsibility only. The views expressed are those of the authors alone and do not represent necessarily those of the Bank of Italy.

Content

1. Introduction

Collateral is a crucial component of loan contracts and received a large amount of attention in banking literature (Berger and Udell,1990 and Holmstrom and Tirole, 1997). In contract theory, collateral policies have the key task of attenuating opportunistic behaviours and facilitating screening activities of lenders (Bernanke and Gertler, 1995). This paper investigates which are the main characteristics of both borrowing firms and lending banks that are associated with the degree of collateralization in corporate lending and how their role changes during economic downturns. In particular, we first focus on the link between the use of collateral and bank balance-sheet health, as measured by banks capitalization and the incidence of bad loans over assets. We then investigate the association between the degree of collateralization and the economic and financial strength of borrowers.

By means of a firm-bank matched dataset built by the Italian Credit Register and Cerved firms register, we exploit the development in collateralized lending in Italy during the period 2007-13, a period comprising the global financial and the euro-area sovereign debt crises. The Italian credit market is an environment as Italy is a bank-based economy and most firms' are bank dependent. Moreover, the two crisis significantly affected the Italian credit market, making it an ideal setting to investigate how the use of collateral changes during downturns.[2]

The relevant dependent variable is the incidence of collateral on total loans at firm-bank level: this measures the share of credit losses protected by collateral in the case of firm default. We first investigate the link between the degree of collateralization and lenders features by regressing our dependent variable on bank balance-sheet characteristics. The granularity of our dataset enables us to follow the methodology first pioneered by Khwaja and Mian (2008) and to include firm-time fixed effects that absorb all observable and non-observable heterogeneity at the firm level and that might potentially confound the links under investigation. We then turn to the investigation between the degree of collateralization and borrowers features: in the same fashion, we regress our dependent variable on firms' characteristics and, in order to insulate borrower side features, we control for all bank heterogeneity through time-varying bank fixed effects. Through the paper we also make use of instrumental variable (IV) approaches to deepen the analysis of endogeneity of specific variables.

We find that the following results. First, for the lender side, we find that collateral policies are tighter at sounder banks –i.e. banks that are more capitalized or that have a lower stock of bad loans. These associations hold even testing the results in instrumental variable versions of our

2 The financial crises induce a very deep and long recession, which leaves a cumulative drop in GDP of almost 10%; this causes a very large increase in non-performing loans (from 5.8% of outstanding bank loans in December 2006 to 16% in December 2013) and a prolonged contraction in bank credit (Angelini et al., 2017; Angelini, 2018). Moreover, unlike other Eurozone countries, Italy does not inject public funds to recapitalize the banking system nor it creates a bad bank to absorb the non-performing loans. As a result, on the borrower side, the double dip recession pushes several firms out of business and stresses many of those who are able to survive; on the lender side, Italian banks remain saddled with a large fraction of bad loans, and several banks struggle to meet the stricter capital requirements imposed by regulators in the aftermath of the crisis.

estimations, which limit possible reverse causality concerns. Second, on the borrower side the incidence of collateral over the amount of loan granted is higher at financially stressed and poorly capitalized firms. We also find that collateral policies tightened for these type of firms after the deflagration of the financial crises.

The paper contributes to the literature in three ways. First, scholars have largely overlooked the lender-side dimension of the use of collateral, and focused instead mainly on its association with borrower opacity. Instead, we document that the incidence of collateral vary also according to banks' soundness. These shocks can occur either through 'one-off' events or even during tranquil periods and their importance and impact might differ during the phases (e.g., Degryse et al., 2019). The literature has shown that during economic crises tensions on bank balance-sheet depress lending (Bernanke and Gertler 1989; Bernanke and Gertler 1995); moreover, the contraction of lending can adversely impact the level of firms investments and depress real economy (Amiti and Weinstein, 2018). However, the literature has not investigated whether adverse shocks on banks balance-sheet channels might also impact lenders' collateral policies, therefore further contributing to the propagation of financial shocks.

Second, by including the years of the global financial and sovereign crisis we also investigate how the correlation between collateral policies and firm characteristics change during periods of financial strains. Moreover, although borrowers' characteristics are at the core of the literature on moral hazard and adverse selection, conclusions are unanimous even in finding a relationship between collateral and firm riskiness, e.g., the firm side of our investigation. The omission of bank-side features, which instead we include, may contribute to explain the different results found so far by the literature.

Third, our study also contributes to the debate on the link between banks' soundness and risk-taking behaviour (e.g., Delis and Kouretas, 2011; Hilscher and Raviv, 2014). In fact, since our results show that sound banks are characterized by higher collateralized loans, we hypothesize that a channel through which loan collateralization operates is the banks risk-taking in lending. To verify whether the channel is at work, we analyse whether loan conditions to similiar borrowers, in term of riskiness, are heterogeneous across banks that differ in terms of capitalization and quality of assets: we find that loans granted by sounder banks are characterized by lower rates and tighter collateral policies, which is consistent with the hypothesis of the risk-taking channel.

The rest of the paper is organised as follows. Section 2 reviews the main literature on collateral in bank lending. Section 3 presents the data. Section 4 describes our empirical strategy. Section 5 summarizes the baseline results. Section 6 deepens the role of personal guarantees. Section 7 explores the role of banks' risk-taking attitude in the request of collateral. Section 8 illustrates other extensions of our analysis. Section 9 presents some robustness checks. Section 10 concludes.

2. Literature review

A large theoretical and empirical literature investigates the use of collateral in loan contracts. Typically, loan collateralization is expected to mitigate informational asymmetries responsible for moral hazard and adverse selection problems in debt markets. For exposition purposes, it is useful to distinguish three issues in the literature.

First, the traditional literature relates the collateral policies to the characteristics of borrowers and splits into two views. The former (the so called sorting-by-observed-risk paradigm) highlights that the use of collateral is positively correlated with borrowers' riskiness because the presence of collateral mitigates frictions and increases ex-post incentives to repay loans. The latter (the so called sorting-by-private-information paradigm) stresses that the use of collateral negatively correlates with observable riskiness because safer borrowers are willing to pledge more collateral to signal their soundness and ability to repay loans. The empirical investigation on the link between collateral and risk is pioneered by Berger and Udell (1990) and subsequently carried-on by several authors. These studies prevailingly show that the collateral policies are more severe when borrowers are observationally riskier in terms of balance sheet characteristics, public ratings, Altman z-score indicator and loan performance.[3]

Second, the traditional literature relates the use of collateral to the nature of the relationship between lenders and borrowers. Relationship lenders might have looser collateral policies because informational asymmetries with clients are smaller, or, alternatively, policies might be tighter if relationship lending is more frequent with relatively opaque borrowers and if some lock-in effect is at work.[4]

Third, a more recent and so far limited strand of research relates the use of collateral to lenders' characteristics. At the best of our knowledge, this stream of research only focuses on organizational features of lending activity. Inderst and Mueller (2007) show that, when competition from distant (transactional) lenders increases, also as a consequence of a technological shock, local lenders might rise the request of collateral to increase the payoffs of the projects that, otherwise, would be inefficiently rejected. Jimenez et al. (2009) also find that loans granted by local lenders are, on average, more secured than loans pledged by distant lenders. Peltoniemi and Vieru (2015) find that the use of personal guarantees is positively correlated with transaction based lending.

[3] The first theoretical strand (sorting-by-observed-risk paradigm) counts Boot, Thakor, and Udell (1991), Boot and Thakor (1994), Aghion and Bolton (1997), Holmstrom and Tirole (1997). The second theoretical strand (sorting-by-private-information paradigm) counts Bester (1985 and 1987), Besanko and Thakor (1987a and 1987b), Chan and Thakor (1987), Boot, Thakor, and Udell (1991). The empirical works include Harhoff and Korting (1998), Pozzolo (2004), Gonas, Highfield and Mullineaux (2004), Chakraborty and Hu (2006), Jimenez, Salas, and Saurina (2006), Bonaccorsi di Patti (2007), Brick and Palia (2007), Calcagnini et al. (2012).

[4] See Berger and Udell (1995), Harhoff and Korting (1998), Chakraborty and Hu (2006), Brick and Palia (2007), Machauer and Weber (1998), Elsas and Krahnen (2000), Lehmann and Neuberger (2001), Ono and Uesegi (2009), Degryse and Van Cayseele (2000), Jiminez et al. (2006). Menkhoff, Neuberger, and Suwanaporn (2006), Voordeckers and Steijvers (2006), Berger, Espinosa-Vega, Frame, and Miller (2011), Berger, Frame and Ioannidou (2011).

Stroebel (2015) shows that better informed mortgage lenders, whose business is integrated with that of property developers, use informational advantages to lend more against higher quality collateral.[5]

3. Data and variable description

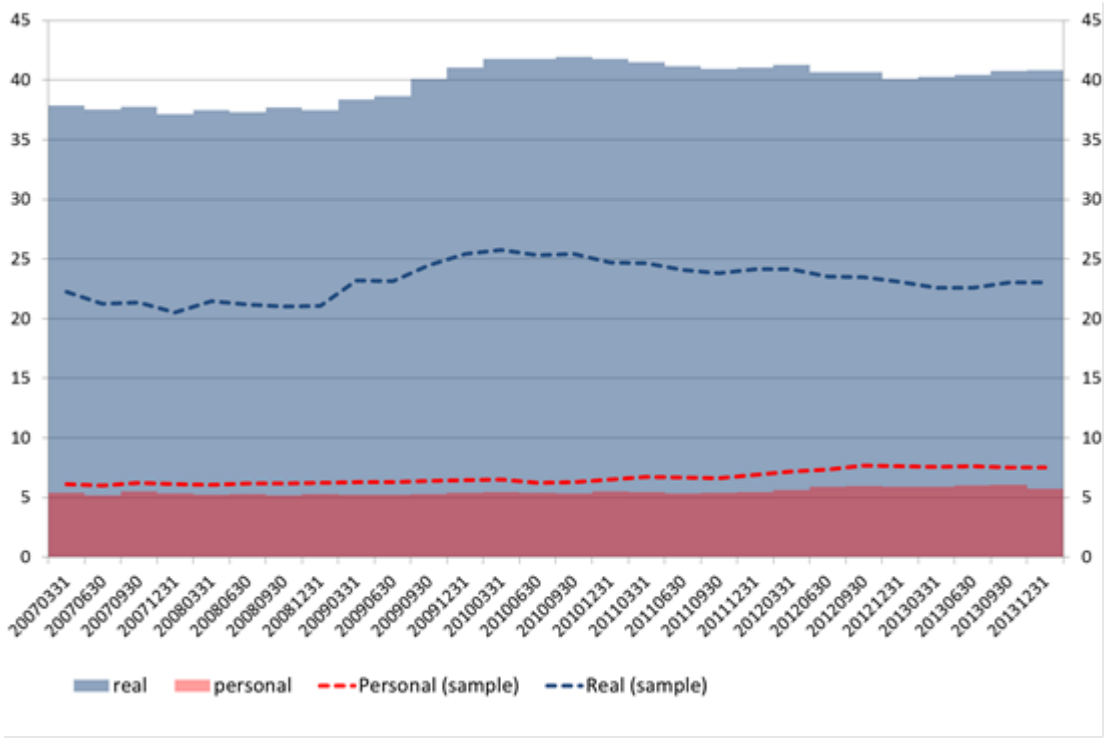
Figure 1 shows aggregated descriptive statistics on how the ratios of real and personal guarantees to total loans develop between 2007 and 2013 for both all Italian firms and the firms included in our sample. Two stylized facts are noteworthy. First, the use of guarantees increases remarkably after the failure of Lehman Brother and remains high until the end of our sample period, at the end of 2013. Second, real collateralization is the predominant type of guarantee in bank lending, probably because of their higher strength in enforcement, but personal guarantees are sizable as well. With regard to our sampled firms, the development of the use of collateral broadly resembles that of the universe of Italian firms. However, while the incidence of personal guarantees is broadly similar across the two domains, our sample highlights a downward shift for the incidence of real guarantees, which is likely to reflect the relatively higher size of the firms we use in the econometric analysis. We turn to the point later on in the paper.

Clearly, the patterns of Figure 1 highlight equilibrium outcomes that are likely to reflect bank- as well as firm-level characteristics associated with loan collateralization. In particular, during the financial crises, when economic strength of borrowers worsens, soundness of some creditors decreases and their attitude toward risk changes. To disentangle bank and firm level factors, our econometric analysis relies, as mentioned, on a dataset containing firm-, bank- and relationship-(bank-firm) variables, covering all banks operating in Italy and a large sample of (largely unlisted) non-financial firms. Our dataset includes around 2 billion of observations. The time span goes from 2007Q1 to 2013Q4 (the information is quarterly), covering both the global financial and the euro-area sovereign debt crises. The dataset is obtained by merging the three following archives.

[5] The most recent literature on collateral has dealt with the role of collateral in association with regulation and firm outcomes. For example, Banerjee (2016) shows that effects of changing house prices on both borrowing and investment are higher at more opaque firms. Cerqueiro, Ongena and Roszbach (2016) show that legal reforms affecting the values of collateral might influence credit limits set by lenders. Calomiris, Larrain, Libertide and Sturgessd (2017) highlight the link between collateral laws and the use of immovable or movable collateral.

Figure 1 – Loans to non-financial corporations: collateral as a share of lending

(percentage points)



Sources: Central Credit Register (CR) of Bank of Italy. Bad loans are excluded from the calculus. The data are not influenced by the break in the coverage of the Credit Register occurred in 2009, as the ratios are computed by applying the same CR threshold throughout the sample period (75,000 euros).

i) The Italian Central Credit Register (CR). This is managed by the Bank of Italy and contains information on loans granted to Italian firms by all banks operating in the Italian territory. The database contains the universe of exposures larger than 30,000 euros. We use information at firm-bank level on the amount of real (and personal) collateral posted on loans (the numerator of our dependent variable) and the amount of outstanding loans (the denominator of our dependent variable).[6] From CR we also get information on the strength of relationship lending, measured as the share of loans granted by each banking group over the total amount of the firm's debt.

ii) The Company Account Database (CAD) owned by Cerved SPA. This archive contains annual data on firm balance sheets for around 32,000 firms on several balance sheet variables such as total assets, leverage, total earnings, sales, etc.

[6] Bad loans, i.e. exposures to insolvent clients, are excluded from our dependent variable (both to the numerator and denominator). This allows us to seize the genuine changing effect of collateral policies over time, that is, to track the use of collateral resulting from lending policies related to exposures whose credit risk's assessment is underway. The exposures we consider include deteriorated lending (different from bad loans) that however have chances of recovery. Instead, bad loans refer to clients that present no or negligible chances to recover and their amount in banks' assets (or their ratio with collateral) does not reflect a lender or borrower choice, but mainly the ongoing legal procedures for liquidation that in Italy historically take long time to resolve (Visco, 2015).

iii) Bank of Italy Supervisory Reports. This archive contains data on bank balance sheets submitted by banks to the national authority. Data are aggregated at the bank group-level as decisions on lending and funding are mostly taken at the bank group level. We build pro-forma data to control for mergers and acquisitions (that is, we consider banks A and B as a sole entity for the whole period if bank A acquires bank B during the period we analyse).

Table 1 reports the list of our variables, at firm-, bank- and pair level, and describes how each of them is computed.[7] In our baseline estimations, our dependent variable *Coll-to-loans* is the amount of real collateralization as a share of lending at the lender-borrower level. Table 2 illustrates its distribution both before and during the financial crises. *Coll-to loan* equals around 7 per cent on average; the figures for the subintervals are broadly comparable. Not surprisingly, Table 2 shows that *Coll-to-loan* equals 0 in a (not negligible) number of cases. In fact, the distribution of the variable reflects the two instrument categories available for corporate lending: (i) term-loans, which are generally used to finance firm investments, have a predefined maturity and are typically covered by collateral; and (ii) current account overdrafts, which are instead an instrument largely used as a liquidity buffer, are revocable at bank's discretion and are usually not backed by collateral. To take into account the role of the two instrument categories, we run on the issue some extension exercises (Section 8). Moreover, as mentioned, many exposures are backed by third parties' personal guarantees (whose role is investigated deeply in Section 6).

Our measures of firm characteristics aim at capturing the economic and financial strength of borrowers, which are relevant to assess credit risk: *Firm capital* (which measures firm soundness through the capital endowment); *Firm doubtful loans* (which measures firm vulnerability through the share of past due loans); *Firm tangible assets* (which also is a measure of firm riskiness because firms with more enforceable assets are typically perceived as less risky); *Firm sales* and *ROA* (higher sales and profits typically signal a lower risk). *Firm size* and *Firm age* complete the picture as standard control variables. Table 3 reports descriptive statistics on our sampled firms. With regard to capital, average equity as a share of assets equals to 2.1 percent. Average natural logarithm of asset tangibility equals to 1.33. The age of the average firm is 25 years. The gap between means and medians as well as size of standard errors indicate that cross-sectional heterogeneities are relevant. Table also illustrates the worsening of soundness during the financial crises. A breakdown by number of financiers shows that the exercises based only on firms having more than a lender, *à la* Kwaya and Mihan (2008) do not imply losses in terms of firm representativeness.[8] Overall, the sample includes around 30,000 firms.

As for banks, indicators of soundness include *Bank capital ratio*, the total burden of *Bank bad loans* and profitability. The list of bank-side characteristics also include *Bank liquidity ratio*, *Foreign interbank borrowing*, *retail funding* and *Bank Size*. Table 4 reports the descriptive statistics on bank

7 Standard truncation at the 1 per cent probability level is applied to the original dataset to avoid the effects of outliers.
8 Cross-country studies indicate that multiple banking is more common in Italy than in other countries (Ongena and Smith, 2000; Degryse et al., 2018).

characteristics. Estimations also include two variables defined at lender-borrower level, that is, variables that are specific of the bank-firm pair. The first variable captures the intensity of the relationship (*Relationship strength – share*); the second variable is a (0,1) dummy identifying withdrawals which amount overcomes the committed amount (*Bind*). The variable also helps to measure the strength of firms capturing those financially stressed.

4. Empirical strategy

Our analysis investigates whether and to what extent firm and bank soundness are associated with the use of collateral in bank lending, and whether the financial crises affects these links.

A typical concern in this bank-firm level analysis is that riskier firms could be indebted with weaker lenders. If it were the case, the importance of firm characteristics could be confounded by that of bank soundness indicators. To tackle the issue, we analyse firm characteristics by including time-varying fixed effects for each bank to absorb all time-varying bank heterogeneity. At the same time, we use time-invariant firm dummies to control for unobservable time-invariant firm heterogeneity. Thus, the residual variation in the data on loan collateralization results to be a function of several time-varying covariates capturing firm opacity and riskiness.[9] Symmetrically, investigating the bank side features related to the use of collateral we include time-varying fixed effects for each borrower to absorb all time-varying firm heterogeneity, and time-invariant bank dummies to capture time-invariant bank heterogeneity. The residual variation in the incidence of collateral is in this case modelled with respect to a vector of time-varying bank indicators, which include those referred to bank soundness.[10]

To control for the lender-borrower relationship, we also include the two bank-firm pair specific variables capturing the intensity of the relationship (*Relationship strength - share*) and the borrowers whose overdraft facilities' drawdowns overcome committed amounts (*Bind*).

a) Firm-side features of collateral

Formally, to estimate the firm side characteristics associated with the use of collateral, our benchmark specification relies on the following:

$$coll_{ijt} = F_{it-1}\,\beta + R_{ijt-1}\,\gamma + b_{jt} + f_i + e_{ijt} \qquad (1)$$

where $coll_{ijt}$ is the collateral to loans ratio, i.e. the amount of collateral outstanding in time *t* on loans of firm *i* with bank *j;* F_{it-1} is a vector of (lagged) time-varying firm covariates; R_{ijt-1} is a row vector of the (lagged) variables defined at *ijt* level; the variables in F_{it-1} and R_{ijt-1} are listed in Table 1; b_{jt} is a

[9] As it is standard in this kind of empirical analysis, therefore, we assume that time-varying firm level factors influencing borrower opacity and riskiness, potentially (and unavoidably) omitted in the empirical model (such as for example firm investment opportunities), are correlated either with the vector of time-varying variables on economic and financial strength of the firm or with the firm level estimated dummies.

[10] Similarly to before, we assume time-varying bank factors influencing lenders' strength, potentially omitted in the empirical model, are correlated either with the vector of time-varying bank covariates or with the bank level estimated fixed effects.

column vector of (time-varying) bank dummies; f_i indicates (time-invariant) firm dummies; e_{ijt} are idiosyncratic errors ~ i.i.d.

b) Bank-side features of collateral

Symmetrically, the analysis of the bank side variables relies on the following:

$$coll_{ijt} = B_{jt-1}\,\delta + R_{ijt-1}\theta + f_{it} + b_j + u_{ijt} \qquad (2)$$

where $coll_{ijt}$ and R_{ijt-1} are defined as before; B_{jt-1} is a vector of (lagged) time-varying bank characteristics; b_j and f_{it} indicate, respectively, (time invariant) bank dummies and (time-varying) firm dummies; u_{ijt} are idiosyncratic errors ~ i.i.d.

To analyse the effects of the financial crises, we re-estimate equations (1) and (2) allowing the slope coefficients to differ over time[11]; we obtain the results within a single empirical estimation rather than through a simple sample splitting to ease the comparison of coefficients.

In addition, in order to manage endogeneity issues related to specific bank-side characteristics, we also employ instrumental variable (IV) estimations of equation 2, where our framework based on large sets of time-invariant and time-varying fixed effects *à la* Kwaja and Mian (2008) is enhanced with the inclusion of specific instruments.

5. Baseline results

Results on firm characteristics more associated with the use of collateral are reported in Table 5; those on lender characteristics in Table 6.

5.1 Firm-side features of the use of collateral

Column A of Table 5 reports the results of our baseline specification for the entire period under investigation; columns B and C show separately the results – obtained through a single empirical model – on the firm characteristics associated with loan collateralization before and during the financial crises.[12]

Qualitatively speaking, all our measures indicate that higher collateral ratios are always associated with riskier and more vulnerable firms: those with less capital (*Firm capital*) and more past due loans (*Firm doubtful loans*); firms whose overdraft facilities' drawdowns overcome

[11] In the basic regressions the turning date is the collapse of Lehman. However, we also experiment with other dates as a check (which shows that the choice of the turning date is irrelevant for our outcomes).

[12] We do not include in these estimations the firm-level z-*score* along with the other covariates because the variable strongly correlates with the rest of firm-level balance sheet characteristics, which indeed it is inferred on. Indeed, we run (unreported but available upon request) regressions, which show that the coefficient for the variable *Firm z-score* is significantly negative if included in the model alone, while its significance attenuates when it is added as an additional variable.

committed amounts (*Bind*); and firms endowed with a lower asset tangibility (*Firm tangible assets*) and lower sales (*Firm sales*). The economic magnitudes, even if not overwhelming, are generally not negligible. A sizable magnitude is estimated for *Bind*: a shift from a sound to a stressed condition (i.e., when a firm drawdown on a credit line reaches the limit set by the lender) implies an increase in the collateral ratio of 0.023, a value representing around 10 per cent of the average ratio, equals to 0.22. Moving on, a 1 standard deviation increase in *Firm capital ratio* is associated with a lessening of collateral by 0.006 [=-0.15*0.04], i.e. around a 3 per cent decrease of the average ratio. Conversely, a 1 standard deviation increase in *Firm doubtful loans* is associated with a rise in collateralization by 0.002 [=0.024*0.085], i.e. around 1 per cent of the average collateral ratio.

With regard to size, we find that the use of collateral is lower at smaller firms: such a result might seem puzzling as larger firms are those usually deemed relatively safer and less in need of posting guarantees (as shown by Figure 1). On the other hand, the result is consistent with Berger and Udell (1995) and Chakraborty and Hu (2006), who show that larger firms might post more collateral in loan contracts in exchange for better conditions.[13] We deepen the issue as an extension in Section 8, where one of the subsections concerns the relationship between collateral use and firm size.

A comparison of the outcomes of columns B and C shows that, while the sensitivity of collateral policies to *Firm sales* does not change significantly after the onset of the crisis, the coefficients of *Doubtful loans* and *Tangible assets* gain significance and the economic magnitude of *Firm capital* raises. These variations point to an increase in the lenders' risk aversion, potentially associated with the worsening of the economic development and loan performance occurred during the financial crises.

5.2 Bank-side features of the use of collateral

Column A of Table 6 reports the estimates on bank characteristics for the overall period, while columns B and C before and during the financial crises. The estimates show that bank characteristics associated with soundness do matter. Collateral ratios are significantly higher at relatively more capitalized banks as well as at lenders accumulating lower stocks of bad loans. Specifically, a one standard deviation increase in bank capitalization or a one standard deviation decrease in the stock of bad loans are associated with an increase of loan collateralization of around 0.01; this value can be compared with the average collateral ratio that equals to 0.22. These results are suggestive of a negative relation between bank soundness (that is, capital and ex-post loan quality), on the one hand, and risk taking behaviour, on the other hand. The issue will be further explored in Section 7.

[13] This argument would be consistent with the lower interest rates charged on bank loans larger than 1 euro million in Italy. See Bank of Italy, Supplements to the Statistical Bulletin, Money and Banking, July 2015, Table 3.1 https://www.bancaditalia.it/pubblicazioni/moneta-banche/2015-moneta/en_suppl_35_15.pdf?language_id=1

Turning to the other covariates, we find banks more reliant on foreign interbank market to adopt stricter collateral policies. This outcome may be a confirmation of tighter collateral policies at sounder banks. In fact, in particular just during the financial crises, interbank funding is obtained by sounder banks thanks to an incentive scheme through interbank peer monitoring (Rochet and Tirole, 1996; Distinguin et al., 2013).

Columns B and C show that *Bank capital ratio* and *Bank bad loans* are significantly associated with the use of collateral, both before and after the aftermath of the financial crises. Instead, with regard to foreign interbank deposits, estimates show a relevant role for such a variable only after the occurrence of the liquidity shock generated by the collapse of Lehman, which confirms our interpretation.

We are aware that reverse causality may be a concern, particularly when we come to the bank-side features of the use of collateral. The analysis shows in fact that the accumulated amount of bad loans at bank level is negatively associated with the collateral. Although we interpret all our outcomes as indicative of a relationship but without establishing a causal nexus, one might still argue that the direction of the link between the two terms moves from collateral policies to bad loans (i.e., bank's bad loans grow less because the collateral policy adopted by the bank is more prudent) and therefore that simply lagging one period bank characteristics is not enough to include bad loans among covariates. Similar arguments may apply to banks' capital endowment. As mentioned, in order to verify if results hold, we enrich our empirical framework employing an instrumental variable (IV) version of equation (2), where we instrument the potentially endogenous variable, while we still include the same large sets of time-invariant and time-varying fixed effects to control for cofounding factors and firm-side features.

The information contained in the Italian credit registry allows a bank to verify how each debtors is performing toward other creditors; even if in principle different classifications across banks in the quality of loans to the same debtor are allowed, in practice a convergence in the assessment of every firm is observed and banks tend to lag the most conservative decisions made by other credit institutions in the classification of the quality of the debtor.

Angelini et al. (2017) exploit the different promptness in the classification of each borrower across banks to proxy the ability, or willingness, of each credit institution to correctly pin down the class of risk of a debtor. Specifically, they first consider those cases for which at least two banks differ in the classification (bad loans versus *in bonis*) of loans to the same borrower; they then use the percentage of the classified as *in bonis* as a proxy of the weaker quality of the bank internal control system.

The relevance of the instrument is ensured by the fact that banks tend to adapt their assessment on the most conservative one recorded in the Credit registry. The exclusion restriction of the instrument is instead assured by the fact that the assessments of firm's financiers other than

the bank are considered to which the use of collateral refers: this avoids the risk of spurious correlation with the use of collateral. In particular, the leave-out type calculation of the instrument strongly limits the concerns about the correlation between the instrument, on the one hand, and the residuals of the firm*time fixed effect regression, on the other hand (that is, about the violation of the exclusion restriction).

In the same fashion, by taking advantage of multiple lending and the effects of information sharing among banks, we instrument the variable *Bank bad loans* through the evaluations made by all creditors except the given bank and draw from the CR all the classification of status assigned to each firm by each bank and track the cases in which each given bank attributes to each borrower a less conservative status.[14] In order to exploit a higher variation than the instrument of Angelini et al. (2017), we widen set the possible status to bad loan, non-performing other than bad loan and performing. Then, for each bank in each period, we instrument the bad loan ratio through the (aggregate) value of such tracked cases, weighted for their share of loans.

The results are presented in the fourth column of Table 6. The (instrumented) bad loans are still negative and statistically significant, while all the other variables confirm their results. The classical weak identification *F* test statistic, which is equal to 16.38, corroborates the estimation. A comparison between OLS and IV shows an overlap of the estimates[15]: the 95 per cent confidence band for the OLS parameter is (-0.481; -0.261), which 'lives' within the band for the IV coefficient (-1.629; -0.184). Due to the overlapping in the statistical distribution of OLS and IV parameters, we focus on the OLS approach in subsequent analysis (see Schiantarelli et al., 2019).[16]

6. Taking into account the role of personal guarantees

Our baseline analysis focuses on real guarantees because this type of collateral generally provides (with respect to personal collateral) a higher level of creditors' protection thanks to claims it gives on a well-defined asset owned by the debtor. Furthermore, the reference empirical literature on banking usually analyses that type of guarantee.

The scope of our analysis related to the current literature and thus focus on the use of real guarantees. Nevertheless, the omission of personal guarantees in the analysis might imply a bias in the estimates as real and personal guarantees might be regarded, at least to some extent, as substitute

[14] Even if classification across loan quality categories has to be consistent with the rules set-up by regulators, room for discretion does remain on the part of banks, especially as far as the distinction between non-performing loans to insolvent borrowers ("bad loans") and other non-performing loans to temporary illiquid borrowers who however have a chance to recover.

[15] See the columns A and D. More specifically, the intervals illustrated in the text are obtained by considering the 95 percent confidence bands associated to the *t*-statistics of each estimates (reported in brackets in Table 6).

[16] Additional robustness tests on the issue of endogeneity are described in Section 9.

in the credit market. If this were the case, not controlling for the presence of personal guarantees in the loan contract might result in an apparent lower recourse to real collateral. In order to control for this possible cross-subsidization, we carry out two exercises.

First, we verify whether our results on firm and bank-level characteristics associated to real collateralization survive when personal guarantees, as a share of total loans, are included in the model as a further covariate. Tables 7 and 8 couple with Tables 5 and 6 with the only difference of including personal guarantees among regressors. As before, column A reports the estimates for the entire period, while columns B and C disentangle for the periods before and during the financial crises. With regard to the firm-side, results of Table 7 confirm those of Table 5, both qualitatively and quantitatively, and the punchline is still that borrower risk is positively correlated with loan collateralization. Interestingly, in all specifications, we find a negative link between personal guarantees and real collateral, corroborating the hypothesis about the substitutability between the two types of guarantee: therefore, it seems that the presence of a personal guarantee lowers the riskiness of a loan , all being equal, and somewhat compensates the decrease in the intensity of real collateralization. Table 8 shows that also for the bank-side results are broadly unchanged with respect to those obtained without the inclusion of personal guarantees among the covariates. Sounder banks, in terms of capital and ex-post loan quality, are associated with higher amounts of real collateral requested.

Second, we build a new dependent variable, which encompasses at the numerator both real and personal guarantees (obtained by summing-up for each bank-firm pair the amount of loans covered by any real and personal type of collateral) and at the denominator the total lending. We employ the new dependent variable in the previous models studying again the firm- and bank-side characteristics associated to loan collateralization (Tables 9 and 10, respectively). Results confirm the importance of firm riskiness and bank soundness as key factors associated with the use of collateral, both before and after the deflagration of the financial crises and suggest that on the one hand real and personal guarantees are substitute and on the other hand the characteristics more associated to their use are broadly the same.

7. A look at the link between bank soundness and the cost of lending

Our results show that bank-side characteristics matter in loan collateralization. When we insulate the collateral requested to a given borrower by different banks, we find that loans granted by sounder banks (that is, banks with more capital and less bad loans) are more collateralized with respect to those granted by weaker lenders.

We complement this analysis by documenting whether sounder banks adopting tighter collateral policies charge lower rates on corporate loans. In fact, conservative policies on loan collateralization

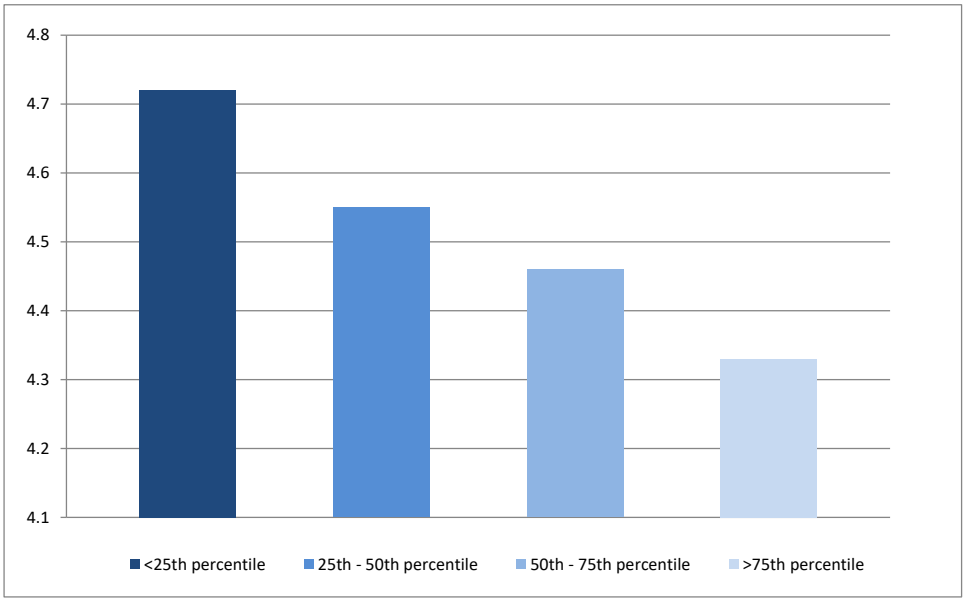
are likely to mitigate opportunistic behaviour of borrowers and, therefore, the riskiness (and the cost) of lending.

To verify whether it is the case, we start by plotting a bivariate statistics showing how rates on loans vary across well capitalized (and likely to require more collateral) banks and their peers. Figure 2 shows that rates applied by sounder banks are lower than those applied by less capitalized institutions: the rate charged by banks in the fourth quartile is around 40 basis points lower than that charged by banks lying in the first quartile of the distribution of bank capital, on average.

Obviously, bivariate statistic might only reflect spurious correlations. One might figure-out different compositions of loan portfolios, in terms of borrower risk, across prudent and less prudent banks, pointing to a higher quality of clients for more prudent lenders (and to a lower cost of lending). Table 12 shows that this is not the case. In fact, the distributions of the z-score indicators of the borrowers, evaluated separately at sounder and weaker banks do not present divergences on this account.[17]

Figure 2 – Interest rates on new loans and bank capital (1)

(percentage values)



Source: Supervisory reports and Taxia

Notes: Term loans extended during the period. Percentiles of the distribution of banks' capital ratio. Data on loan interest rates are reported by around 200 banks accounting for over 90% of total outstanding loans.

[17] The statistical equivalence of the loan portfolios at sounder and weaker banks in terms of borrowers' riskiness also corroborates the robustness of our econometric analysis on the use of collateral because it excludes systematic patterns all (including borrower risk) being equal.

Then, to further control for confounding effects, we also run an econometric model that regresses the interest rate on loans granted to each borrower on a set of bank-level variables. Importantly, the model also controls for all time varying firm heterogeneity through time-varying firm fixed effects (firm × quarter fixed effects), thus it analyses whether and to which extent rates applied to a given borrower vary across well capitalized (and likely to require more collateral) lenders and their peers. Results of Table 11 are consistent with those of Figure 2. The sounder the lender, the lower the rate applied on bank loans to a given borrower (the coefficient of bank capital is negative and statistically significant). Even the second indicator of bank quality (i.e., the bad loans ratio) confirms the picture as the interest rates applied by banks accumulating higher stocks of impaired assets are higher, all being equal. This result, thus, suggests that safer banks (in terms of capitalization and relative amount of bad loans) use collateral policy to mitigate risk: indeed, for the same borrower, loan collateralization is tighter and interest rates are lower at safer banks than at riskier banks.[18]

8. Other extensions

a) Controlling for the size of loans

It is possible that the use of collateral presents confounding effects with the size of the exposure. For instance, higher collateral/loan ratios might be required by sounder banks just because exposures associated to those loans are more sizable. To address the issue, we include the size of loans among our covariates in both equations 1 and 2. However, the inclusion of the amount of loan among regressors rises again a potential issue of endogeneity with the dependent variable (the use of collateral), which is likely to be jointly determined with the decision on the amount. In this light, we apply a new IV regression using as an instrument the same variable put forward by Jimenez et al. (2006): the *Product market risk*, that is, a variable that captures the amount of impaired loans as a share of total loans in the sector where the firm operates (lagged one period). This variable is likely to be taken into account by the potential financiers of the firm projects as it (inversely) proxies investment opportunities in the borrower's economic sector. The exclusion restriction requires that the instrument does not affect the collateral policies directly, but only through the channel of the decision about loan availability (i.e., whether and to what extent the credit is granted by the lender to the firm), which is indeed very plausible. Our results are based on this assumption.

[18] Being based on the within-borrower variation (i.e., on the loans extended to a given firm by different banks), the interest rates under investigation refer to the same level of borrower risk; therefore, they reasonably proxy the differences between the returns, expected by sounder (and requiring more collateral) banks and weaker (and requiring less collateral) banks, on exposures that are identical in terms of borrower riskiness. It is also to notice that our results are confirmed controlling for the size of the exposures (columns B and D of Table 11), which address the concern of potential confoundedness associated to heterogeneities of loan size across sounder and weaker banks.

Table 13 reports the results of the IV exercise for the bank-side characteristics. In the first stage equation, where the size of loans is the dependent variable, we find our instrumental variable to be highly significant and with a negative sign, exactly as in Jimenez et al. (2006). The diagnostic also shows that the weak identification test is passed. We report the results of our baseline regression (column A), the model augmented with loan size (column B) and the second stage of our IV model (column C). The positive association between bank soundness and the use of collateral is confirmed: the coefficients of bank capital and bad loans are broadly stable and significant, and confirm to be respectively positive and negative. Turning to loan size, the variable being instrumented in the first stage, our model shows that the higher the size of the loan, the higher the collateral ratios. The outcome is in line with the literature that shows that the use of collateral, by reducing asymmetric information and incentive problems, implies an equilibrium characterized by less adverse selection and less credit rationing.[19] The result also tallies with the evidence we found about the higher use of collateral in lending to larger firms, whose exposures are supposed to be relatively more sizable (see the results on the firm characteristics associated to higher collateral in Table 4). With regard to the firm characteristics associated to the use of collateral, the results of our IV exercise are reported in Table 14. Although the power of the instrument turns out to be weaker in this case, the inclusion of the size of the exposure among our covariates (columns B and C) does not alter again the results of the baseline model (column A).

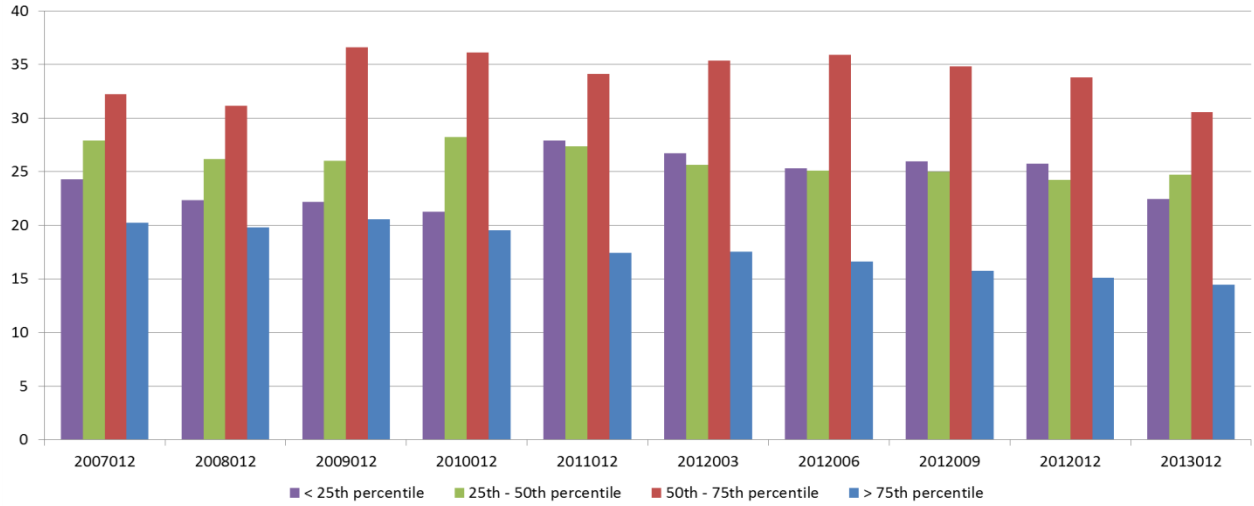
b) Collateral and firm size

As noticed above, while Figure 1 shows that in aggregate smaller firms post higher collateral to loan ratios, our estimations show that the variable *Firm size* affects positively the use of collateral. In order to clarify the relationship between our results and the aggregate statistics, we deepen the issue in two ways.

[19] See for instance the seminal paper by Stiglitz and Weiss (1981).

Figure 3 – Ratio of real collateral to credit drawn by firm size quartiles

(percentages)



Sources: Central Credit Register of Bank of Italy.

First, we plot in Figure 3 the collateral/loan ratios across our sample period for the four quartiles of the distribution of the variable *Firm size*. Figure 3 shows that the firms in the three lower quartiles of the *Firm size* distribution present a use of guarantees that is increasing in the size (as in our econometric exercise), while the top quartile (i.e., the largest firms) presents a lower level of guarantees (as in Figure 1). This evidence suggests a non-linear relationship between firm size and the use of collateral.

Second, and accordingly, we carry out the regression presented in Table 15, where we add the quadratic term of the variable *Firm size* to the baseline regressors, controlling for bank and time fixed effects. While confirming all the other results, the exercise corroborates an inverted U shaped relation between firm size and collateral (the coefficient of the quadratic term of Firm Size is negative, though statistically insignificant, and thus it suggests that the relationship is positive, reaches a maximum and then turns out negative).

c) Loan types

As clarified in Section 3, our definition of loans include two types of bank lending: term loans and overdrafts. The former category is generally used to finance firm investments as it has a predefined maturity. Overdrafts, instead, are typically used to address firm liquidity needs and are revocable at bank discretion. In our baseline specifications we analyse, for each bank-firm relationship, a single indicator: the ratio of the total amount of collateral on the total loans. However, given that collateral are mainly posted on term loans, while overdrafts are mostly uncollateralized – even because they might be offered as an additional facility of the term loan instruments – one might be interested in insulating the characteristics associated to the use of collateral for the two

instruments. Tables 16 and 17 report the results focusing only on term loans, which prove to be consistent with our previous empirical outcomes.

9. Robustness checks

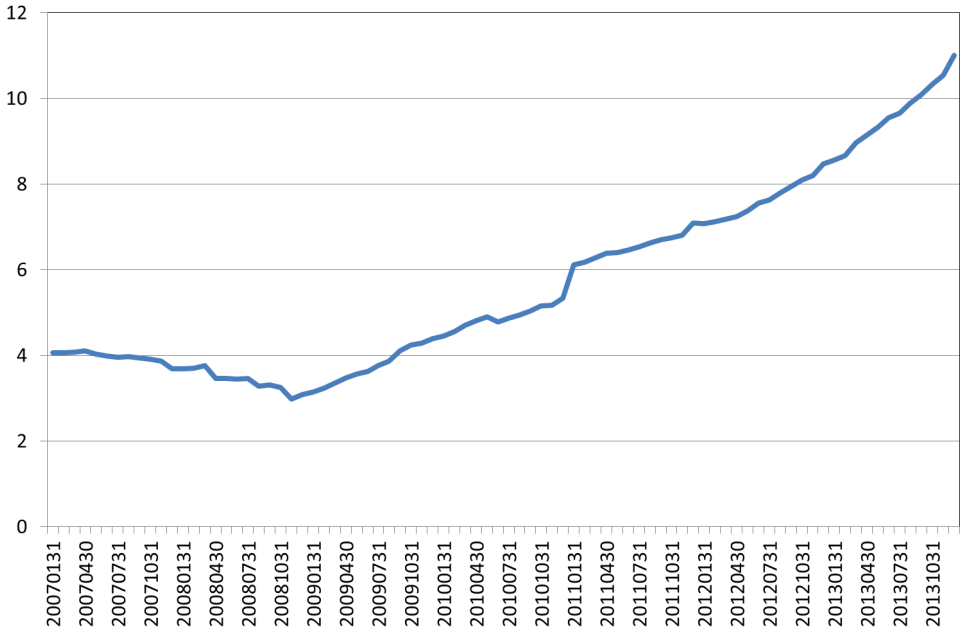
a) Again on the endogeneity of bank-side characteristics

As argued, our analysis on bank-side characteristics may rise concerns on the direction of the relationship between bank bad loans and capital endowment and the request of larger amounts of guarantees. In addition to the IV exercise described above, in order to further test the robustness of our results, we run additional exercises.

First, we address the issue on bad loans also by exploiting a stylized fact of bad loan developments in Italy. Figure 4 shows a reversal in the development of loan quality occurred in December 2008, which is likely to reflect a deterioration of the borrowers' ability to repay loans arising from the deepening of the economic recession in Italy. Hence, it might be regarded as less affected by reverse causality problems associated with the influence of collateral policies on bad loans' accumulation. We thus regress the collateral ratio between December 2008 and March 2009 over *Bank bad loans* for the same period, i.e., when the reversal occurs in Italy. The link between the two variables confirm to be negative and statistically significant (Table 18).

Figure 4 – Loans to the private sector in Italy: bad loans as a share of total loans

(percentages)



Source: Supervisory reports.

Second, we carry out a new IV regression, where *Bank bad loans* are now instrumented by exploiting the effects exerted on the classification of impaired assets by the so called Assessment Quality Review (AQR) exercise, conducted at the end of 2014 by the ECB towards a large number of European banks in order to verify whether the allocation of bank loans was appropriate as well as in line with the "true" (expected) value of the assets. Belonging to the group of banks subject to the AQR might have represented a (less endogenous) source of variation for the stock of bad loans. The IV strategy is applied to our model of equation 2. Table 18 compares the results of the baseline OLS estimation (column B, which corresponds to the results of Table 6) with the new IV results (column C). Results confirm that a larger stock of bad loans at bank level is negatively associated with the use of collateral. The statistical diagnostics on the power of the instrument are also passed.

Likewise the AQR might also influence the bank capital ratios. Against this background, we apply the same instrument also to verify possible endogeneity concerns that could regard banks' capital. We run two new IV estimations, alternatively instrumenting either the variable *Bank capital ratio* alone or the Texas ratio (that is, the ratio between bank bad loans and capital), excluding in this case the single components as separate covariates. Results of IV estimations (columns D and F) always confirm the OLS results (reported in column A, for the capital ratio, and in column E, for the Texas ratio). The statistical diagnostics on the power of the instrument are passed in all cases.[20]

b) Removing fixed effects to assess generalizability of results

As explained in Section 4, our baseline estimation strategy makes use of a large number of dummy variables. These dummies are aimed to fully control for the effects potentially confounding the identification of firm- and bank-side characteristics associated to the use of collateral. This strategy *à la* Khwaja and Mian (2008) has the pros of increasing the internal validity of results and the cons of reducing its generalizability, as it may imply a reduction of sampling size (for instance, the identification strategy in the firm side restricts the sample only to firms having more than one lender, which however are very typical in Italy, e.g., Ongena and Smith, 2000; Degryse et al., 2018).

To verify whether our results can be extended to a broader sample of loans, for instance to those firms having one lender only, we also analyse a less severe specification that includes additive (bank and firm) dummies that do not vary over the period, along with a complete set of non-interacted time dummies. Moreover, this model allows us to estimate the effects of bank and firm characteristics in a single model (Table 19). We run models both with and without the inclusion of loan size among the covariates (see previous Section, point *a*). The results show that basically all our variables are significant and maintain the signs exhibited in the previous (more severe) specifications.

[20] In all three cases, in the first stage the effect of our instrumental dummy is significant: its effect is positive when it is used to instrument *Bank bad loans*; it is negative as for *Bank capital ratio*, and it is positive for the Texas ratio. The Kleibergen-Paaprk Wald F statistic is equal to 19.0 for the variable *Bank bad loans*, to 36.48 for the variable *Bank capital ratio* and to 15.01 for the Texas ratio.

c) Sorting effects

As mentioned, the firm- and bank-level characteristics associated with the use of collateral might be also influenced by factors which are specific for the lender-borrower pair. On this account, our study already controls for the possible effect through three variables: the strength of the lending relationship (*Relationship strength*); a dummy variable identifying (large) unauthorized withdrawals (*Bind*); and the size of the loan. Notwithstanding the inclusion of these variables, one might be still concerned about the omission of other variables, correlated with ours, reflecting the presence of "sorting" effects in the selection of borrowers on the part of banks. Suppose that large firms were subject to a tighter loan collateralization than small firms, and that large banks tend to lend more to large firms; if it were the case, we would observe a larger use of collateral at larger banks only because their clients are different (larger banks would be more likely to select larger firms than their peers). To address the issue, we run our models by including specific dummies for each lender-borrower pair. Such an estimation demeans the dependent variable by the average collateral ratios, calculated for each lender-borrower pair, so that the (time invariant) elements that characterize relationships are fully controlled for. The results, displayed in Tables 20 and 21, confirm our previous evidence about both firm- and bank-level characteristics.

d) The sovereign debt crisis

Our results on financial crises might be affected by the European sovereign debt crisis, which hit Italy since the summer of 2011, more than by the global financial crisis. Indeed, the European sovereign debt crisis is arguably more systemic for Italy than the external shock that follows the Lehman default as it represented a systemic shock to both the Italian economy and the banking system and threatens the very survival of many banks. To verify this possibility, we exclude as a check all quarters after June 2011 in equation 2 and in the dummy c_t. The results, not presented here but available on request, remain broadly unchanged, indicating that the effects of the financial crises are already present in the global crisis.

10. Conclusions

We show that the use of collateral in bank lending is significantly associated with both firm- and bank-side characteristics. In particular, tighter collateral policies are adopted toward observationally riskier firms, that is, borrowers that are lowly capitalized, financially stressed and with larger amounts of doubtful loans. The relationship between firm capital (and delinquency) and loan collateralization becomes even stronger during the financial crises, signalling that the prudence and the attention on firms' characteristics in lenders' collateral policy intensify after the collapse of Lehman Brothers.

As far as we know, we are the first to document that bank balance sheet conditions are associated with higher incidence in the use of collateral. Specifically, banks that are more capitalized and that have lower stocks of impaired assets tend to be characterized by higher degrees of collateralization. Consistently with this result, our findings also show that tighter collateral policies adopted by banks are correlated with low interest rates on loans to non-financial firms since higher degree of collateralization lower the level of loan riskiness.

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Tables

Table 1 – List and description of variables

Variable	Description
Bank-firm variables	
Coll to loans	The dependent variable is computed as the ratio of the value of all real collateral on loans of firm *i* from bank *j* to the total loans of firm *i* from bank *j*.
Credit size	Natural logarithm of credit of firm *i* from bank *j* (revolving and term-loans).
Bind	Dummy variable equal to one if the firm has drawn an amount equal or higher (unauthorized, the so called "sconfinamenti") than the amount granted by the bank; zero otherwise. Thus, the value is equal to one when the firm is financially stressed ("cash" constrained).
Relationship strength (share)	Share of loans granted by the bank over the total amount of the firm's debt.
Firm variables	
Firm size	Natural logarithm of total assets.
Firm capital ratio	Capital and reserves over total assets.
Firm doubtful loans	Loans are doubtful when payments of interest and principal are past due by 90 days or when payments are less than 90 days overdue but loan repayment is uncertain. The variable is built as the share of doubtful loans over total loans.
Firm sales	Sales as a share of total assets (also referred to as Asset Turnover ratio).
Firm age	Number of years.
Firm z-score	Altman indicator of riskiness: it ranges from 1 ("low risk") to 9 ("hi risk").
Firm ROA	Profits as a share of total assets.
Firm tangible assets	Natural logarithm of firm tangible assets.
Bank variables	
Bank size	Natural logarithm of total assets.
Bank capital ratio	Capital and reserves over total assets.
Bank liquidity ratio	Euro-area sovereign bonds and cash over total assets.
Bank bad loans	Bad loans over the total loans to households and firms.
Foreign interbank borrowing	Foreign interbank borrowing over total assets.
Bank retail funding	Deposits from households and bank bonds held by households over total assets.
Bank ROA	Profits as a share of total assets.

Table 2 – Collateral to loan ratio (bank-firm level data)

Mean	Median	Std.Dev.	Obs.
Before the financial crises			
7.0	0.0	25.2	741,339
During the financial crises			
7.5	0.0	26,0	2,717,602

Table 3 - Firm characteristics (firm-level data)

Before the financial crise

	Panel 1A Whole sample				Panel 1B firms borrowing from 2 banks or more			
Variable	Mean	Median	Std. Dev.	Obs	Mean	Median	Std. Dev.	Obs
Firm size (1)	9.88	9.71	1.10	38,444	9.89	9.72	1.09	30,919
Firm capital ratio (2)	2.11	1.39	3.9 9	38,444	1.92	1.38	3.14	30,919
Firm doubtful loans to total loans(2)	1.57	0.00	8.4 9	38,444	1.62	0.00	8.56	30,919
Firm sales (2)	126.41	112.31	77.6 4	38,444	125.66	111.63	76.87	30,919
Firm age (3)	24.67	22.00	15.5 0	38,444	24.75	23.00	15.45	30,919
Firm ROA (2)	7.54	6.31	14.5 1	38,444	7.20	6.22	14.00	30,919
Firm tangible assets (1)	1.33	0.00	2.57	38,444	1.36	0.00	2.59	30,919

During the financial crise

	Panel 2A Whole sample				Panel 2B firms borrowing from 2 banks or more			
Variable	Mean	Median	Std. Dev.	Obs	Mean	Median	Std. Dev.	Obs
Firm size (1)	9.92	9.76	1.0 8	38,744	9.93	9.76	1.08	31,611
Firm capital ratio (2)	2.28	1.5	4.13	38,744	2.12	1.49	3.38	31,611
Firm doubtful loans (2)	4.69	0	17.2 3	38,744	4.83	0	17.44	31,611
Firm sales (2)	115.8	100.81	77.8 5	38,744	115.11	100.22	77.14	31,611
Firm age (3)	26.01	24	15.7 1	38,744	26.08	24	15.67	31,611
Firm ROA (2)	5.20	3.70	12.9 7	38,744	4.94	3.67	12.50	31,611
Firm tangible assets (1)	1.04	0.00	2.3 4	38,744	1.06	0.00	2.36	31,611

(1)Log of total quantity. (2) Percentage points. (3) Number of years.

Table 4 – Bank characteristics (bank-level data)

Before the financial crise

Variable	Mean	Median	Std.Dev.	Obs.
Bank size (1)	24.98	25.7	2.148	528
Bank capital ratio (2)	8.49	8.59	2.20	528
Bank liquidity ratio(2)	4.02	2.60	4.19	528
Bank bad loans (2)	2.62	2.55	1.2	528
Foreign interbank borrowing (2)	6.5	3.8	9.4	528
Bank retail funding (2)	50.03	47.51	15.54	528
Bank profitability (2)	0.82	0.90	0.34	528
Relationship strength (share) (2)	26.02	16.51	26.60	741,339
Bind (4)	18.50	0.00	38.80	741,339

During the financial crise

	Mean	Median	Std.Dev.	Obs.
Bank size (1)	25.01	25.41	2.10	538
Bank capital ratio (2)	9.6	9.6	2.3	538
Bank liquidity ratio(2)	6.3	5.2	4.5	538
Bank bad loans (2)	6.1	5.7	3.4	538
Foreign interbank borrowing (2)	5.9	3.4	9.5	538
Bank retail funding (2)	47.62	42.91	15.18	538
Bank profitability (2)	0.3	0.3	0.3	538
Relationship strength (share) (2)	25.5	15.6	26.9	2,717,602
Bind (4)	0.25	0.00	0.44	2,717,602

Table 5 - The firm side features of the use of collateral (2007Q1 - 2013Q4)

	Coll to loans (A)	Coll to loans (before crisis) (B)	Coll to loans (crisis) (C)
Firm size	0.0286***	0.0251***	0.0304***
	(9.886)	(7.523)	(10.70)
Firm capital ratio	-0.149***	-0.0753***	-0.155***
	(-5.821)	(-2.832)	(-5.728)
Firm doubtful loans	0.0235***	-0.0124	0.0236***
	(3.403)	(-0.828)	(3.292)
Firm sales	-0.00592***	-0.00745***	-0.00590***
	(-3.233)	(-3.657)	(-3.258)
Firm age	-0.00109	-0.00145	-0.00159
	(-0.521)	(-0.646)	(-0.704)
Relationship strength (share)	0.380***	0.375***	0.381***
	(12.19)	(11.90)	(12.13)
Bind	0.0228***	0.0241***	0.0225***
	(8.615)	(5.218)	(8.328)
Firm ROA	-0.00421	0.0186**	-0.0105**
	(-0.993)	(2.445)	(-2.579)
Firm tangible assets	-0.000720***	-0.000312	-0.000774***
	(-3.009)	(-0.688)	(-3.509)
Observations	1880431	1880431	
Bank*quarter fixed effects	yes	yes	
Firm fixed effects	yes	yes	

Table 6 - The bank side features of the use of collateral (2007Q1 - 2013Q4)

	Coll to loans	Coll to loans (before crisis)	Coll to loans (crisis)	Coll to loans
	(A) - OLS	(B) - OLS	(C) - OLS	(D) – IV (Bad loans instrumented)
Bank size	0.0221	0.0244	0.0226	0.017
	(1.224')	(1.607 ')	(1.504')	(0.709)
Bank capital ratio	0.237**	0.241*	0.250**	0.571**
	(2.24 ')	(1.74')	(2.572')	(2.07')
Bank liquidity ratio	0.0181	-0.127**	0.0582	0.0974
	(0.473')	(2.423')	(1.516')	(1.085')
Bank bad loans	-0.317***	-0.430***	-0.317***	-0.907**
	(-5.721)	(-2.775)	(-6.077)	(-2.474)
Foreign interbank borrowing	0.0771***	0.0884	0.0501**	0.0699**
	(2.909')	(1.361')	(2.361')	(2.115')
Bank retail funding	0.0261	0.0789	0.0274	0.0416
	(0.445')	(1.607')	(0.527')	(0.655')
Bank ROA	-0.671*	-0.46	-0.922**	-0.0386
	(-1.811)	(-0.536)	(-2.534)	(-0.0527)
Relationship strength (share)	0.425***	0.392***	0.433***	0.422***
	(12.94')	(12.23')	(13.08')	(12.68')
Bind	0.0306***	0.0330***	0.0302***	0.0286***
	(11.78')	(4.921')	(11.42')	(12.02')
Observations	2585884	2585884		2367867
Firm*quarter fixed effects	yes	yes		yes
Bank fixed effects	yes	yes		yes

Notes: Independent variables are lagged with respect to dependent variable.
Standard errors are clustered at bank and firm level. T-statistics are reported in parentheses. *** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level.

Table 7 - The firm side features of the use of collateral: personal guarantees among regressors (2007Q1 - 2013Q4)

	Coll to loans (A)	Coll to loans (before crisis) (B)	Coll to loans (crisis) (C)
Firm size	0.0285***	0.0251***	0.0302***
	(9.872)	(7.498)	(10.70)
Firm capital ratio	-0.149***	-0.0748***	-0.155***
	(-5.787)	(-2.801)	(-5.699)
Firm doubtful loans	0.0233***	-0.0124	0.0234***
	(3.376)	(-0.829)	(3.262)
Firm sales	-0.00598***	-0.00756***	-0.00594***
	(-3.272)	(-3.691)	(-3.297)
Firm age	-0.00111	-0.00146	-0.00160
	(-0.530)	(-0.648)	(-0.708)
Relationship strength (share)	0.380***	0.374***	0.381***
	(12.18)	(11.89)	(12.12)
Bind	0.0227***	0.0240***	0.0224***
	(8.577)	(5.211)	(8.286)
Personal guar to loans	-0.0213***	-0.0245***	-0.0205***
	(-5.630)	(-4.782)	(-5.416)
Firm ROA	-0.00419	0.0188**	-0.0105***
	(-0.990)	(2.475)	(-2.589)
Firm tangible assets	-0.000717***	-0.000310	-0.000772***
	(-3.002)	(-0.688)	(-3.494)
Observations	1880431	1880431	
Bank*quarter fixed effects	yes	yes	
Firm fixed effects	yes		

Notes: Independent variables are lagged with respect to dependent variable. Standard errors are clustered at bank and firm level. T-statistics are reported in parentheses. *** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level.

Table 8 - The bank side features of the use of collateral: personal guarantees among regressors (2007Q1 - 2013Q4)

	Coll to loans (A)	Coll to loans (before crisis) (B)	Coll to loans (crisis) (C)
Bank size	0.0224	0.0246	0.0228
	(1.234)	(-1.618)	(-1.515)
Bank capital ratio	0.237**	0.242*	0.251**
	(2.236)	(-1.744)	(-2.569)
Bank liquidity ratio	0.0183	-0.128**	0.0586
	(0.477)	(-2.439)	(-1.525)
Bank bad loans	-0.318***	-0.429***	-0.317***
	(-5.705)	(-2.774)	(-6.061)
Foreign interbank borrowing	0.0769***	0.0881	0.0500**
	(2.896)	(-1.356)	(-2.352)
Bank retail funding	0.0261	0.0792	0.0275
	(0.445)	(-1.615)	(-0.528)
Bank ROA	-0.663*	-0.448	-0.915**
	(-1.787)	(-0.522)	(-2.513)
Relationship strength (share)	0.425***	0.392***	0.433***
	(12.91)	(-12.2)	(-13.05)
Bind	0.0305***	0.0329***	0.0301***
	(11.73)	(-4.919)	(-11.35)
Personal guar to loans	-0.0213***	-0.0239***	-0.0209***
	(-4.379)	(-3.537)	(-4.343)
Observations	2585884	2585884	
Firm*quarter fixed effects	yes	yes	
Bank fixed effects	yes	yes	

Notes: Independent variables are lagged with respect to dependent variable. Standard errors are clustered at bank and firm level. T-statistics are reported in parentheses. *** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level.

Table 9 - The firm side features of the use of collateral: an aggregated indicator for real and personal collateralization (2007Q1 - 2013Q4)

	Real and Personal guar to loans (A)	Real and Personal guar to loans (before crisis) (B)	Real and Personal guar to loans (crisis) (C)
Firm size	0.0233***	0.0214***	0.0251***
	(8.782)	(6.401)	(9.718)
Firm capital ratio	-0.136***	-0.0503	-0.143***
	(-4.756)	(-1.452)	(-4.866)
Firm doubtful loans	0.0111	-0.0185	0.0119
	(1.525)	(-1.308)	(1.522)
Firm sales	-0.00783***	-0.0105***	-0.00722***
	(-4.525)	(-5.026)	(-4.159)
Firm age	-0.00171	-0.00178	-0.00205
	(-0.777)	(-0.757)	(-0.872)
Relationship strength (share)	0.373***	0.366***	0.374***
	(11.96)	(11.93)	(11.87)
Bind	0.0188***	0.0211***	0.0184***
	(7.408)	(4.808)	(7.059)
Firm ROA	-0.00126	0.0246***	-0.00847**
	(-0.342)	(3.181)	(-2.419)
Firm tangible assets	-0.000586**	-9.15e-05	-0.000676***
	(-2.434)	(-0.214)	(-2.697)
Observations	1880431	1880431	
Bank*quarter fixed effects	yes	yes	
Firm fixed effects	yes		

Notes: Independent variables are lagged with respect to dependent variable. Standard errors are clustered at bank and firm level. T-statistics are reported in parentheses. *** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level.

Table 10 - The bank side features of the use of collateral: an aggregated indicator for real and personal collateralization (2007Q1 - 2013Q4)

	Real and personal guar to loans (A)	Real and personal guar to loans (before crisis) (B)	Real and personal guar to loans (crisis) (C)
Bank size	0.0269	0.0289*	0.0274*
	(-1.514)	(-1.951)	(-1.848)
Bank capital ratio	0.256**	0.320**	0.269***
	(-2.328)	(-2.175)	(-2.704)
Bank liquidity ratio	0.0208	-0.171***	0.0679*
	(0.507)	(-3.030)	(-1.724)
Bank bad loans	-0.358***	-0.423***	-0.368***
	(-6.627)	(-3.000)	(-7.239)
Foreign interbank borrowing	0.0726**	0.0843	0.0413*
	(-2.499)	(-1.329)	(-1.963)
Bank retail funding	0.00880	0.079	0.0145
	(0.153)	(-1.611)	(-0.286)
Bank ROA	-0.829**	-0.416	-1.253***
	(-2.154)	(-0.491)	(-3.516)
Relationship strength (share)	0.410***	0.375***	0.418***
	(12.68)	(-12.1)	(-12.79)
Bind	0.0242***	0.0283***	0.0236***
	(-9.629)	(-4.485)	(-9.038)
Observations	2585884	2585884	
Firm*quarter fixed effects	yes	yes	
Bank fixed effects	yes	yes	

Notes: Independent variables are lagged with respect to dependent variable. Standard errors are clustered at bank and firm level. T-statistics are reported in parentheses. *** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level.

Table 11 – Bank characteristics asscociated with interest rates on new loans

	Interest rate	Interest rate	Interest rate	Interest rate
	(A)	(B)	(C)	(D)
Bank size	-2.722***	-2.843***	0.0380	0.0980
	(-4.032)	(-3.915)	(0.104)	(0.257)
Bank capital ratio	-13.21***	-15.32***	-6.252**	-7.457**
	(-3.877)	(-4.492)	(-2.339)	(-2.621)
Bank bad loans	13.67***	14.99***	6.600***	7.956***
	(5.187)	(5.464)	(3.210)	(3.546)
Bank liquidity ratio	1.163	1.128	0.142	-0.0310
	(0.252)	(0.238)	(0.190)	(-0.0453)
Foreign interbank borrowing	4.989	5.850	-1.550**	-1.314*
	(1.424)	(1.585)	(-2.579)	(-1.951)
Bank retail funding	-10.60***	-10.94***	-0.0184	0.0768
	(-4.294)	(-4.205)	(-0.0193)	(0.0795)
Bank ROA	118.0***	107.1***	8.609	5.899
	(6.030)	(5.190)	(1.303)	(0.860)
Relationship strength (share)		-0.113		0.0685
		(-0.700)		(1.428)
Bind		0.645***		0.0242
		(9.789)		(0.832)
Loan size		-0.267***		-0.0351***
		(-11.84)		(-3.421)
Observations	308705	265860	217828	181192
Bank fixed effects	yes	yes	yes	yes
Firm fixed effects	yes	yes	-	-
Firm*quarter fixed effects	no	no	yes	yes

Notes: Independent variables are lagged with respect to dependent variable. Standard errors are clustered at bank and firm level. T-statistics are reported in parentheses.*** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level. Data on loan interest rates are reported by around 200 banks accounting for over 90% of total outstanding loans.

Table 12 – The composition of borrowers at sounder and weaker lenders

Capital to total assets		Z-Score of borrowers of banks in the Quartile of the bank Capital distribution	Z-Score of borrowers of banks in the Quartile of the bank Bad loans distribution
1st quartile	mean	5,17	5,22
	25th pct	4	4
	50th pct	5	5
	75th pct	7	7
2nd quartile	mean	5,22	5,20
	25th pct	4	4
	50th pct	5	5
	75th pct	7	7
3rd quartile	mean	5,19	5,18
	25th pct	4	4
	50th pct	5	5
	75th pct	7	7
4th quartile	mean	5,17	5,15
	25th pct	4	4
	50th pct	5	5
	75th pct	7	7

Table 13 - The bank side features of the use of collateral controlling for loan size: an IV approach based (2007Q1 -2008Q2)

	Coll to loans	Coll to loans	Coll to loans (IV)
	(A)	(B)	(C)
Bank size	0.0221	0.0163	-0.00415
	(1.224)	(0.919)	(-0.181)
Bank capital ratio	0.237**	0.250**	0.277**
	(2.240)	(2.569)	(2.393)
Bank liquidity ratio	0.0181	0.0399	0.0754
	(0.473)	(0.995)	(1.176)
Bank bad loans	-0.317***	-0.282***	-0.214**
	(-5.721)	(-5.579)	(-2.557)
Foreign interbank borrowing	0.0771***	0.0436*	-0.0232
	(2.909)	(1.781)	(-0.518)
Bank retail funding	0.0261	0.0394	0.0251
	(0.445)	(0.649)	(0.340)
Bank ROA	-0.671*	-1.075***	-1.554***
	(-1.811)	(-2.807)	(-3.264)
Bind	0.0306***	0.0306***	0.0299***
	(11.78)	(10.23)	(8.362)
Relationship strength (share)	0.425***	0.256***	-0.171
	(12.94)	(6.387)	(-0.895)
Loan size		0.0362***	0.122***
		(7.744)	(3.054)
Observations	2585884	2017496	2165429
Firm*quarter fixed effects	yes	yes	yes
Bank fixed effects	yes	yes	yes

Notes: Independent variables are lagged with respect to dependent variable. Standard errors are clustered at bank and firm level. T-statistics are reported in parentheses.*** Significant at the 1 percent level.** Significant at the 5 percent level.* Significant at the 10 percent level.

Table 14 - The firm side features of the use of collateral controlling for loan size: an IV approach (2007Q1 -2008Q2)

	Coll to loans	Coll to loans	Coll to loans (IV)
	(A)	(B)	(C)
Firm size	0.0286***	0.00411	0.0357
	(9.886)	(1.008)	(1.306)
Firm capital ratio	-0.149***	-0.00874	-0.175*
	(-5.821)	(-0.284)	(-1.758)
Firm doubtful loans	0.0235***	0.0176**	0.0162
	(3.403)	(2.483)	(0.603)
Firm sales	-0.00592***	-0.00385**	-0.00527**
	(-3.233)	(-2.032)	(-2.010)
Firm age	-0.00109	-0.000870	-0.00109
	(-0.521)	(-0.364)	(-0.613)
Bind	0.0228***	0.0165***	0.0135
	(8.615)	(5.609)	(0.417)
Relationship strength (share)	0.380***	0.233***	0.421***
	(12.19)	(6.839)	(2.795)
Firm ROA	-0.00421	0.0176***	-0.00829
	(-0.993)	(3.493)	(-0.520)
Firm tangible assets	-0.000720***	-0.000514**	-0.000662***
	(-3.009)	(-2.326)	(-2.729)
Loan size		0.0318***	-0.0138
		(7.500)	(-0.297)
Observations	1880431	1880431	1840301
Bank*quarter fixed effects	yes	yes	yes
Firm fixed effects	yes	yes	yes

Notes: Independent variables are lagged with respect to dependent variable. Standard errors are clustered at bank and firm level. T-statistics are reported in parentheses.*** Significant at the 1 percent level.** Significant at the 5 percent level.* Significant at the 10 percent level.

Table 15 - The firm side and the bank side features of the use of collateral (2007Q1 - 2013Q)

	Coll to loans
Bank size	0.0372*
	(1.863)
Bank capital ratio	0.278***
	(3.147)
Bank liquidity ratio	0.0361
	(1.055)
Bank bad loans	-0.348***
	(-6.005)
Foreign interbank borrowing	0.0751***
	(3.121)
Bank retail funding	0.0409
	(1.188)
Bank ROA	-0.785***
	(-2.879)
Firm size	0.0390
	(1.567)
Firm size square	-0.000477
	(-0.376)
Firm capital ratio	-0.150***
	(-5.268)
Firm doubtful loans	0.0238***
	(3.392)
Firm sales	-0.00615***
	(-3.363)
Firm age	0.000851
	(0.364)
Bind	0.0229***
	(8.715)
Share of total loans	0.386***
	(11.83)
Firm ROA	-0.00296
	(-0.675)
Firm tangible assets	-0.000711***
	(-2.887)
Observations	1751059
Bank fixed effects	yes
Firm fixed effects	yes
Time fixed effects	yes

Notes: Independent variables are lagged with respect to dependent variable. Standard errors are clustered at bank

and firm level. T-statistics are reported in parentheses. *** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level.

Table 16 – The firm side features of the use of collateral: term loans

	Coll to loans (A)	Coll to loans (before crisis) (B)	Coll to loans (crisis) (C)
Firm size	0.0243***	0.0191***	0.0272***
	(7.025)	(4.814)	(8.053)
Firm capital ratio	-0.187***	-0.0622	-0.194***
	(-5.411)	(-1.397)	(-5.632)
Firm doubtful loans	0.0401***	0.0251	0.0376***
	(3.618)	(1.139)	(3.403)
Firm sales	-0.00833***	-0.00813***	-0.00897***
	(-4.083)	(-3.441)	(-4.752)
Firm age	0.000106	-0.000307	-0.000415
	(0.0432)	(-0.117)	(-0.157)
Relationship strength (share)	0.400***	0.382***	0.404***
	(10.92)	(9.685)	(11.25)
Bind	0.0302***	0.0347***	0.0293***
	(8.769)	(5.833)	(8.705)
Firm ROA	-0.00877*	0.0279***	-0.0189***
	(-1.829)	(3.493)	(-3.831)
Firm tangible assets	- 0.000866***	-0.000322	-0.00115***
	(-2.742)	(-0.476)	(-4.157)
Observations	1316540	1316540	
Bank*quarter fixed effects	yes	yes	
Firm fixed effects	yes	yes	

Notes: Independent variables are lagged with respect to dependent variable. Standard errors are clustered at bank and firm level. T-statistics are reported in parentheses. *** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level.

Table 17 – The bank side features of the use of collateral: term loans

	Coll to loans (A)	Coll to loans (before crisis) (B)	Coll to loans (crisis) (C)
Bank size	-0.00317	0.0055	0.0039
	(-0.127)	(-0.28)	(-0.199)
Bank capital ratio	0.198	0.2210	0.214*
	(1.533)	(-1.372)	(-1.77)
Bank liquidity ratio	0.102*	-0.0778	0.136**
	(1.828)	(-1.097)	(-2.45)
Bank bad loans	-0.383***	-0.523***	-0.360***
	(-6.095)	(-2.638)	(-5.872)
Foreign interbank borrowing	0.0247	0.0714	0.0057
	(0.931)	(-1.088)	(-0.275)
Bank retail funding	-0.0159	0.0915	-0.0106
	(-0.175)	(-1.18)	(-0.135)
Bank ROA	-1.179**	-0.9120	-1.357***
	(-2.412)	(-0.841)	(-2.961)
Relationship strength (share)	0.456***	0.401***	0.470***
	(10.77)	(-9.694)	(-11.23)
Bind	0.0378***	0.0401***	0.0374***
	(10.53)	(-5.111)	(-10.23)
Observations	1653757	1653757	
Firm*quarter fixed effects	yes	yes	
Bank fixed effects	yes	yes	

Notes: Independent variables are lagged with respect to dependent variable. Standard errors are clustered at bank and firm level. T-statistics are reported in parentheses.*** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level.

Table 18 – The bank side features of the use of collateral: endogeneity of *bank bad loans*

	Coll to loans (IV 1 - Bad loans) (A)	Coll to loans (OLS – Table 5 A) (B)	Coll to loans (IV 2 - Bad loans) (C)	Coll to loans (IV - Capital ratio) (D)	Coll to loans (OLS - Texas) (E)	Coll to loans (IV - Texas) (F)
Bank bad loans	-0.907**	-0.317***	-0.876**	-0.542***		
	(-2.474)	(-5.721)	(-2.474)	(-3.170)		
Bank size	0.0170	0.0221	0.0123	0.0401*	0.0226	0.0128
	(0.709)	(1.224)	(0.662)	(1.852)	(1.199)	(0.813)
Bank capital ratio	0.571**	0.237**	0.529**	1.014**		
	(2.070)	(2.240)	(2.198)	(2.037)		
Bank liquidity ratio	0.0974	0.0181	0.0757*	0.0672*	0.00104	0.0670
	(1.085)	(0.473)	(1.681)	(1.873)	(0.0267)	(1.635)
Foreign interbank borrowing	0.0699**	0.0771***	0.0988***	0.151***	0.0913***	0.212***
	(2.115)	(2.909)	(2.623)	(2.967)	(2.901)	(2.659)
Bank retail funding	0.0416	0.0261	0.0337	-0.00193	0.0390	0.0887
	(0.655)	(0.445)	(0.520)	(-0.0259)	(0.714)	(1.453)
Bank ROA	-0.0386	-0.671*	-0.166	-0.777	-0.826**	-0.474
	(-0.0527)	(-1.811)	(-0.231)	(-1.514)	(-2.378)	(-0.843)
Bind	0.0286***	0.0306***	0.0307***	0.0307***	0.0306***	0.0308***
	(12.02)	(11.78)	(12.86)	(12.77)	(11.75)	(12.81)
Relationship strength (share)	0.422***	0.425***	0.425***	0.425***	0.426***	0.425***
	(12.68)	(12.94)	(13.07)	(13.06)	(12.93)	(13.05)
Bank Texas ratio					-0.0444***	-0.203**
					(-2.867)	(-2.311)

Observations	2367867	2585884	2585884	2585884	2585884	2585884
Firm*time fixed effects	yes	yes	yes	yes	yes	yes
Bank fixed effects	yes	yes	yes	yes	yes	yes

Notes: Independent variables are lagged with respect to dependent variable. Standard errors are clustered at bank and firm level. T-statistics are reported in parentheses. *** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level.

Table 19 - Removing fixed effects to assess generalizability of results (only additive dummies; column A), also controlling for loan size (column B) (2007Q1 - 2008Q2)

	Coll to loans (A)	Coll to loans (B)
Bank size	0.0372*	0.0284
	(1.863)	(1.457)
Bank capital ratio	0.278***	0.258***
	(3.146)	(2.886)
Bank liquidity ratio	0.0361	0.0591
	(1.054)	(1.644)
Bank bad loans	-0.348***	-0.294***
	(-6.007)	(-5.237)
Foreign interbank borrowing	0.0751***	0.0506**
	(3.121)	(2.277)
Bank retail funding	0.0410	0.0429
	(1.188)	(1.225)
Bank ROA	-0.785***	-0.983***
	(-2.881)	(-3.406)
Firm size	0.0295***	0.00452
	(10.03)	(1.123)
Firm capital ratio	-0.150***	-0.00238
	(-5.269)	(-0.0723)
Firm doubtful loans	0.0239***	0.0174**
	(3.382)	(2.387)
Firm sales	-0.00620***	-0.00415**
	(-3.254)	(-2.109)
Firm age	0.000857	0.00129
	(0.376)	(0.495)
Bind	0.0229***	0.0160***
	(8.702)	(5.366)
Relationship strength (share)	0.386***	0.238***
	(11.83)	(6.818)
Firm ROA	-0.00287	0.0195***
	(-0.652)	(3.644)
Firm tangible assets	-0.000714***	-0.000508**
	(-2.897)	(-2.231)
Loan size		0.0317***
		(7.215)
Observations	1751059	1751059
Bank fixed effects	yes	yes

Firm fixed effects	yes	yes
Time fixed effects	yes	yes

Notes: Independent variables are lagged with respect to dependent variable. Standard errors are clustered at bank and firm level. T-statistics are reported in parentheses.*** Significant at the 1 percent level.** Significant at the 5 percent level.* Significant at the 10 percent level.

Table 20 –The firm side features of the use of collateral controlling for "sorting" effects in banks' selection of borrowers (2007Q1 - 2013Q4)

	Coll to loans (A)	Coll to loans (before crisis) (B)	Coll to loans (crisis) (C)
Firm size	0.0171***	0.0124***	0.0185***
	(6.971)	(4.847)	(7.607)
Firm capital ratio	-0.0613***	0.0200	-0.0682***
	(-4.678)	(0.852)	(-4.881)
Firm doubtful loans	0.0284***	-0.0113	0.0275***
	(4.425)	(-0.968)	(4.283)
Firm sales	-0.00639***	-0.00646***	-0.00704***
	(-3.796)	(-4.105)	(-4.008)
Firm age	0.00229	0.00211	0.00209
	(0.801)	(0.825)	(0.818)
Relationship strength (share)	0.126***	0.121***	0.127***
	(7.046)	(6.377)	(7.154)
Bind	0.000695	-0.00291*	0.00121
	(0.891)	(-1.796)	(1.593)
Firm ROA	0.00253	0.0190***	-0.00172
	(0.914)	(3.343)	(-0.648)
Firm tangible assets	-0.000624***	-0.000698**	-0.000557***
	(-3.021)	(-2.025)	(-2.669)
Observations	1871606	1871606	
Bank*quarter fixed effects	yes	yes	
Firm fixed effects	yes	yes	
Bank*firm fixed effect	yes		

Notes: Independent variables are lagged with respect to dependent variable. Standard errors are clustered at bank and firm level. T-statistics are reported in parentheses. *** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level.

Table 21 –The bank side features of the use of collateral controlling for "sorting" effect in banks' selection of borrowers (2007Q1 - 2013Q4)

	Coll to loans (A)	Coll to loans (before crisis) (B)	Coll to loans (crisis) (C)
Bank size	0.0467***	0.0434***	0.0426***
	(-5.456)	(-5.712)	(-5.508)
Bank capital ratio	0.190**	0.181**	0.230**
	(-2.218)	(-1.987)	-2.5730
Bank liquidity ratio	-0.0614**	-0.153***	-0.0266
	(-2.227)	(-3.836)	(-0.960)
Bank bad loans	-0.246***	-0.0485	-0.299***
	(-6.538)	(-0.567)	(-9.490)
Foreign interbank borrowing	0.0939***	0.0643**	0.0659***
	(-3.411)	(-2.573)	(-2.913)
Bank retail funding	0.0210	0.0332	0.0161
	(0.667)	(-1.044)	(-0.527)
Bank ROA	-0.542**	0.0239	-0.741**
	(-2.396)	(-0.0614)	(-2.473)
Relationship strength (share)	0.184***	0.170***	0.187***
	(10.02)	(-9.082)	(-10.2)
Bind	3.29e-05	-0.00357	0.000669
	(0.0429)	(-1.564)	(-0.782)
Observations	2572414	2572414	
Firm*quarter fixed effects	yes	yes	
Bank fixed effects	yes	yes	
Bank*firm fixed effect	yes	yes	

Notes: Independent variables are lagged with respect to dependent variable.

Standard errors are clustered at bank and firm level. T-statistics are reported in parentheses. *** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level.

Table 22 – The bank side features of the use of collateral: exploiting the end-2008 reversal in the development of loan quality to attenuate endogeneity of *bank bad loans* (2008Q4-2009Q1)

	Coll to loans
Bank size	0.0262
	(1.031)
Bank capital ratio	0.0921
	(0.758)
Bank liquidity ratio	-0.108
	(-1.137)
Bank bad loans	-0.173**
	(-2.486)
Foreign interbank borrowing	-0.0262
	(-0.649)
Bank retail funding	0.0767
	(0.912)
Bank ROA	0.302
	(0.901)
Relationship strength (share)	0.425***
	(13.74)
Bind	0.0264***
	(5.484)
Observations	199356
Bank fixed effects	yes
Firm*quarter fixed effects	yes

Notes: Independent variables are lagged with respect to dependent variable. Standard errors are clustered at bank and firm level. T-statistics are reported in parentheses. *** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level.