Risk Mitigating *versus* Risk Shifting: Evidence from Banks Security Trading in Crises

José-Luis Peydró Andrea Polo Enrico Sette Victoria Vanasco

Abstract

We show that risk-mitigating incentives dominate risk-shifting incentives in fragile banks. We study security trading by banks, as banks can easily and quickly change their risk exposure within their security portfolio. For identification, we exploit different crisis shocks and supervisory ISIN-bank-month-level data. Less capitalized banks take relatively less risk after financial stress shocks. Results hold within identical regulatory capital risk weights categories. Moreover, additional tests suggest that banks' own incentives, rather than supervision, are the main drivers. Results hold in the *available for sale* and *trading* portfolios but not in the *held to maturity* portfolio. A model of bank behavior rationalizes our findings.

Keywords: risk shifting, financial crises, securities, bank capital, reach for yield, uncertainty, risk weights, supervision, franchise value, available for sale, held to maturity, trading book, COVID-19.

JEL Codes: G00, G01, G21, G28, G30.

[*] José-Luis Peydró: Imperial College London, ICREA-UPF-CREi-BSE, CEPR, jose.peydro @gmail.com; Andrea Polo: Luiss University, EIEF, CEPR, ECGI, andreapolo@gmail.com; Enrico Sette: Bank of Italy, enrico.sette@bancaditalia.it; Victoria Vanasco: vvanasco@crei.cat, CREi-UPF-BSE and CEPR. This draft is from February 2023. We thank Franklin Allen, Bo Becker, Juanita Gonzalez Uribe, Luigi Guiso, Peter Koudijs, Jose Liberti, Frederic Malherbe, Clemens Otto, Enrique Schroth, Amit Seru, Per Stromberg, Jason Sturgess, David Thesmar and participants at the CEPR/Study Center Gerzensee European Summer Symposium in Financial Markets and the 2021 ECGI Finance Prize award ceremony for helpful comments and suggestions. We also thank Chiara Lattanzio for excellent research assistance. Sette is an officer of the Bank of Italy, the banking supervisor of Italy (jointly with the ECB-SSM) and the paper has been reviewed by the management of the Department of Economics and Statistics of the Bank of Italy prior to its circulation, in line with the policy of the Bank of Italy. However, the views of this paper do not represent the views of the Bank of Italy or of the Eurosystem. This project has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (grant agreement No 648398). Vanasco acknowledges financial support from the Spanish Ministry of Economy and Competitiveness through the Severo Ochoa Programme for Centres of Excellence in R&D (SEV-2015-0563) and from the Generalitat de Catalunya, through CERCA and SGR Programme (2017-SGR-1393). Peydró and Vanasco also acknowledges financial support from the Spanish Ministry of Science and Innovation, through the Severo Ochoa Programme for Centres of Excellence in R&D (CEX2019-000915-S).

1. Introduction

A central result in corporate finance is that, due to limited liability, the payoffs of shareholders in leveraged corporations are convex, hence shareholders have incentives to increase risk at the expense of other stakeholders when the firm is close to distress (Jensen and Meckling, 1976). This is particularly relevant in the banking industry since banks are among the most leveraged corporations with very low skin in the game (Admati and Hellwig, 2013), banking is an opaque industry (Morgan, 2002) and some of their liabilities are guaranteed (explicitly and implicitly) by the government (Freixas and Rochet, 2008). However other forces, such as regulation and supervision (Dewatripont and Tirole, 1994) or the preservation of franchise value (Keeley, 1990; Hellmann, Murdock and Stiglitz, 2000), may push shareholders of distressed banks to reduce risk instead of increasing it. [1] Moreover, how banks adjust the riskiness of their portfolios in times of distress remains an open empirical question.

We analyze banks' risk-taking behaviour in times of distress by studying banks' security trading during crises. We do so for several reasons. First, for banks it is particularly easy to quickly change risk by buying and selling securities (Boot and Ratnovsky, 2016; Brunnermeier, Dong and Palia, 2020). The fact that trading exposure can be quickly scaled up or down makes the trading activity more prone to excessive risk-taking. Securities, as compared to loans, are highly liquid, and, as shown by Myers and

[1] Deposit insurance encourages risk shifting by banks (see, e.g., Merton, 1977), which can be controlled by requiring sufficient bank capital, and hence the effect of capital adequacy requirements is usually to decrease risk-taking (Freixas and Rochet, 2008). However, the reverse is also possible: see, e.g., Kim and Santomero (1988), Furlong and Keeley (1989), Gennotte and Pyle (1991), Rochet (1992), Besanko and Kanatas (1996), Gale and Özgür (2005), Gale (2010). Keeley (1990) focuses on a different mechanism. He shows that the perverse incentives created by the deposit insurance system are countervailed by the potential loss of charter (franchise) value that induces banks to limit their own risk-taking. Hellman, Murdock and Stiglitz (2000) analyze the effect of both a higher charter value and capital adequacy requirements on risk-taking incentives. They find that both are necessary to constraint bank risk-taking.

Rajan (1998), holding more liquid assets reduces management's ability to commit credibly to a (long-term) investment strategy that protects investors from moral hazard problems (the "paradox of liquidity"). Second, the amount of securities held by banks as a percentage of total assets is large, more than 20 percent in Europe and the US (Mayer et al., 2018). Third, detailed data on the riskiness of individual assets is available for banks. In particular, we rely on administrative data for all the securities each bank holds in Italy every month at the *ISIN-bank-month* level during several crisis periods: the Global Financial crisis, the Euro Area Sovereign Debt crisis and the COVID-19 Crisis. In addition, analysing security trading provides a unique setting where, due to the high granularity of our proprietary dataset, we can control for the role of regulation by analysing trading in different securities within the same regulatory risk weights (Becker and Ivashina, 2015). We conduct additional tests to shed light on whether results are driven by supervision or by banks' own incentives, such as to preserve franchise value (Keeley, 1990).

Since the Global Financial Crisis and Euro Area Sovereign Debt Crisis, academics and regulators around the world have been concerned that fragile banks may use their portfolio of securities to risk shift. Regulators intervened in constraining security trading in the US and there have been related policy proposals in Europe. In the US, the Volcker Rule contained in the Dodd–Frank Wall Street Reform and Consumer Protection Act, specifically prohibits banks from engaging in proprietary trading (although a number of exceptions to this ban are included and there has been a softening over the last years). In the UK, the Vickers' report, and in the European Union (EU), the Likaanen Report, suggest that market-based activities should be segregated in firewalled subsidiaries. European banking regulators have also considered introducing limits on some security trading by banks, specifically in the purchases of sovereign bonds (ESRB, 2015).

However, none of these proposals has been implemented in the European Union at the moment. Analysing the European sovereign crisis, several papers gave substance to this concern arguing that in distressed countries there was risk shifting in security trading as more fragile banks purchased larger quantity of sovereign debt (Acharya and Steffen, 2015; Drechsler et al., 2016; Altavilla, Pagano and Simonelli, 2017).

The interpretation of the evidence in this paper provides the opposite conclusion. We argue that *comprehensive* micro data at the *security level* by each *bank* are crucial both for identification and for a more comprehensive analysis. Thanks to the granularity of our data, we find that in response to financial stress shocks, ex-ante less capitalized banks take less risk. Results are strong within rating*maturity*month fixed effects (that determine regulatory capital) and within government bonds (with zero capital risk weights). Hence, capital regulation does not drive our results. Tests based on supervisory inspections data and franchise value suggest that banks own incentives, instead of supervision, are the main drivers of our findings. Results are robust to considering other sources of balance sheet fragility, different measures of risk-taking, and different crisis events. Finally, we rationalize our findings with a stylized model that highlights when banks may benefit from reducing their risk exposures in response to a negative net worth shock.

We exploit security (ISIN) level supervisory data of *all* securities investments (not just government bonds, or just securities that banks pledge as collateral to borrow ECB liquidity) of *all* Italian banks at a *monthly* frequency (*security-bank-time*) since 2005:M1. We exploit the Global Financial Crisis and the Euro Area Sovereign Debt Crisis, until 2013:M12 (before the implementation of the negative rate policy and the start of quantitative easing, with the associated huge increase in excessive reserves), and also analyze the recent COVID-19 Crisis. We consider only bonds (81% of holdings) to have a similar measure of risk, and, for each security, we obtain yields, prices, issuer, maturity and rating from Thomson Reuters and FactSet. We also match data with the supervisory list of bank inspections (start and end date) to test for the role of supervision.

In our main results we use the yield as a measure of security risk (following Becker and Ivashina, 2015; Di Maggio and Kacperczyk, 2017). The literature which analyzes the European sovereign crisis does not distinguish between securities with high versus low yields (the unit of observation in this literature is typically at a less granular level). Without very disaggregated data at the security level, data may show that two banks have similar amount of securities in their portfolio, but the composition of securities may still be very different (e.g., on yields or rating, even within the same issuer). We also look at alternative measures of risk-taking such as the concentration of risk at the bank level. Since the portfolio of securities can be adjusted quickly, it is important to analyze data at a high frequency level to capture the reactions of the banks to negative shocks.

For identification, along with crisis shocks, we analyze the data at the *security-bank-month* level. This is crucial for analysing security heterogeneity (and hence reach for yield) as well as for controlling for unobservables in the regressions, via security*month fixed effects. The inclusion of security*month fixed effects also helps us to control, in each month, for how much of each security is issued and outstanding and, therefore, isolate the demand of securities by banks.

For crisis shocks, we proxy for the turmoil in financial markets by using the changes in the 3 months Euribor-OIS spread as this variable captures well the different 2007-13 crisis shocks (alternatively we use several other different crisis variables). This Euribor-OIS spread is the difference between the rate at which European banks lend to each other (EURIBOR) and the (riskless) overnight indexed swap (OIS) rate on the overnight rate (EONIA) for a 3-month period. The Euribor-OIS spread, similar to its counterpart, Libor-

OIS in the U.S. market, is a leading indicator of financial stress among practitioners and has been used as a proxy for financial stress, among others, by Gorton and Metrick (2012) for the US and by Aggarwal, Bai and Laeven (2020) for the Euro Area. The Euribor-OIS spread was close to zero before the Global Financial Crisis, but then it massively increased and was much more volatile for several years. The time series shows three peaks which correspond to the three worse periods of financial stress: the initial freeze-out of the European interbank market, the failure of Lehman Brothers, and the European sovereign crisis (Figure 1a). In addition, we use 2019-20 data and analyze the recent COVID-19 shock (Figure 1b). Moreover, exploiting the crisis shocks and the granular security data, we analyze risk-taking based on ex-ante bank level measures of fragility. We match the security register with supervisory bank-level balance sheet information and exploit ex-ante bank capital (capital in excess of the regulatory requirement) as the main dimension of bank heterogeneity. We also use other measures of capital and a measure of uninsured wholesale (interbank) liabilities. Importantly, we control for several other bank observable characteristics and also include bank fixed effects.

FIGURE 1 HERE

In contrast to the risk-shifting hypothesis, we find that, in response to (higher) financial stress, less ex-ante capitalized banks buy securities with lower yield.[2] Regarding economic effects, the increase in purchases of securities with lower yield (one standard

[2] Risk shifting by less (compared to more) capitalized banks requires that these banks increase their risk by relatively more. Our findings, however, show that more fragile banks take on lower (not higher) risk in reaction to financial stress shocks. See also below our results when we control for the correlation with the ex-ante portfolio of securities.

deviation) by banks with low capital (10th-percentile) with respect to banks with high capital (90th-percentile), in response to a one standard deviation increase in financial stress, is larger than 17 per cent of the average net purchases over the period.

This result survives to a very large battery of robustness checks. First, results remain similar if we adopt an alternative definition of the dependent variable or if we fix bank capital to its pre-crisis level or if we use several alternative definitions of capital (leverage ratio, net worth—leverage ratio plus ROA—, Tier 1 ratio) or alternative definitions of risk, by analysing the rating instead of the yield. Second, results are also similar if we control for several macroeconomic, bank and security portfolio variables (e.g., if we control explicitly for monetary policy by the ECB).[3] Third, a threat to identification is that large banks could benefit from a too-big-to-fail status. To address this, we exclude the three largest banks and our results are similar. Fourth, results are also robust to the inclusion of additional fixed effects, as bank*time fixed effects or security*bank fixed effects to control for unobserved time-varying bank heterogeneity or time-invariant security-bank matching heterogeneity. Finally, results are very similar after controlling for the correlation of securities traded with the existing entire bank portfolio, which therefore suggests changes in bank risk-taking.[4]

The identification of the crisis shocks is crucial for our analysis. We try several alternative specifications and find consistent results. Different definitions of the financial stress variable give the same results, e.g., changes in several versions of Euro Area indexes of systemic stress (ECB's CISS), changes in the European CDS index, a dummy for the largest spikes in the Euribor-OIS spread instead of a continuous variable, a dummy

[3] See Peydro, Polo and Sette (2021) on how monetary policy affects lending and trading.

[4] Furthermore, in our sample the profits from trading in securities and the profits from derivatives are not correlated, thereby suggesting that banks do not use derivatives to hedge the higher risk they get in trading in securities.

for the European sovereign crisis months—between June 2011 and December 2012. Moreover, results are confirmed if instead of using all the sample we limit the analysis to a short time window around the failure of Lehman Brothers (September, 15th 2008), which was the strongest shock in the data. We show that banks with low capital react to the failure of Lehman by reducing their exposure to securities with high yields.

Furthermore, we also look at an alternative source of bank balance sheet fragility: we analyze not only the level of bank capital but also the fragility of the debt structure, proxied by the level of ex-ante interbank exposure (Brunnermeier, 2009; Gorton and Metrick, 2012).[5] If, in addition to bank capital, we include also the percentage of interbank funding, we find that bank capital is still significant while interbank funding is not statistically significant. However, when we split the sample between Italian government bonds and the rest of the securities, we find that while bank capital has a similar effect in both subsamples, interbank funding exposure only matters in the subsample of Italian government bonds. Banks with an ex-ante more fragile liability structure based on interbank funding, throughout the analyzed period, buy Italian government bonds with lower yield. Moreover, this effect is even stronger in response to financial stress shocks.[6] This is consistent with a matching between liabilities and assets risk (Hanson et al., 2015; Ippolito et al., 2016).

Regulation and supervision could limit risk-shifting incentives. By looking at security trading and, thanks to the high granularity of our proprietary dataset, we can explicitly exclude the role of capital regulation in explaining our findings. We do so by

---

[5] A fragile liability is crucial in some key models in banking as e.g. in Calomiris and Kahn (1991) and Diamond and Rajan (2001). In those models, depositors are not insured. Interbank depositors as compared to retail depositors are not insured, and hence they tend to be more fragile.

[6] The fact that the effect of interbank exposure is confined only to the Italian government bond subsample may be due to the fact that Italian banks tend to use these securities as collateral when they borrow from other banks in the private interbank market or when they borrow from the ECB.

applying the methodology introduced by Becker and Ivashina (2015) which consists in analysing reach-for-yield behaviour within regulatory risk classes. We show that more fragile banks react to financial stress shocks by purchasing securities with lower yield even within the same regulatory risk weight class. The results hold when we include rating*maturity*month fixed effects (that determines regulatory capital) or when we analyze *only* Italian Government bonds (which all have zero risk weights). In fact, results are stronger in the portfolio of Italian government bonds or when we control for securities with the same rating and maturity in the same month, so results are the strongest where capital regulation (across the different securities) is the least important.

Two remaining drivers can explain our results: supervision or bank own incentives.

To test whether supervision plays a major role in explaining our results we match our data with the list of on-site bank inspections conducted by the Bank of Italy. These inspections are thorough audits at the offices of the supervised banks. Their goal is to validate the quality of banks' assets and their reporting activity to the supervisor. When necessary, the supervisors may also force measures upon the inspected banks. Similar data have been used by Bonfim et al. (2022) and Passalacqua et al. (2021) to assess the effectiveness of bank supervision. In our sample bank receive on average 3.5 bank inspections for an average length of 108 days. One could be concerned that our results are due to the activity of bank supervisors which force weaker banks to reduce their risk during their inspections. If we exclude all the observations when the bank is subject to on-site inspections, our results are still present. In additional tests, we show that our main results survive even if we only look at the subsample of observations where capital is larger than the median level. This is a subsample of relatively strong banks where the scrutiny and attention by bank supervisors is much less relevant. So supervision, again, is unlikely to be the key mechanism behind our results.

The second test is based on evidence from different accounting portfolios. If a security is in the held to maturity portfolio, unrealized changes in price do not have any impact on the financial statements. On the other hand, if a security is held in the other portfolios, the unrealized changes in prices are recognized in the income statement (trading portfolio) or in the comprehensive income (available for sale portfolio). If the results were purely driven by supervision, we would expect a similar behaviour in the two portfolios: if fragile banks are acting under the guidance of the supervisors, the supervisors would push banks to reduce risk across all portfolios. On the contrary, we find that our results are strongly statistically (and economically) significant only in the available for sale and trading portfolios. Moreover, in the held to maturity portfolio our coefficient of interest even changes sign, suggesting opposite behaviour (higher risk-taking) in this section of the security portfolio. The coefficient has a different sign but it is not statistically significant. It is highly unlikely that this behaviour is prescribed by bank supervisors. As there are more securities (number and volume) in the trading and available for sale portfolios than in the held to maturity portfolio, the former effects dominate the latter ones, i.e. risk mitigating dominates.

Finally, to investigate the importance of bank own incentives we analyze the role of franchise value: the present value of the stream of profits that a firm is expected to earn as a going concern. More fragile banks could take less risk in response to a shock only when they have enough franchise value. Our results are strong only in the subsample of banks where the Lerner Index is larger than the median.[7] This is consistent with Keeley (1990) and Demsetz, Saidenberg, and Strahan (1996) which suggest that franchise value

[7] We proxy the franchise value with the Lerner Index. This is a commonly used measure of market power in banking (Vives, 2016) and it is defined as the difference between output prices and marginal costs (relative to prices).

is the main economic force which constrains bank risk-taking.[8] Our results do not imply that regulation and supervision are, in general, not important in constraining bank risk-taking but that preserving franchise value is a key risk mitigating driver at play in our setting. In addition, the effect of regulation and supervision may vary little across banks, and our cross-sectional identification is not well suited to capture common aggregate effects.

We show that more fragile banks reduce their exposure toward securities with high yield in response to financial stress shocks, but it could still be the case that more fragile banks increase their overall risk exposure by increasing the concentration of their holdings to one specific issuer (i.e., the Italian government) or to one specific country (i.e., Italy). We address this concern by looking at concentration risks in terms of type of issuer and instrument at bank level using the portfolio of all securities, following the methodology of Di Maggio and Kacperczyk (2017). Here, we find some evidence that more fragile banks, if anything, react to negative crisis shocks by reducing the concentration risk. For robustness, we also adopt the main regression specification at security-bank-month level but using a dummy variable for Italian government bonds (or, in general for Italian issued securities). Again, we can strongly rule out the concern that more fragile banks increase concentration risk. This finding also suggests that our results are not driven by moral suasion by government (as these banks should depend more on government public guarantees).

Finally, we analyze bank behaviour around the recent COVID-19 shock. The spread of the coronavirus and the worldwide pandemic is a shock which, in comparison to the

[8] Moreover, if the results were driven by supervision, we would have expected a stronger effect in the low franchise value subsample (as these banks not only have low current bank capital but also lower future expected profits and hence overall capital). Instead, the coefficient of interest even changes sign in this subsample (although coefficient is economically small and not statistically significant).

previous analyzed ones, has a very different nature since it is not originated in financial markets but has had crucial effects on financial markets and in particular on banks. In addition, during this shock, banking regulation and supervision were softened (Altavilla et al., 2020). We analyze the time window which includes the six months before and after March 2020, the month in which the Italian government imposed the national lockdown. Consistently with rest of the results in the paper, we find that, also after this shock, more fragile banks take less risk relatively to better capitalized ones. All in all, our results show that, when faced with crisis shocks, for ex-ante fragile banks, risk mitigating concerns dominate risk-shifting motives.

We conclude our paper by providing a framework to rationalize our main findings. We show that in the presence of financial frictions that limit banks' ability to pledge their full franchise value to outside investors, it may be optimal for banks to have a precautionary behaviour after a negative net worth shock. The intuition is as follows. When banks are choosing how much risk to take, they face a trade-off: while riskier investments may have a higher expected return for shareholders when leverage is sufficiently high, they increase the probability of bank default and thus of shareholders losing part of their franchise value. We show that indebted but solvent banks with a sufficiently high franchise value will respond to a negative net worth shock, which all-else-equal increases the banks' likelihood of default, by lowering their investment in risky assets as an attempt to off-set the increase in the risk of default. Moreover, we show that (i) in the absence of financial frictions and/or (i) when franchise value is sufficiently low, the standard risk shifting result obtains.

Contribution to the literature. Results are particularly relevant since the empirical literature on risk shifting in banks is largely in favour of the risk-shifting hypothesis.[9] Saunders, Strock, and Travlos (1990) and Laeven and Levine (2009) show that stockholder-controlled banks take more risk than managerially-controlled banks. Case study evidence also seems to support the risk-shifting hypothesis (Esty, 1997; and Landier, Sraer, and Thesmar, 2015). Similar conclusions are reached by the literature on banks' increase in holdings of sovereign debt during the Euro area sovereign crisis. Acharya and Steffen (2015) use bank-level data released in the European stress tests on the amount of government bonds held by banks. Drechsler et al., (2016) complement this information with data on the collateral pledged by banks to borrow from the ECB. Altavilla, Pagano and Simonelli, (2017) analyze bank-level data on the holdings of sovereign bonds from an ECB proprietary dataset. These latter papers, using Euro area data, show that in distressed countries banks with less capital purchased larger quantity of sovereign debt. In light of this evidence, these authors argue that risk shifting was a key driver of the securities purchases.[10]

Differently from these papers, we have a comprehensive dataset with granular information on all securities investments (not just government bonds, or just securities that banks pledge as collateral to borrow ECB liquidity) of all Italian banks at a monthly frequency and analyze these data at the *security-bank-time* level. This allows for a stronger identification and a more complete analysis which leads us to a different

[9] The risk-shifting hypothesis has also been investigated in other sectors of the financial industry. While substantial agreement exists in favor of the risk-shifting hypothesis in the mutual fund industry (see, for instance, Huang, Clemens, and Hanjiang (2011) and literature cited within), results are mixed in the insurance sector (Becker and Ivashina, 2015; Foley-Fisher, Narajabad, and Verani, 2016; Kirti, 2017).

[10] Also Horvath, Huizinga and Ioannidou (2015) using similar data suggest that the risk-shifting motive is a driver of the investment in domestic government bonds but they do not base their analysis on measures of bank balance sheet fragility. They also analyzed whether the purchases of domestic government bonds is driven by moral suasion. On this, see also Becker and Ivashina (2017).

conclusion. In response to financial stress shocks, more fragile institutions buy securities with lower—not higher—yield which is not consistent with risk shifting. Our results are complementary with Ben-David, Palvia & Stulz (2020) who show with *bank-level* data that US distressed banks deleverage instead of increasing bank-level risk-taking. However, without granular information, it is difficult to explicitly exclude the role of banking regulation and supervision in mitigating bank risks. Further, by analyzing bank behavior around the COVID-19 shock we contribute also to the emerging literature on the effects of the COVID-19 crisis. For example, while Chodorow-Reich et al. (2021), Greenwald et al. (2020) and Li, Strahan, and Zhang (2020) study the lending behavior of banks in response to the pandemic shock, we analyze securities trading. Finally, as we analyze the behavior of banks during times of financial distress, our paper contributes to the literature on bank fragility (Diamond and Dybvig 1983, Goldstein and Pauzner, 2005; Vives, 2014; Chen, Goldstein, Huang and Vashishtha, 2020).

Given that our results suggest that regulation and supervision are not directly driving the risk-mitigating effects we report, our findings also have a broader message for the corporate finance literature. The evidence from the literature on non-financial firms is somewhat mixed. Some papers provide evidence supporting the risk-shifting hypothesis. Eisdorfer (2008) show that volatility has a positive effect on distressed firms' investment and that the investments by distressed firms during times of high uncertainty generate less value. Becker and Stromberg (2012) show that managers invest less in riskier projects when their fiduciary duties require them to consider debtholders' interests. Favara et al. (2017) find that higher shareholders' expected recovery in default, due to imperfect enforcement of debt contracts, reduces shareholder-debtholder conflicts and induces more leveraged firms to take less risk when they approach distress. Aretz, Banerjee and Pryshchepa (2019), exploiting hurricane strikes, show that moderately, but not highly, distressed firms skew their asset mixes toward riskier segments after negative shocks. On the other hand, a large literature finds that risk mitigating incentives outweigh risk-shifting incentives when companies are close to distress. When financial conditions deteriorate, firms take more cautious investments in their pension funds (Rauh, 2009), undertake diversifying acquisitions (Gormley and Matsa, 2011), and, in the case of oil and gas firms, take less exploratory projects, which are risky (Gilje, 2016). These results are also confirmed in a laboratory experiment (Hernandez, Povel, and Sertsios, 2016). Our results contribute to this debate. We find that, even for institutions characterized by very high leverage and opportunities to quickly change risk exposure, risk-mitigating dominate risk-shifting incentives.

The rest of the paper is organized as follows. Section 2 describes the main datasets and explains the empirical strategy. Section 3 presents the main results, the different robustness tests and a stylised model to rationalize our main findings. Section 4 concludes.

2. Data and Empirical Strategy

In this section we describe the proprietary datasets that we exploit in this paper and the empirical strategy, including the main variables and the econometric specifications.

2.1 Data

We have access to the security register, which is a supervisory centralized dataset managed by the Bank of Italy in its role of bank supervisor. The security register includes microdata on *all* securities investments – at the *security-level* (ISIN code) – for *each* bank in Italy (bonds, ABS, equities, derivatives and shares of mutual funds) in *each* month.

Our main sample is from January 2005 to December 2013. In the last part of the paper we extend the database to analyze the recent COVID-19 shock (August 2019 – August 2020).

For each security, banks must report the notional amount they hold at the end of each period (stock of individual securities). We use the unique International Security Identification Number (ISIN) associated with every security to merge the data on holdings with Thomson Reuters to obtain the monthly time series of prices and yields and FactSet to get additional information regarding the issuer, residual maturity and the time series of ratings (Moody's). We compute the quantity of securities in banks' portfolio by dividing the notional amount by the market price at the corresponding date (banks are required by regulation to report the market value of the securities they hold using the closing market price of the last working day of the month). This is crucial to control for changes in values which may be caused by changes in prices. We merge the security register with the bank balance sheet data taken from the Italian supervisory reports.

The composition of securities is the following: 81 per cent are bonds; 9 per cent are Asset Backed Securities (ABS); 3 per cent are shares; and 7 per cent are other securities (e.g. shares of mutual funds, derivatives, covered and structured bonds). In Figure 2 we report the evolution of the composition of the bond portfolio in our main sample. We confirm the home-bias in the portfolio: the share of foreign issued bonds is below twenty per cent throughout the sample period, with a trivial share of foreign government bonds. Moreover, we notice an increase in the share of Italian government bonds at the expense of bonds issued from other Italian entities (mostly financial firms) at the onset of the sovereign bond crisis.

We apply the following filters to the securities data. We consider only bonds as they represent the large majority of securities and we can compare differential risk-taking by different banks in a class of very similar securities.[11] We exclude the holdings of bonds issued by the same bank or by a bank belonging to the same group. To reduce the influence of securities of small value, we drop those for which the total holdings for the entire banking sector are below EUR 10 million and the securities for which the average holding across all periods of each bank is below EUR 10 thousands. The resulting set of securities comprises over 95% of the total holdings for which price data are available. We also exclude from the analysis banks with total assets below EUR 1 billion and mutual banks, the latter being subject to specific capital regulation. The final sample consists of 1684 securities and 115 banks for the main sample. All major banks operating in the country are included in our sample. When we look at alternative measures of risk-taking, as the concentration risk at bank level, since we do not need security level information, we use all the securities.

We match the security register with supervisory data on bank-level balance sheet characteristics and with the supervisory list of bank inspections (start and end date) to test for the role of supervision.

2.2 Empirical Strategy

We analyze how banks vary their portfolio depending on financial markets stress, bank, and security characteristics. The risk-shifting hypothesis predicts that more fragile banks when faced with financial stress shocks would buy riskier securities. We test this hypothesis using the following econometric specification:

---

[11] We exclude derivatives and assets backed securities because these are mostly traded over the counter (OTC), hence we do not observe the market price and thus we cannot calculate a measure of net buys. However: a) the profits from trading in securities and the profits from derivatives are not correlated, thereby suggesting that banks do not use derivatives to hedge the higher risk they get in trading in securities; b) Italian banks have never been significantly exposed to ABS issued by countries with a real estate bubble, e.g. US, Spain, Ireland (for the exposure to asset backed securities, see Bonaccorsi di Patti and Sette (2016) and BIS data, www.bis.org/statistics); d) our results are confirmed when we take out the largest banks which have a higher derivatives exposure.

$$\text{Net Buys}_{s,b,t} = \beta_1 \text{Capital}_{b,t-1} * \text{Risk}_{s,t-1} * \text{Financial Stress}_{t-1} + \beta_2 \text{Capital}_{b,t-1} * \text{Risk}_{s,t-1} + \beta_3 \text{Capital}_{b,t-1} * \text{Financial Stress}_{t-1} + \gamma \text{Controls}_{b,t-1} + \alpha_{s,t} + \alpha_b + \varepsilon_{s,b,t} \quad (1)$$

We analyze *Net Buys* of security *s* by bank *b* in month *t* on the left-hand side and on the right-hand side we are interested in the coefficient of the triple interaction between a lagged measure of financial stress, a lagged measure of bank capital and a lagged measure of security risk. We include the lower level of interactions not spanned by the fixed effects (the two double interactions *Capital*Risk* and *Capital*Financial Stress*). We include bank controls (*Size*, *Liquidity*, *Interbank*, *Bad Loans/Total Assets*) and security*time fixed effects ($\alpha_{s,t}$) and bank fixed effects (α_b).[12] We triple-cluster the standard errors at security, bank and month level.

We analyze the data at the *security-bank-month* level, instead of the bank level. This is crucial for studying heterogeneity, as different securities (even within the same issuer and even in the same time period) have different ex-ante yields, as well as rating. Moreover, and crucially for identification, our micro-level data allow us to control for key unobservables, via security*time fixed effects. Security*time fixed effects are a multiplication of a dummy for each security and a dummy for each month of each year (substantially stronger than adding just security and time fixed effects). They help us to control for how much of each security is issued and outstanding in each month, thus isolating the demand of securities by banks (they also fully control for ratings, price or other unobserved time-varying risk at the security level). For example, we can analyze

[12] The third double interaction *Financial Stress*Risk* is absorbed by the security*time fixed effects. When we do not include these fixed effects, we include the *Financial Stress*Risk* and also macro controls *(Δ CPI and Δ Unemployment*).

the risk-taking of different banks controlling fully for time-varying ratings and maturity, the main determinants of capital regulation. In addition, as explained below in the results sections, we include other fixed effects and we provide a battery of robustness checks.

Our main dependent variable is the net buys of security *s* by bank *b* at time *t* (month). We use the Davis-Haltiwanger definition (Davis and Haltiwanger, 1992) to include both the extensive and intensive margin. We define the following:

$$\text{Net Buys}_{s,b,t} = \frac{\text{Holdings}_{s,b,t} - \text{Holdings}_{s,b,t-1}}{\frac{1}{2} * (\text{Holdings}_{s,b,t} + \text{Holdings}_{s,b,t-1})} \quad (2)$$

$\textit{Net Buys}_{s,b,t}$ is the increase in holdings of security *s*, by bank *b* during the month *t*. This variable is symmetric around 0 and it lays in the closed interval [-200, 200] with final sales (initial purchases) corresponding to the left (right) endpoint. This measure facilitates the integrated treatment of initial purchases (passing from 0 to a positive number), final sales (passing from a positive number to 0) and continuing trading in the empirical analysis (see the Appendix for an exact definition on all the variables used). In Table 1 (which reports the descriptive statistics of the main variables used in the paper), we report that the average monthly net buys in the crisis period is 5.0. The median change is around zero but there is a large standard deviation (82.2) which implies a very large heterogeneity in banks' securities trading. For robustness, we use the change of log holdings as an alternative measure of banks' securities trading.[13]

[13] In this case we take care of initial purchases and final sales by setting the logarithm of the holdings equal to 0 when the holdings are 0.

TABLE 1 HERE

We proxy financial markets stress by using the lagged changes in the 3 months Euribor- OIS spread. This is the difference between the rate at which European banks lend to each other (EURIBOR) and the overnight indexed swap (OIS) rate on the overnight rate (EONIA) among the same banks for a 3-month period. Euribor is the rate at which banks indicate they are willing to lend to other banks for a specified term of the loan. The term OIS rate is a measure of the market's expectation of the overnight funds rate over the term of the contract. The Euribor-OIS spread has been close to zero before the summer of 2007, but then it massively increased and has been much more volatile since then. The time series show three peaks which correspond to the three worse periods of strong financial stress: the initial freeze-out of the European interbank market, the failure of Lehman Brothers and the European sovereign crisis. The Euribor-OIS spread is considered the principal market indicator of health of the banking system. As detailed in the results section, we check whether results hold if we use several alternative measures of financial markets stress: dummy for the largest spikes in the Euribor-OIS spread instead of a continuous variable, dummy for the European sovereign crisis months—between June 2011 and December 2012, changes in the European CDS index or changes in several versions of ECB's Euro Area indexes of systemic stress-CISS, or a small time window around the failure of Lehman Brothers.

We focus on ex-ante bank capital heterogeneity since (based on theory) bank capital is a good proxy for the intensity of the agency conflict between bank shareholders and their financiers (including depositors, debtholders and tax payers) and a key measure for the strength of bank balance sheets (Holmstrom and Tirole, 1997; Bernanke, 2007;

Freixas and Rochet, 2008). Admati and Hellwig (2013) identify bank capital as a key driver of banks' behavior during crises. As the main measure of bank capital we use capital (shares subscribed, book value of equity plus retained earnings) in excess of the regulatory minimum divided by total assets (Gambacorta and Mistrulli, 2004). For robustness we fixed the capital at the pre-crisis level or we use several alternative proxies of bank capital such as leverage ratio, net worth (leverage ratio plus ROA), Tier 1 ratio. In addition, we also exploit variations in another aspect of the bank balance sheets which is the fragility of the debt structure, proxied by the level of interbank exposure—the ratio of total borrowing from other banks to total assets (Brunnermeier, 2009; Gorton and Metrick, 2012).

The average value of the variable *Capital* is 2.5 per cent[14] and the average value of *Interbank* is 9.3 per cent. There is a large variability among banks: the interquartile range goes from 1.5 to 3.0 per cent for *Capital* and from 3.4 to 12.0 per cent for *Interbank*. We also control for other bank variables, such as time invariant heterogeneity via bank fixed effects, and time-varying bank controls: *Size*, the logarithm of the total assets; *Liquidity*, the sum of cash and sovereign bonds divided by total assets; and *Bad Loans/Total Assets*. In robustness tests we also include security*bank and bank*time fixed effects.

We analyze risk-taking by using the ex-ante yield as a measure of risk of securities (Becker and Ivashina, 2015; Di Maggio and Kacperczyk, 2017).[15] The yield is calculated as the Yield-to-Redemption minus the overnight interest rate for the Euro area. The

---

[14] This is capital in excess of regulatory minimum. This corresponds to a leverage ratio (equity divided by total assets) of 7.8 per cent, a net worth (leverage ratio plus ROA) of 8.2 per cent and a Tier 1 ratio (equity divided by risk-weighted assets) of 9.0 per cent. In the appendix we show that our results do not hinge on the specific definition of capital we use.

[15] The size of the yield is a superior measure of risk in comparison with rating since, as shown in Becker and Ivashina (2015), financial institutions may select securities with an ex-ante higher yield, within the same rating category, to increase risk and obtain a higher return. Moreover, since results are very similar after controlling for the correlation of securities traded with the existing entire bank portfolio, we identify changes in bank risk-taking.

average yield is 2.1 per cent with an interquartile range between 0.7 per cent and 3.2 per cent. The average yield within the sub-sample of Italian government bonds (1.7 per cent) is much smaller than the average yield in the rest of the sample (2.5 per cent). In a robustness check we also use *rating* as an additional measure of security heterogeneity. The Interquartile range for the rating is between BBB and AA (Moody's). Further, we exploit time series variations in uncertainty in economic policy to test whether our result differ in times of high versus low economic policy uncertainty.

Furthermore, as we explain in detail in the results section, we analyze different subsamples of securities, portfolios and banks to analyze the possibility that regulation or supervision might be the key drivers of the observed behavior. For example, we analyze government bonds that have regulatory capital weights equal to zero, or subsamples of banks not under on-site supervisor inspection or with different levels of franchise value.

We also explore alternative measures of risk-taking, namely the concentration risks. We start by substituting the yield with a dummy *Italian* (a dummy equal to 1 if the issuer of the security is the Italian government or any Italian issuer) in equation 1. Then, we collapse the data from *security-bank-month* to *bank-month* level and we run bank level regressions with the concentration risk of the portfolio as the main dependent variable as in Di Maggio and Kacperczyk (2017). We adopt the following econometric specification:

$$\text{Concentration Risk}_{b,t}=\beta \text{Capital}_{b,t-1}*\text{Financial Stress}_{t-1}+\gamma \text{Controls}_{b,t-1}+\alpha_t+\alpha_b+\varepsilon_{b,t} \qquad (3)$$

We use three different definitions of *Concentration Risk*: a) the share of Italian government bonds, b) the HHI index of holdings by issuers, c) the HHI index of holdings by type of instruments.[16] Higher values of these measures imply higher risk-taking. We include several bank controls, time and bank fixed effects. In this case we double-cluster the standard errors at bank and month level.

Finally, in the last part of the paper, we extend the database to the recent COVID-19 shock. We analyze the time window which includes the six months before and after March 2020. Using a very similar specification as the one described in equation 1. The main difference is that the variable *Financial Stress* is in this case a dummy variable equal to 1 for the six months after the shock (March 2020- August 2020) and 0 in the six months before (August 2019- February 2020). For robustness, we also use February 2020 as the post variable as Italy already got significant number of COVID cases at that time, though the lockdown was in March 2020.

3. Results

In this section we discuss the main results, provide a large set of robustness checks, explore alternative identification of the shocks, discuss the alternative mechanisms, analyze alternative measures of risk-taking and conclude by analyzing the recent COVID-19 shock.

3.1 Main Results

[16] In the portfolio of Italian banks we have the following instruments: mutual funds, ABS, shares of Italian financial companies, shares of foreign financial companies, shares of Italian non-financial companies, shares of foreign non-financial companies, bonds of foreign financial companies, bonds of Italian financial companies, bonds of foreign non-financial companies, bonds of Italian non-financial companies, Italian government bonds, foreign government bonds.

Table 2 reports the main results of the paper. We estimate equation 1 using Ordinary Least Squares and triple-clustering the standard errors at bank, security and month level. In column 1 we include only macro and bank controls. In column 2 we include security fixed effects and in column 3 we add also time fixed effects. We continue by gradually saturating the model with fixed effects: in column 4 we add rating*maturity*time (which are the main determinants of regulatory capital weights) fixed effects, in column 5 we add security*time fixed effects to isolate the demand of securities by banks and also to fully control for ratings, price or maturity and other unobserved time-varying risk at the security level. Finally, in the last column we also include bank fixed effects to control for time invariant bank heterogeneity. We always control for the lower level of interactions in case they are not spanned by fixed effects.

In all specifications, the coefficient of the triple interaction *Capital*Risk*Financial Stress* is positive and highly statistically significant. The coefficients in column 1 and in column 9 are very similar.[17] Results are also economically significant. The increase in purchases of securities with lower yield (one standard deviation) by banks with low capital (10^{th}-percentile) with respect to banks with higher capital (90^{th}-percentile), in response to a standard deviation increase in the lagged changes of the Euribor-OIS spread, is larger than 17% per cent of the average net purchases over the period. More ex-ante fragile banks react to financial stress shocks by rebalancing their portfolio toward securities with lower yield.[18]

[17] Only in column 4 it differs (actually it becomes larger) but notice that in this column the sample is smaller since we require information on maturity and rating which is not available for all the securities in the sample. Nevertheless, with these key fixed effects, as well as later as we will see in the sample for sovereign debt where risk weights are zero, results suggest that controlling for bank capital regulation reinforces the main findings of the paper.

[18] The three double interactions *Capital*Risk*, *Financial Stress*Risk*, *Capital*Financial Stress* and the variable *Financial Stress* are almost never significant.

TABLE 2 HERE

3.2 Robustness

We provide a large battery of robustness checks adopting different definitions of the main variables, adding further controls, analyzing different samples, and adding more fixed effects.

In Table A2 we use a different definition of the dependent variable and in Table A3 we use different definitions of *Capital*. First, we show that our results do not depend on the definition of our dependent variable. Instead of the Davis-Haltiwanger definition of *Net Buys*, in Table A2 we use the difference between the logarithm of (holdings of security s, by bank b at time t) and the logarithm of (holdings of security s, by bank b at time t-1). Results are similar. In Table A3 we show that results hold also if we use several alternative definitions of bank capital: *Leverage ratio, Net worth* or *Tier1 ratio.*

In Table A4 we keep adding further interaction terms. First, we address a potential concern that the results may be driven by diversification motives. We control for the existing portfolio of each bank at the beginning of each month, by including the shares of the bank portfolios invested in different type of securities according to the issuer: Italian government, foreign governments, Italian banks, foreign banks, Italian non-financial corporations, foreign non-financial corporations. Results do not change (column 1). Second, as bank size is somewhat correlated with capital, we include the triple (and double) interactions with bank *Size, Financial Stress* and *Risk.* Our coefficient of interest remains largely significant (column 2). In columns 3 and 4 we control for unconventional and conventional monetary policy changes which occurred in the sample period: we include the triple (and double) interactions between *Capital*, *Risk* and the *LTRO dummy* (a dummy equal to 1 in the months of the announcement and allotments of the LTRO) and also triple (and double) interactions between *Capital*, *Risk* and the *EONIA* rate (overnight reference rate for European interbank lending). With the Long Term Refinancing Operations (LTRO), the ECB provided more than one trillion of (euro) lending with a 3-year maturity to European banks. The LTRO was announced on December 8, 2011 and the funds were distributed in two allotment dates: December 21, 2011 and February 29, 2012. Also after controlling for these additional variables, our coefficient of interest remains strongly significant.

In Table A5, finally, we check whether results hold also if we fix bank capital at a pre-crisis level, if we exclude the largest banks, if we add additional fixed effects or we use rating instead of yield as a measure of the riskiness of a security. In column 1 we fix the capital to the pre-crisis level by taking the average of excess capital between January 2005 and June 2007 before the first signs of tension in the interbank market in the summer of 2007. Pre-crisis capital level is not affected by potential subsequent developments which may have affected bank capital during the crisis. Results are similar to the baseline specifications. We show that results remain significant also if we exclude from the analysis the largest three banks in our sample in terms of total assets in column 2. This is important to confirm that our results are not just driven by few large banks which could be considered too-big-to-fail. The top three banks are the biggest banks in the country with the largest international presence, they have a large portfolio of securities, and rely more on derivatives. While the main results include already bank and security*time fixed effects, in columns 3-5 we show that results are also robust to the inclusion of additional fixed effects, as bank*time fixed effects or security*bank fixed effects to control for unobserved time-varying bank heterogeneity such as, for example, bank risk (bank*time fixed effects) or time-invariant security-bank matching heterogeneity proxying e.g. for different specialization of banks in some securities (security*bank fixed effects). Finally, in column 6 we use *Rating* instead of yield as a measure of security risk. As we explain above, this is a poorer measure in comparison to yield since this is less granular: one could buy securities with higher yield within the same rating category (Becker and Ivashina, 2015). However, the triple interaction *Capital*Rating*Financial Stress* is also statistically significant with a negative sign: banks with high capital expand security holdings with lower rating (higher risk) in response to financial stress shocks.

3.3 Identifications of the shocks

The objective of this study is to analyze how more ex-ante fragile banks react to negative financial crisis shocks. The way we identify shocks is then crucial. The turbulence in the financial markets experienced in Europe after 2007 offers a large laboratory. In the main results we study how fragile banks respond to the one month lagged changes in the Euribor-OIS spread. We choose this variable since the Euribor-OIS spread is a leading indicator of financial market stress (Gorton and Metrick, 2012; Aggarwal, Bai and Laeven, 2020). In this section we analyze whether changing the way we identify shocks affect our conclusions.

First, we look at continuous measures of financial stress different from the Euribor-OIS spread. We use variables which are not specific to the banking sector and are not specific to Italy. We look at the monthly changes in several versions of the ECB's Euro Area indexes of systemic stress (CISS). CISS is a composited indicator of systemic risk introduced by the ECB which should measure "the current level of frictions, stresses and strains (or the absence thereof) in the financial system and summarizes it in a single continuous statistic" (Hollo, Kremer, Lo Duca, 2012). We use the composited indicator and also the sub-indices of the bond market and the money market. We also use the monthly changes in the Markit iTraxx European Credit Default Swap Index (which comprises 125 equally-weighted European corporations) which is one of the most widely traded indexes of CDS in Europe. Independently of the proxy for financial stress we use, we find consistent results. The coefficient of the triple interaction *Capital*Risk*Financial Stress* is always positive and statistically significant.

Second, since we are particularly interested in the negative shocks, we use dummy variables instead of continuous variables. The first is a Dummy for high Δ Euribor-OIS spread. It takes the value of one if the monthly change is among the largest monthly increases in the spread. Here we capture how banks behave in the months following the biggest shocks (top 10 per cent). Alternatively, we focus on a dummy which is equal to one in the months of the European sovereign crisis (Dummy for Sovereign crisis). This dummy takes the value one in the months between July 2011 and December 2012 which are the worse months of the sovereign debt crisis. The spread between 10-year Italian BTP and German Bund started increasing abruptly, reaching historically high levels, from July 2011 (Bofondi, Carpinelli and Sette, 2017). In column 5 of Table 3 we use the Dummy for high Δ Euribor-OIS spread and in column 6 of Table 3 we use the Dummy for Sovereign crisis. In all cases, we find that more ex-ante fragile banks react to these negative crisis shocks by reducing the risk relatively to better capitalized banks.

Finally, instead of using the all sample from 2005 to 2013, we focus only on the six months around the failure of Lehman Brothers (September, 15^{th} 2008). We do so since this is associated with the largest spike in our main measure of financial stress (see Figure 1). Also in this sample, we show that banks with low capital react to the financial stress shock (the failure of Lehman) by reducing their exposure to securities with high yields (column 7).[19]

TABLE 3 HERE

3.5 Fragility, Regulation, Supervision and Economic Forces

In this section we offer additional evidence on the risk-shifting hypothesis by analyzing also another source of bank balance sheet fragility, namely the exposure to the wholesale funding market. Moreover, we investigate alternative channels which could drive the investment behavior of more fragile banks in response to financial stress shocks: regulation, supervision or economic forces (franchise value).

In Table 4, we augment equation 1 with the triple interaction between *Interbank*, *Risk* and *Financial Stress* (we also include the double interaction *Interbank*Risk* and *Interbank*Financial Stress*). The variable *Interbank* which is calculated as the ratio of total borrowing from other banks to total assets is a proxy for the fragility of the debt structure. We find that the coefficient of the triple interaction *Interbank*Risk*Financial Stress* is never significant, while the estimated coefficient of the triple interaction *Capital*Risk*Financial Stress* remains almost unchanged and significant at 1 per cent. We also notice that banks with less stable funding structure, throughout the sample, buy securities with lower yield. *Interbank*Risk* is, in fact, negative and significant. This is consistent with the risk management hypothesis: since their liabilities are relatively more

[19] In this last specification, given the short-time window, we double-cluster the standard errors at bank and security level. However, results do not change if we triple-cluster at bank, security and time level.

fragile banks with more interbank exposure buy assets with lower risk (Ippolito et al., 2016). Also, if we consider this alternative source of fragility we do not find evidence of risk shifting.

TABLE 4 HERE

Maybe more fragile banks do not increase risk because they are constrained by regulation or supervision. Banks with low capital may buy less risky securities just to minimize the regulatory capital since safer securities have lower risk-weights. However, thanks to the granularity of our data we can rule out the impact of capital regulation. We have already shown in Table 2 that the results hold when we include rating*maturity*time fixed effects, which are the key determinants of regulatory risk weights. In this section, we confirm our result by analyzing the sub-sample of Italian government bonds which have *zero* risk weights and the rest of the securities. In Table 5 we show that the coefficient of the triple interaction *Capital*Risk*Financial Stress* remains positive and significant even in the subsample of the Italian government bonds (where risk weights for capital are 0). Regulation is not driving our results.

The analysis of the Italian government bonds sample reveals another interesting pattern in the data. Here, the triple and double interactions, *Interbank*Risk*Financial Stress* and *Interbank*Risk* are negative and strongly significant. Banks with larger interbank exposure, throughout the analyzed period, buy Italian government bonds with lower yield and this effect is even stronger in response to financial stress shocks. The difference between the full sample and the sub-sample of Italian government bonds is consistent with the fact that Italian banks tend to use these securities as collateral when they borrow from other banks in the private interbank market or when they borrow from the ECB. Safer securities have lower haircuts when used as collateral. This is further evidence against the risk-shifting hypothesis.

TABLE 5 HERE

To test the role of supervision we match our data with the list of on-site bank inspections conducted by the Bank of Italy. One could be concerned that our results are due to the activity of bank supervisors which force weaker banks to reduce their risk during their inspections. Data on on-site bank inspections have been used by Bonfim et al. (2022) and Passalacqua et al. (2021) to assess the effectiveness of bank supervision. These inspections are conducted by personnel of the supervisory authority at the offices of the inspected banks. In our sample bank receive on average 3.5 (median is equal to 3) bank inspections for an average length of 108 days (median is equal to 106 days). Their goal is to validate the quality of banks' assets and their reporting activity to the supervisor. During the on-site inspections, supervisors may force measures upon the inspected banks. In Table 6 we report the results of our baseline specifications, excluding all the security-bank-month observations when the bank is subject to on-site inspection. Our coefficient of interest is still positive and statistically significant even in this smaller sample and this suggests that supervision is unlikely to be the key driver of our results. In addition, in Table A6 we show that our results survive if we only look at the subsample of observations where capital is larger than the median level. This is a subsample of relatively strong banks where the scrutiny and attention by bank supervisors is much less relevant.

TABLE 6 HERE

To provide an additional test on the role of supervision we exploit information on the regulatory portfolio each security is held in. We split the sample into securities placed in different accounting portfolios. If a security is in the trading or available for sale portfolios, the unrealized changes in fair value are recognized in the income statement (trading) or in the balance sheet in the comprehensive income (available for sale). On the contrary, if a security is in the held to maturity portfolio, unrealized changes in fair value are not reported on either the income statement or the balance sheet, but the securities need to be owned until maturity and cannot be traded. If the results were driven by supervision we would have expected a similar behaviour in the two portfolios: if fragile banks are acting under the guidance of the supervisors, banks would reduce risk across all portfolios. On the contrary, we find that our results are strongly statistically significant only in the available for sale and trading portfolios (Table 7). Moreover, in the held to maturity portfolio our coefficient of interest even changes sign, suggesting opposite behaviour (higher risk-taking) in this section of the security portfolio. The coefficient has a different sign but it is not significant at conventional levels. It is highly unlikely that this behaviour is prescribed by bank supervisors. It is also interesting to notice the different signs of the double interaction Capital* Financial Stress in the two sub-samples. In response to financial stress shocks, banks with low capital, at the margin, increase the size of the held to maturity portfolio which shield them from the fluctuations of bond prices that could further damage their already fragile balance sheet.

TABLE 7 HERE

Finally, to investigate the importance of bank own incentives in driving our findings we run a test based on franchise value (Table 8). We find that more fragile banks take less risk in response to a shock only when they have enough franchise value. We proxy the franchise value with the Lerner Index. This is a commonly used measure of market power in banking (Vives, 2016) and it is defined as the difference between output prices and marginal costs (relative to prices).[20] We calculate the Lerner index in June 2007 before the first signs of tensions in the European interbank market in August 2007. This variable is positively correlated with bank ROA (0.45) but is not correlated with *Capital* (-0.03). ROA and *Capital* are correlated among themselves with a smaller coefficient (0.21). Our results are strong only in the subsample of banks where the Lerner Index is larger than the median.[21] This is consistent with Demsetz, Saidenberg, and Strahan (1996) which suggest that franchise value—the present value of the stream of profits that a firm is expected to earn as a going concern—is a key economic force in constraining bank risk-taking. Moreover, if the results were driven by supervision we would have expected a stronger effect in the low franchise value subsample. Instead, the coefficient of interest even changes sign in this subsample, although coefficient is economically very small and not statistically significant.

---

[20] The Lerner index measures a banks' markup and is calculated as: Lerner Index= P – MC / P. The price of the banking good P is given by the ratio of total operating income to total assets. The marginal cost, MC, is obtained from a translog function which estimates the total cost a bank faces as the function of labor, physical capital and funding. The index goes from 0 to 1 with larger values implying higher market power. See Vives (2016) for a summary of the literature on bank competition.

[21] The sample used in this table is smaller since for some banks we do not have all the variables necessary to construct the Lerner Index.

TABLE 8 HERE

3.6 Concentration Risk

In this section we address a remaining concern. We have shown so far that more fragile banks reduce their exposure toward securities with higher yield in response to financial stress shocks, but it could still be the case that more fragile banks increase their overall risk exposure by increasing the concentration of their holdings to one specific issuer (e.g. the Italian government) or to one specific country (e.g. Italy). We address this issue in two ways.

First, to analyze the concentration risk, instead of using data at security-bank-month level, as we do throughout the paper, here we analyze data at the bank-month level. As we describe in Section 2.2 we use three measures of concentration risk. First we use the share of Italian government bonds out of the total portfolio, second, following Di Maggio and Kacperczyk (2017), we create two Herfindahl indexes of holdings by issuers and by instruments. Since here we do not need granular information at the security level, we can use the all portfolio of securities. Higher levels of the share of Italian government bonds or higher levels of the HHI indexes suggest reduced diversification, hence higher risk-taking.

We report estimates of specification 3 in Table 9. Here, we are interested in the coefficients of the double interactions *Capital* Financial Stress* and *Interbank* Financial Stress*. In the first eight columns which have as dependent variables the share of Italian government (columns 1-4) or the HHI Issuers (columns 5-8), the two double interactions are almost never significant. By analyzing the HHI of the type of instruments (columns 9-12) we find some evidence that more fragile banks (with less stable funding or less capital) reduce (instead of increasing) concentration risks (although results are less statistically significant for *Capital* Financial Stress*). The standalone variables *Capital* and *Interbank* are never significant.

TABLE 9 HERE

Second, in Table A7 we adopt the same regression specification as in equation 1 but we substitute the yield, our key measure of security risk, with a dummy variable *Italian*, which is equal to 1 if the issuer of the security is the Italian government (columns 1-4) or, in general, any Italian issuer—either corporate or government (columns 5-8), and 0 otherwise. We find some evidence that better capitalized banks (not the more fragile ones) buy more Italian issued securities, throughout the period (positive and significant coefficient of the double interaction *Capital*Italian* but only in the specifications with security*time fixed effects) and, in response to financial stress shocks, we do not find any differential behavior between more or less fragile banks. The triple interaction *Capital*Italian*Financial Stress* is, in fact, never significant.

Results therefore suggest that more fragile banks in response to financial stress shocks do not concentrate their portfolio on some specific issuer or type of security. If anything, we find that more fragile banks react to negative shocks by reducing the concentration risk. These additional results confirm that, when faced with financial stress shocks, risk mitigating concerns dominate risk-shifting motives. This finding also suggests that our results are not driven by moral suasion by the government.

3.7 Recent Evidence from the COVID-19 Shock

In the last part of the paper we analyze the trading behavior of banks in response to the recent COVID-19 shock. This shock is similar to the previous analyzed ones in so far as also during this episode there is massive increase in the Euribor-OIS Spread. On the other hand, this shock has a very different nature since it is not originated in the financial markets. In addition, during this period banking regulation and supervision were softened (Altavilla et al., 2020).

In Table 10 we analyze the time window which includes the six months before and after the shock and we use a very similar specification as the one described in equation 1. The main difference is that the variable *Financial Stress*, in this case, is replaced by a dummy variable equal to 1 for the six months after the shock, and 0 in the six months before it (*Post COVID-19*). We consider March 2020 as the beginning of the post period since on March 9th 2020 the government of Italy imposed a national lock-down, restricting the movement of the population, in response to the growing pandemic of COVID-19 in the country. Since the end of February, the spread of the COVID-19 epidemic had a strongly negative impact on economic activity: in the first quarter of 2020 Italy's GDP fell by 5.3 per cent. In the last three columns, for robustness, we anticipate the start of the post period to February 2020 since in the north of Italy the locked down in some municipalities started already toward the end of this month and the FTSE MIB started to fall from the 19th of February 2020. All bank variables are fixed in the last available quarter before the shock (December 2019). In columns 3 and 6 we fix the yield of the security in the last month before the shock (January 2020). We double-cluster the standard errors at bank and security level but results are similar if we add the third dimension of time.

Consistently with rest of the results in the paper, we find that also after this negative shock, despite its different nature, more fragile banks take less risk relatively to better capitalized ones. The coefficient of the triple interaction *Capital*Risk*Post COVID-19* is positive and statistically significant across all the specifications.

TABLE 10 HERE

3.8 Conceptual Framework

We now propose a stylized model to highlight a potential mechanism underpinning our empirical findings. Mainly, we are interested in rationalizing the following two observations: first, that less capitalized banks take relatively less risk after a negative shock to their net worth, and second, that this is more likely to be the case for levered banks with high franchise value.

We show that, in the presence of financial frictions, indebted banks may find it optimal to reduce their risk exposures after a negative shock to their net worth. This is in sharp contrast to the risk-shifting mechanism in Jensen and Meckling (1976), which would prescribe an increase in risk-taking incentives. The reason is that when banks cannot pledge their full franchise value to outside creditors (i.e., there are financial frictions), there is a cost associated with default: shareholders loose part of the bank's franchise value. As a result, when default risk increases, banks may benefit from investing relatively more in safe assets in order to off-set such increase.

Our mechanism relates to Almeida, Campello and Weisbach (2011), who show that in the presence of financing frictions, modeled as ad-hoc costs of external funding, when leverage increases firms may reduce, rather than increase, their risk exposure. In their setting, however, firms want to do so not to reduce the probability of default, but to prevent financing constraints from binding in the future. We view both mechanisms as complementary.

In what follows, we formalize these ideas in a stylized three period model, with $t \in \{0,1,2\}$. Consider a bank that at $t = 0$ has net worth n_0 and outstanding debt b_0 with face value $b_0 \cdot r_b$ to be repaid in $t = 1$, resulting in total assets $a_0 = n_0 + b_0$.

At $t = 0$, given its assets and leverage level, the bank chooses its asset risk. For simplicity, it can invest amount x in risky projects that pay return $r \sim U[0, \bar{R}]$ and amount $s = a - x$ into safe projects that pay return $r_f \geq 1$. We suppose that $s \geq 0$ and $x \geq 0$; that is, bank projects cannot be shorted.

At $t = 1$, risky and safe projects cash flows are realized. In addition, the bank can issue new debt b_1 from competitive lenders, where the risk-free rate is normalized to one. With these funds, if the bank is able to fully repay its outstanding debt, $b_0 \cdot r_b$, it continues operating and has franchise (or continuation) value $V_2 > 0$, which for simplicity we assume is known at $t = 0$. Otherwise, the bank defaults: debtholders seize the bank assets at $t = 1$ and shareholders receive zero.

Financial friction: The only friction in this setting is that banks can only pledge a fraction $\phi \in [0,1]$ of their franchise value to outside creditors at $t = 1$. As V_2 is deterministic, the bank can raise $b_1 \leq \phi \cdot V_2$ at the risk-free rate, and it is without loss of generality to suppose that it issues as much debt as possible, i.e., $b_1 = \phi \cdot V_2$.

With this, we have that the bank avoids default in $t = 1$ if return to risky projects r is high enough to ensure that the bank has enough resources to repay its debt obligations:

$$x \cdot r + (a_0 - x) \cdot r_f + \phi \cdot V_2 \geq b_0 \cdot r_b.$$

Thus, the bank does not default if $r \geq \underline{r}(b_0, x)$, where:

$$\underline{r}(b_0, x) = Max\left\{\frac{b_0 \cdot r_b - (a_0 - x) \cdot r_f - \phi \cdot V_2}{x}, 0\right\}.$$

With this, we can state our first formal result.

Proposition 1. There exist thresholds $\underline{B}$ *and* $\overline{B}$*, with* $0 \leq \underline{B} \leq \overline{B}$*, such that (i) if debt is sufficiently low,* $b_0 \leq \underline{B}$*, the bank invests all of its assets in the project with the highest net-present value, and (ii) if debt is sufficiently high,* $b_0 \geq \overline{B}$*, the bank invests all of its assets in the risky project.*

The previous Proposition combines two different findings. The first one is that if indebtedness is sufficiently low, then the bank chooses its portfolio to maximize the value of assets, as default is a zero-probability event. In this scenario, as the bank is risk-neutral, it chooses to invest all of its assets in the project with the highest NPV.[22] Conversely, when indebtedness is sufficiently high, the bank is motivated by risk-shifting incentives and invests all of its assets in risky projects, independently of their NPV. When the bank always optimally invests all of its assets in risky projects we say that $\underline{B} = \overline{B} = 0$. It follows that our finding requires that banks are sufficiently indebted, but not to the point where default is imminent, which is consistent with the state of bank balance sheets in

[22] Note that we have not made any assumptions on whether risky or safe projects have higher NPV.

our sample where bank capital is always higher than the regulatory minimum. The behavior of such banks is described in the following proposition.

Proposition 2. If $b_0 < \overline{B}$*, then the bank responds to a fall in net worth,* n_0*, by weakly reducing its exposure to risky projects. Moreover,* $\overline{B}$ *increases in franchise value,* V_2*.*

First, if $b_0 < \underline{B}$, it must be that the bank invests all of its assets in the safe or the risky project and thus will continue to do so after small shocks. In contrast, an indebted but solvent bank, defined as one with $b_0 \in [\underline{B}, \overline{B})$ has to trade-off the potential return benefits from investing in risky assets with a higher probability of default, which implies a higher probability of losing fraction $1 - \phi$ of its franchise value, V_2. We find that when V_2 is sufficiently high, these banks choose an interior portfolio: they limit the amount invested in risky projects to avoid default; that is, they chooses $x^* \in (0, a_0)$ so that $\underline{r}(b_0, x^*) = 0$, as zero is the worst possible return risky projects can generate. As net worth falls, all else equal, the probability of default increases. In view of this, the bank responds by reducing its investment in risky projects to reduce the default probability. Moreover, the interval $[\underline{B}, \overline{B}]$ is non-empty when risky returns have a positive net present value and V_2 is sufficiently high, as it is the fear of losing franchise value what induces the precautionary investment decision of the bank.

4. Conclusions

In this paper we analyzed the question whether banks engage in risk-shifting when they are closer to distress or become more cautious.

Analyzing the European sovereign crisis, several papers (Acharya and Steffen, 2015; Drechsler et al., 2016; Altavilla, Pagano and Simonelli, 2017) argue that in distressed countries there was risk shifting in security trading since they show that more fragile banks purchased larger quantity of sovereign debt. Moreover, not only are securities held by banks important quantitatively, but also regulators since the Global Financial Crisis have been eager to intervene. In the US the Volcker Rule, contained in the Dodd–Frank Wall Street Reform and Consumer Protection Act, specifically prohibits banks from engaging in proprietary trading (although a number of exceptions to this ban are included). In the UK the Vickers' report and in the European Union the Likaanen Report suggested that market-based activities should be segregated in firewalled subsidiaries. Moreover, European banking regulators have been considering introducing limits on bank securities trading, specifically in the area of the purchases of sovereign bonds. Nevertheless, in the EU there was not regulation on security trading by banks.

However, in the absence of comprehensive micro data at the security level on banks' trading activities it has proved difficult to bring robust evidence on these issues. Thanks to the ISIN-bank-month supervisory data, that allows a stronger identification and a more complete analysis, our evidence suggests the opposite result: in response to financial stress shocks, less capitalized banks take less risk.

Results are confirmed if we consider different sources of balance sheet fragility and different measures of risk-taking. One could be concerned that banks cannot risk shift because they are subject to regulation and supervision. Again, analyzing security trading provides a unique setting where, thanks to the high granularity of our proprietary dataset, we are able to explicitly exclude the role of capital regulation (in fact results are somewhat stronger when we control for capital regulation at the security level). Moreover, additional tests, based on data on on-site bank inspections and franchise value, suggest also that bank own incentives, instead of supervision, are the main drivers behind the observed behavior. Finally, our findings are similar if we analyze bank behavior around the recent COVID-19 shock, which is important as it was not originated in the financial system and regulation and supervision were softened. A stylized model of bank behavior rationalizes these findings. In the presence of financial frictions and if banks do not have excessive low levels of net worth (which is the case in our sample as banks' capital ratios are above regulatory minimum), preservation of franchise value drives banks to restrain risk taking when they are hit by strong shocks which increase the probability of default.

References

Abbassi, P., Iyer, R., Peydró, J.-L. & Tous, F.R. (2016). Securities trading by banks and credit supply: micro-evidence from the crisis. *Journal of Financial Economics*, 121(3), 569-594.

Acharya, V., Engle, R., & Pierret, D. (2014). Testing macroprudential stress tests: The risk of regulatory risk weights. *Journal of Monetary Economics*, 65, 36-53.

Acharya, V. V., & Steffen, S. (2015). The “greatest” carry trade ever? Understanding eurozone bank risks. *Journal of Financial Economics*, 115(2), 215-236.

Admati, A., & Hellwig, M. (2014). *The Bankers' New Clothes: What's Wrong with Banking and What to Do About it*. Princeton, NJ: Princeton University Press.

Aggarwal, R., Bai, J., & Laeven, L. (2020). Safe Asset Shortages: Evidence from the European Government Bond Lending Market. *Journal of Financial & Quantitative Analysis*, forthcoming.

Altavilla, C., Pagano, M., & Simonelli, S. (2017). Bank exposures and sovereign stress transmission. *Review of Finance*, 21(6), 2103-2139.

Altavilla, C., Barbiero, F., Boucinha, M., & Burlon, L. (2020). The great lockdown: pandemic response policies and bank lending conditions. ECB Working Paper. No 2465

Andrade, G., & Kaplan, S. N. (1998). How costly is financial (not economic) distress? Evidence from highly leveraged transactions that became distressed. *Journal of Finance*, 53(5), 1443-1493.

Aretz, K., Banerjee, S., & Pryshchepa, O. (2019). In the path of the storm: does distress risk cause industrial firms to risk-shift? *Review of Finance*, 23(6), 1115-1154.

Becker, B., & Strömberg, P. (2012). Fiduciary duties and equity-debtholder conflicts. *The Review of Financial Studies*, 25(6), 1931-1969.

Becker, B., & Ivashina, V. (2015). Reaching for yield in the bond market. *Journal of Finance*, 70(5), 1863-1902.

Becker, B., & Ivashina, V. (2017). Financial repression in the European sovereign debt crisis. *Review of Finance*, 22(1), 83-115.

Ben-David, I., Palvia, A. A., & Stulz, R. M. (2020). How Important Is Moral Hazard For Distressed Banks? Fisher College of Business Working Paper, (2020-03), 009.

Bernanke, B. (2007). Speech at the Credit Channel of Monetary Policy in the Twenty-first Century Conference. Federal Reserve Bank of Atlanta, Georgia.

Besanko, D., & Kanatas, G. (1996). The regulation of bank capital: Do capital standards promote bank safety? *Journal of Financial Intermediation*, 5(2), 160-183.

Bofondi, M., Carpinelli, L., & Sette, E. (2017). Credit supply during a sovereign debt crisis. *Journal of the European Economic Association*, 16(3), 696-729.

Bonfim, D., Cerqueiro, G., Degryse, H., & Ongena, S. (2022). On-site inspecting zombie lending. *Management Science.*

Boot, A. W., & Ratnovski, L. (2016). Banking and trading. *Review of Finance*, 20(6), 2219-2246.

Bonaccorsi Di Patti, E., & Sette, E. (2016). Did the securitization market freeze affect bank lending during the financial crisis? Evidence from a credit register. *Journal of Financial Intermediation*, 25, 54-76.

Brunnermeier, M. K. (2009). Deciphering the liquidity and credit crunch 2007-2008. *Journal of Economic Perspectives*, 23(1), 77-100.

Brunnermeier, M., Dong G., and Palia D. (2020), Banks' Non-Interest Income and Systemic Risk. *Review of Corporate Finance Studies*, 9(2), 229-255.

Brunnermeier, M. K., Garicano, L., Lane, P. R., Pagano, M., Reis, R., Santos, T., Thesmar, D., Van Nieuwerburgh, S., & Vayanos, D. (2016). The sovereign-bank diabolic loop and ESBies. *American Economic Review. Papers and Proceedings*, 106(5), 508-512.

Chen, Q., Goldstein, I., Huang, Z., & Vashishtha, R. (2020). Liquidity transformation and fragility in the us banking sector (No. w27815). *National Bureau of Economic Research.*

Chodorow-Reich, G., Darmouni, O., Luck, S., & Plosser, M. C. (2021). Bank Liquidity Provision Across the Firm Size. *Journal of Financial Economics*, forthcoming.

Davis, S., & Haltiwanger, J. (1992). Gross job creation, gross job destruction and employment reallocation. *Quarterly Journal of Economics*, 107(3), 819-63.

Demirgüç-Kunt, A., and Huizinga, H. (2010). Bank Activity and Funding Strategies: The Impact on Risk and Returns. *Journal of Financial Economics*, *98*(3), 626-650.

Demsetz, R. S., Saidenberg, M. R., & Strahan, P. E. (1996). Banks with something to lose: The disciplinary role of franchise value. *Economic Policy Review*, 2(2).

Dewatripont, M., & Tirole, J. (1994). *The prudential regulation of banks*. Cambridge: MA: MIT Press.

Diamond, D. W., and P. H. Dybvig. "Bank runs, deposit insurance, and liquidity." *Journal of Political Economy,* 91.3 (1983): 401-419.

Diamond D., & Rajan, R. (2011). Fear of fire sales, illiquidity seeking, and credit freezes. *Quarterly Journal of Economics*, 126(2), 557-591.

Di Maggio, M., & Kacperczyk, M. (2017). The unintended consequences of the zero lower bound policy. *Journal of Financial Economics*, 123(1), 59-80.

Drechsler, I., Drechsel, T., Marques-Ibanez, D., & Schnabl, P. (2016). Who borrows from the lender of last resort? *Journal of Finance*, 71(5), 1933-1974.

Eisdorfer, A. (2008). Empirical evidence of risk shifting in financially distressed firms. *Journal of Finance, 63*(2), 609-637.

ESRB (2015). Report on the regulatory treatment of sovereign exposures. March 2015.

Esty, B. C. (1997). Organizational form and risk taking in the savings and loan industry. *Journal of Financial Economics*, 44(1), 25-55.

Favara, G., Morellec, E., Schroth, E., & Valta, P. (2017). Debt enforcement, investment, and risk taking across countries. *Journal of Financial Economics*, 123(1), 22-41.

Foley-Fisher, N., Narajabad, B., & Verani, S. (2016). Securities lending as wholesale funding: Evidence from the US life insurance industry (No. w22774). National Bureau of Economic Research.

Furlong, F. T., & Keeley, M. C. (1989). Capital regulation and bank risk-taking: A note. *Journal of Banking & Finance*, 13(6), 883-891.

Freixas, X., and Rochet J. C. (2008). *The Microeconomics of Banking*. Cambridge: MA: MIT Press.

Gale, D., & Özgür, O. (2005). Are bank capital ratios too high or too low? Incomplete markets and optimal capital structure. *Journal of the European Economic Association*, 3(2-3), 690-700.

Gale, D. (2010). The effects of bank capital on lending: What do we know, and what does it mean? *International Journal of Central Banking*, 6(34), 187-204.

Gambacorta, L., & Mistrulli, P. E. (2004). Does bank capital affect lending behavior? *Journal of Financial Intermediation*, 13(4), 436-457.

Gennotte, G., & Pyle, D. (1991). Capital controls and bank risk. *Journal of Banking & Finance*, 15(4-5), 805-824.

Gilje, E. P. (2016). Do firms engage in risk-shifting? Empirical evidence. *The Review of Financial Studies*, 29(11), 2925-2954.

Goldstein, I., and A. Pauzner. "Demand–deposit contracts and the probability of bank runs." *The Journal of Finance*, 60.3 (2005): 1293-1327.

Gormley, T. A., & Matsa, D. A. (2011). Growing out of trouble? Corporate responses to liability risk. *The Review of Financial Studies*, 24(8), 2781-2821.

Gorton, G., & Metrick, A. (2012). Securitized banking and the run on repo. *Journal of Financial Economics*, 104(3), 425-451.

Graham, J. R., & Harvey, C. R. (2001). The theory and practice of corporate finance: evidence from the field. *Journal of Financial Economics*, 60(2-3), 187-243.

Greenwald, D. L., Krainer, J., & Paul, P. (2020). The credit line channel. Federal Reserve Bank of San Francisco Working Paper.

Hanson, S. G., Shleifer, A., Stein, J. C., & Vishny, R. W. (2015). Banks as patient fixed-income investors. *Journal of Financial Economics*, 117(3), 449-469.

Hellmann, T. F., Murdock, K. C., & Stiglitz, J. E. (2000). Liberalization, moral hazard in banking, and prudential regulation: Are capital requirements enough?. *American Economic Review*, 90(1), 147-165.

Hernández-Lagos, P., Povel, P., & Sertsios, G. (2016). An experimental analysis of risk-shifting behavior. *Review of Corporate Finance Studies*, 6(1), 68-101.

Hollo, D., Kremer, M., & Duca, M. L. M. (2012) CISS–A Composite Indicator of Systemic Stress in the Financial System (No. 1426). European Central Bank Working Paper Series.

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

Horváth, B. L., Huizinga, H., & Ioannidou, V. (2015). Determinants and valuation effects of the home bias in European banks' sovereign debt portfolios. Working paper.

Huang, J., Sialm, C., & Zhang, H. (2011). Risk shifting and mutual fund performance. *The Review of Financial Studies*, 24(8), 2575-2616.

Ippolito, F., Peydró, J. L., Polo, A., & Sette, E. (2016). Double bank runs and liquidity risk management. *Journal of Financial Economics*, 122(1), 135-154.

Jensen, M. C., & Meckling, W. H. (1976). Theory of the firm: Managerial behavior, agency costs and ownership structure. *Journal of Financial Economics*, 3(4), 305-360.

Keeley, M. C. (1990). Deposit insurance, risk, and market power in banking. *The American Economic Review*, 1183-1200.

Kim, D., & Santomero, A. M. (1988). Risk in banking and capital regulation. *Journal of Finance*, *43*(5), 1219-1233.

Kirti, D. (2017). When gambling for resurrection is too risky. International Monetary Fund Working Paper.

Laeven, L., & Levine, R. (2009). Bank governance, regulation and risk taking. *Journal of Financial Economics*, 93(2), 259-275.

Landier, A., Sraer, D. A., & Thesmar, D. (2015). The risk-shifting hypothesis: Evidence from subprime originations. Working paper.

Li, L., Strahan, P. E., & Zhang, S. (2020). Banks as lenders of first resort: Evidence from the COVID-19 crisis. *The Review of Corporate Finance Studies*, 9(3), 472-500.

Merton, R. C. (1977). An analytic derivation of the cost of deposit insurance and loan guarantees an application of modern option pricing theory. *Journal of Banking & Finance*, 1(1), 3-11.

Myers, S. C., & Rajan, R. G. (1998). The paradox of liquidity. *The Quarterly Journal of Economics*, 113(3), 733-771.

Passalacqua, A., Angelini, P., Lotti, F., & Soggia, G. (2021). The real effects of bank supervision: evidence from on-site bank inspections. *Bank of Italy Temi di Discussione* (Working Paper) No, 1349.

Parrino, R., & Weisbach, M. S. (1999). Measuring investment distortions arising from stockholder–bondholder conflicts. *Journal of Financial Economics*, 53(1), 3-42.

Peydró, J. L., Polo, A., & Sette, E. (2021). Monetary policy at work: security and credit application registers evidence. *Journal of Financial Economics*, 140(3), 789-814.

Rauh, J. D. (2009). Risk shifting versus risk management: investment policy in corporate pension plans. The *Review of Financial Studies*, 22(7), 2687-2733.

Rochet, J. C. (1992). Capital requirements and the behaviour of commercial banks. *European Economic Review*, 36(5), 1137-1170.

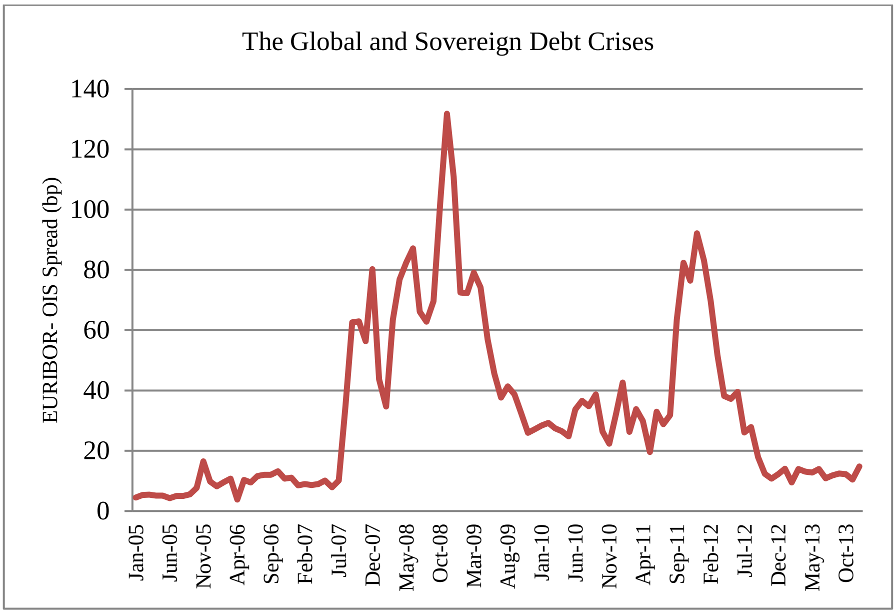
Saunders, A., Strock, E., & Travlos, N. G. (1990). Ownership structure, deregulation, and bank risk taking. *Journal of Finance*, *45*(2), 643-654.

Shleifer, A., & Vishny, R. (2010). Unstable banking. *Journal of Financial Economics*, 97(3), 306-318.

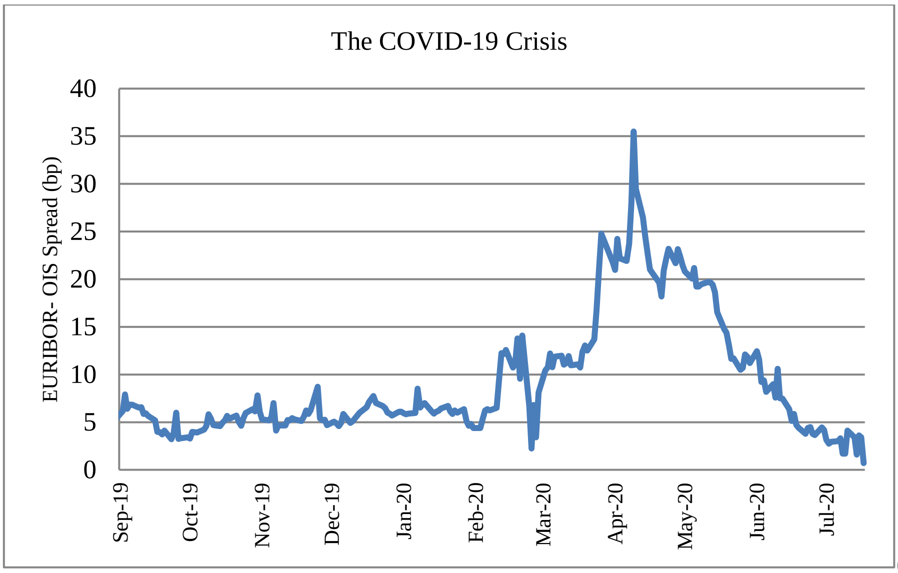
Vives, X. (2014). Strategic complementarity, fragility, and regulation. *The Review of Financial Studies*, 27(12), 3547-3592.

Vives, X. (2016). *Competition and Stability in Banking: The Role of Regulation and Competition Policy*. Princeton, NJ: Princeton University Press.

Figure 1: The Evolution of the Euribor-OIS Spread



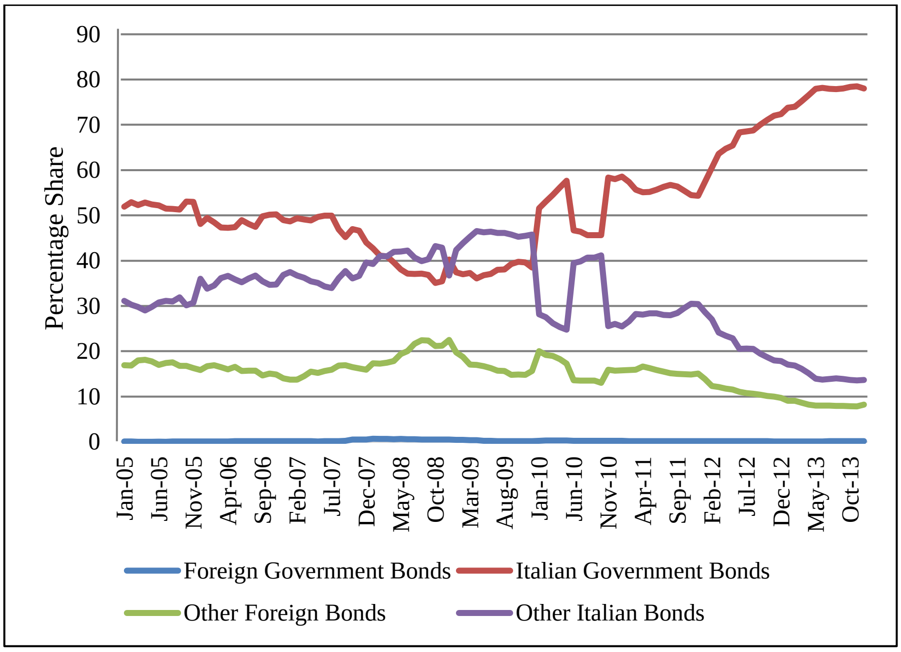
(a)



(b)

The Figure a reports the time series of the 3 months Euribor-OIS spread from January 2005 to December 2013 at a monthly frequency. The Figure b reports the time series of the 3 months Euribor-OIS spread from September 2019 to July 2020 at a daily frequency. This spread is the difference between the rate at which European banks lend to each other (EURIBOR) and the overnight indexed swap (OIS) rate on the overnight rate (EONIA) among the same banks for a 3 month period.

Figure 2: The Composition of the Banks' Aggregate Bond Portfolio



The Figure reports the time series of the shares of the bond portfolios of Italian banks from January 2005 to December 2013 at a monthly frequency. We report the share of Foreign and Italian government bonds and Foreign and Italian bonds issued by non-government entities.

Table 1: Descriptive Statistics

Variables	Mean	St.Dev.	Median	p25	p75	Obs.
Net Buys	5.028	82.171	0.007	-1.415	2.768	304830
Δ Log (Holdings)	21.491	284.476	0.007	-1.417	2.765	304830
Capital (in excess of regulatory minimum)	2.477	1.545	2.221	1.485	2.951	304568
Leverage	7.805	1.990	7.691	6.634	8.725	304830
Net Worth	8.186	2.095	8.102	7.019	9.149	303889
Tier 1	8.997	3.045	8.150	7.174	9.875	304568
Precrisis Capital (in excess of regulatory minimum)	2.662	1.985	2.056	1.786	2.541	290498
Size	10.221	1.936	10.160	8.478	11.823	304830
Interbank	9.290	9.683	6.836	3.376	11.784	304830
Liquidity	9.819	7.183	8.182	5.039	11.876	304830
Bad Loans	3.143	1.934	3.004	1.640	4.477	304830
Lerner Index	0.439	0.116	0.462	0.344	0.507	250830
Yield	2.140	1.918	1.739	0.721	3.157	304830
Yield (Italian Government)	1.668	1.706	0.975	0.302	2.768	132168
Yield (non Italian Government)	2.502	1.991	2.061	1.216	3.358	172662
Rating	701.599	38.922	710 (A+)	670 (BBB)	730 (AA)	232475
Rating=AAA	0.065	0.247	0	0	0	232475
Rating>A	0.706	0.455	1	0	1	232475
Concentration Risk by Issuer	4451.438	2662.879	3802.606	2253.402	6332.314	6423
Concentration Risk by Type of Instrument	5375.765	2243.051	4998.104	3563.036	6960.814	6423
Share of Italian Government Bonds	49.930	30.820	50.770	22.780	76.410	6366
Δ Euribor-OIS Spread	-0.002	0.102	-0.002	-0.045	0.023	304830
Δ European CDS Index	0.206	16.747	-1.350	-7.780	8.490	285431
Δ Euro Area Syst. Stress Index	-0.002	0.092	-0.002	-0.051	0.041	304830
Δ Euro Area Syst. Stress Index, Bond	0.000	0.018	-0.003	-0.010	0.009	304830
Δ Euro Area Syst. Stress Index, Money	0.000	0.017	-0.002	-0.008	0.011	304830
Eonia	1.198	1.292	0.593	0.344	2.067	304830
Δ Unemployment	0.058	0.214	0.000	-0.100	0.200	304830
Δ CPI	0.167	0.203	0.200	0.000	0.300	304830

The table shows descriptive statistics of the main variables employed in our analysis. The definitions of the variables are reported in Table A1 in the Appendix.

Table 2: Main Results

Dependent Variable:	Net Buys $_{s,b,t}$					
	(1)	(2)	(3)	(4)	(5)	(6)
Capital*Risk*Financial Stress	1.443***	1.378***	1.462***	2.097***	1.480***	1.421***
	(0.430)	(0.426)	(0.393)	(0.565)	(0.540)	(0.514)
Capital*Risk	0.090	0.077	0.073	0.038	0.053	0.069
	(0.059)	(0.056)	(0.047)	(0.067)	(0.059)	(0.066)
Financial Stress*Risk	0.265	-0.078	-1.104	3.733		
	(1.326)	(1.047)	(1.136)	(2.334)		
Capital*Financial Stress	0.950	1.020	0.698	-0.142	1.251	1.761*
	(0.685)	(0.777)	(0.719)	(1.016)	(0.816)	(1.024)
Financial Stress	-1.846	-1.225				
	(3.276)	(3.313)				
Macro Controls	Yes	Yes	-	-	-	-
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes
Security Fixed Effects	No	Yes	No	No	-	-
Time Fixed Effects	No	No	Yes	-	-	-
Rating*Maturity*Time Fixed Effects	No	No	No	Yes	-	-
Security*Time Fixed Effects	No	No	No	No	Yes	Yes
Bank Fixed Effects	No	No	No	No	No	Yes
Observations	304568	304568	304568	232162	304568	304568

The table shows regressions of net buys of security *s* by bank *b* at time *t*, as a function of a set of security, macro and bank variables at time t-1. The variable Risk is the yield of the security. The variable Financial Stress is the monthly change in the Euribor-OIS spread. Macro controls include changes in Italian unemployment and Consumer Price Index. Bank controls include capital, interbank, liquidity, bad loans/total assets and size. The definitions of the variables are reported in Table A1 in the Appendix. The sample period starts in January 2005 and ends in December 2013. Fixed effects are either included ("Yes"), not included ("No") or spanned by another set of effects ("-"). Standard errors are triple-clustered at bank, security and time level, and are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 3: Alternative Proxies for Financial Stress

Dependent Variable:	Net Buys $_{s,b,t}$						
	Δ Euro Area Systemic Stress Index	Δ Euro Area Systemic Stress Index, Bond Market	Δ Euro Area Systemic Stress Index, Money Market	Δ European CDS Index	Dummy for high Δ Euribor-OIS Spread	Dummy for Sovereign Crisis	Post Lehman Shock– Restricted Sample
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Capital*Risk*Financial Stress	1.148*	6.211***	5.763**	0.003*	0.382**	0.356**	1.136**
	(0.686)	(2.295)	(2.389)	(0.002)	(0.168)	(0.161)	(0.434)
Capital*Risk	0.089	0.087	0.087	0.057	0.012	-0.011	-0.735**
	(0.077)	(0.076)	(0.075)	(0.076)	(0.070)	(0.072)	(0.330)
Capital*Financial Stress	-1.086	-7.481	-5.880	-0.004	-0.114	-0.704**	0.366
	(1.556)	(8.462)	(6.295)	(0.010)	(0.449)	(0.303)	(0.968)
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes	-
Security*Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	304568	304568	304568	285169	304568	304568	8565

The table shows regressions of net buys of security *s* by bank *b* at time *t*, as a function of a set of security, macro and bank variables at time t-1. The variable Risk is the yield of the security. In column 1 the variable Financial Stress is the monthly change in the Euro Area Systemic Stress Index (ECB's CISS). In column 2 the variable Financial Stress is the monthly change in the Euro Area Systemic Stress Index (ECB's CISS), subindice Bond Market. In column 3 the variable Financial Stress is the monthly change in the Euro Area Systemic Stress Index (ECB's CISS), subindice Money Market. In column 4 the variable Financial Stress is the monthly change in the European Markit iTraxx Credit Default Swap Index (5 years). In column 5 the variable Financial Stress is a dummy equal to 1 if the monthly change in the Euribor-OIS spread is larger or equal to the 90th percentile and 0 otherwise. In column 6 the variable Financial Stress is a dummy equal to 1 in the months between June 2011 and December 2012 and 0 otherwise. Bank controls include capital, interbank, liquidity, bad loans/total assets and size. In column 7 we restrict the sample to the six months around the failure of Lehman Brothers (September, 15th 2008) and the variable Financial Stress is a dummy equal to 1 in the months after the Lehman shock. The definitions of the variables are reported in Table A1 in the Appendix. In the first 6 columns the sample period starts in January 2005 and ends in December 2013. Standard errors are triple-clustered at bank, security and time level, and are reported in parentheses (in the last column standard errors are double-clustered at bank and security level as we only use six months around the Lehman failure). *** p<0.01, ** p<0.05, * p<0.1

Table 4: The Role of Interbank Exposure

Dependent Variable:	Net Buys $_{s,b,t}$					
	(1)	(2)	(3)	(4)	(5)	(6)
Capital*Risk*Financial Stress	1.444***	1.374***	1.485***	2.123***	1.474***	1.401***
	(0.431)	(0.439)	(0.405)	(0.552)	(0.557)	(0.530)
Interbank*Risk*Financial Stress	-0.010	-0.009	0.015	0.028	-0.007	-0.020
	(0.122)	(0.097)	(0.104)	(0.139)	(0.097)	(0.099)
Capital*Risk	0.074	0.065	0.058	0.028	0.046	0.059
	(0.053)	(0.056)	(0.044)	(0.070)	(0.059)	(0.058)
Interbank*Risk	-0.027***	-0.022***	-0.024***	-0.023***	-0.014*	-0.017**
	(0.006)	(0.008)	(0.006)	(0.006)	(0.008)	(0.008)
Capital*Financial Stress	0.789	0.848	0.564	-0.197	1.208	1.772
	(0.666)	(0.800)	(0.852)	(1.149)	(0.980)	(1.199)
Interbank*Financial Stress	-0.217	-0.225	-0.197	-0.095	-0.068	-0.007
	(0.139)	(0.140)	(0.134)	(0.198)	(0.150)	(0.157)
Macro Controls	Yes	Yes	-	-	-	-
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes
Security Fixed Effects	No	Yes	No	No	-	-
Time Fixed Effects	No	No	Yes	Yes	-	-
Rating*Maturity*Time Fixed Effects	No	No	No	Yes	-	-
Security*Time Fixed Effects	No	No	No	No	Yes	Yes
Bank Fixed Effects	No	No	No	No	No	Yes
Observations	304568	304568	304568	232162	304568	304568

The table shows regressions of net buys of security *s* by bank *b* at time *t*, as a function of a set of security, macro and bank variables at time t-1. The variable Risk is the yield of the security. The variable Financial Stress is the monthly change in the Euribor-OIS spread. Macro controls include changes in Italian unemployment and Consumer Price Index and the variable Financial Stress non-interacted. Bank controls include capital, interbank, liquidity, bad loans/total assets and size. The definitions of the variables are reported in Table A1 in the Appendix. The sample period starts in January 2005 and ends in December 2013. Fixed effects are either included ("Yes"), not included ("No") or spanned by another set of effects ("-"). Standard errors are triple-clustered at bank, security and time level, and are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 5: Regulation: Evidence from Sub-sample of Securities with Zero Risk Weights

Dependent Variable:	Net Buys $_{s,b,t}$					
	(1)	(2)	(3)	(4)	(5)	(6)
Capital*Risk*Financial Distress	1.908*	1.749	1.805*	2.222***	2.003*	2.048*
	(1.103)	(1.109)	(1.004)	(0.827)	(1.174)	(1.194)
Interbank*Risk*Financial Distress	-0.266***	-0.269**	-0.253***	-0.258***	-0.274***	-0.262***
	(0.102)	(0.107)	(0.091)	(0.079)	(0.099)	(0.092)
Capital*Risk	0.091	0.045	0.059	0.017	0.012	-0.006
	(0.109)	(0.106)	(0.099)	(0.105)	(0.116)	(0.127)
Interbank*Risk	-0.058***	-0.052***	-0.054***	-0.046***	-0.045***	-0.068***
	(0.023)	(0.012)	(0.011)	(0.009)	(0.011)	(0.015)
Capital*Financial Distress	0.982	0.928	0.902	-0.789	1.829	2.597
	(2.174)	(2.269)	(2.359)	(2.439)	(2.286)	(2.496)
Interbank*Financial Distress	-0.071	-0.047	-0.013	-0.006	0.027	0.140
	(0.266)	(0.276)	(0.258)	(0.232)	(0.281)	(0.304)
Macro Controls	Yes	Yes	-	-	-	-
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes
Security Fixed Effects	No	Yes	No	No	-	-
Time Fixed Effects	No	No	Yes	Yes	-	-
Rating*Maturity*Time Fixed Effects	No	No	No	Yes	-	-
Security*Time Fixed Effects	No	No	No	No	Yes	Yes
Bank Fixed Effects	No	No	No	No	No	Yes
Observations	131951	131951	131951	98683	131951	131951

The table shows regressions of net buys of security *s* by bank *b* at time *t*, as a function of a set of security, macro and bank variables at time t-1. This table includes only the sample of Italian government Bonds. The variable Risk is the yield of the security. The variable Financial Stress is the monthly change in the Euribor-OIS spread. Macro controls include changes in Italian unemployment and Consumer Price Index and the variable Financial Stress non-interacted. Bank controls include capital, interbank, liquidity, bad loans/total assets and size. The definitions of the variables are reported in Table A1 in the Appendix. The sample period starts in January 2005 and ends in December 2013. Fixed effects are either included ("Yes"), not included ("No") or spanned by another set of effects ("-"). Standard errors are triple-clustered at bank, security and time level, and are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 6: Supervision: Evidence from Sub-sample of Periods with No Bank Inspections

Dependent Variable:	Net Buys $_{s,b,t}$					
	(1)	(2)	(3)	(4)	(5)	(6)
Capital*Risk*Financial Distress	1.258*	1.190*	1.284**	1.981**	1.468*	1.348+
	(0.659)	(0.662)	(0.644)	(0.854)	(0.885)	(0.870)
Interbank*Risk*Financial Distress	0.169	0.175*	0.172	0.180	0.117	0.123
	(0.104)	(0.097)	(0.107)	(0.134)	(0.104)	(0.107)
Capital*Risk	0.130*	0.129*	0.132**	0.105	0.131	0.131
	(0.070)	(0.071)	(0.064)	(0.078)	(0.083)	(0.086)
Interbank*Risk	-0.036***	-0.035***	-0.035***	-0.032***	-0.025***	-0.026***
	(0.008)	(0.008)	(0.006)	(0.008)	(0.008)	(0.007)
Capital*Financial Distress	-0.154	0.052	-0.239	-1.486	0.442	1.053
	(0.945)	(1.055)	(1.137)	(1.443)	(1.227)	(1.398)
Interbank*Financial Distress	-0.276	-0.280	-0.225	-0.067	-0.010	0.019
	(0.177)	(0.184)	(0.190)	(0.277)	(0.224)	(0.230)
Macro Controls	Yes	Yes	-	-	-	-
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes
Security Fixed Effects	No	Yes	No	No	-	-
Time Fixed Effects	No	No	Yes	Yes	-	-
Rating*Maturity*Time Fixed Effects	No	No	No	Yes	-	-
Security*Time Fixed Effects	No	No	No	No	Yes	Yes
Bank Fixed Effects	No	No	No	No	No	Yes
Observations	219313	219285	219313	165600	212885	212885

The table shows regressions of net buys of security *s* by bank *b* at time *t*, as a function of a set of security, macro and bank variables at time t-1. This table includes only the sample of observations when banks are not under on-site supervisory inspection. The variable Risk is the yield of the security. The variable Financial Stress is the monthly change in the Euribor-OIS spread. Macro controls include changes in Italian unemployment and Consumer Price Index and the variable Financial Stress non-interacted. Bank controls include capital, interbank, liquidity, bad loans/total assets and size. The definitions of the variables are reported in Table A1 in the Appendix. The sample period starts in January 2005 and ends in December 2013. Fixed effects are either included ("Yes"), not included ("No") or spanned by another set of effects ("-"). Standard errors are triple-clustered at bank, security and time level, and are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.16

Table 7: Supervision: Evidence from Different Accounting Portfolios

Dependent Variable:	Net Buys $_{s,b,t}$							
	Trading book and Available for Sale				Held To Maturity			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Capital*Risk*Financial Stress	1.317***	1.409***	1.471**	1.383*	-0.524	-0.416	-1.286	-0.411
	(0.469)	(0.432)	(0.689)	(0.706)	(1.224)	(1.337)	(2.215)	(1.889)
Interbank*Risk*Financial Stress	0.108	0.131	0.088	0.061	-0.051	-0.006	-0.018	-0.013
	(0.159)	(0.165)	(0.165)	(0.170)	(0.151)	(0.141)	(0.125)	(0.127)
Capital*Risk	0.048	0.040	0.054	0.081	-0.026	0.020	-0.195	-0.312
	(0.059)	(0.049)	(0.062)	(0.065)	(0.177)	(0.123)	(0.205)	(0.198)
Interbank*Risk	-0.038***	-0.036***	-0.022**	-0.020**	-0.020	-0.029**	-0.004	-0.004
	(0.005)	(0.005)	(0.010)	(0.010)	(0.014)	(0.014)	(0.015)	(0.017)
Capital*Financial Stress	1.664*	1.347	1.634	1.953*	-5.083	-5.735	-4.653	-6.516*
	(0.920)	(0.916)	(1.012)	(1.162)	(3.457)	(4.088)	(4.323)	(3.578)
Interbank*Financial Stress	-0.297	-0.271	-0.093	-0.010	-0.038	-0.164	-0.331	-0.389
	(0.289)	(0.284)	(0.304)	(0.313)	(0.132)	(0.197)	(0.334)	(0.357)
Macro Controls	Yes	-	-	-	Yes	-	-	-
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	No	Yes	-	-	No	Yes	-	-
Security*Time Fixed Effects	No	No	Yes	Yes	No	No	Yes	Yes
Bank Fixed Effects	No	No	No	Yes	No	No	No	Yes
Observations	208795	208795	207619	207619	14558	14558	7913	7910

The table shows regressions of net buys of security *s* by bank *b* at time *t*, as a function of a set of security, macro and bank variables at time t-1. In this table we split the sample between the Trading Book and Available for Sale portfolios (columns 1-4) and Held To Maturity portfolio (columns 5-8). The variable Risk is the yield of the security. The variable Financial Stress is the monthly change in the Euribor-OIS spread. Macro controls include changes in Italian unemployment and Consumer Price Index and the variable Financial Stress non-interacted. Bank controls include capital, interbank, liquidity, bad loans/total assets and size. The definitions of the variables are reported in Table A1 in the Appendix. The sample period starts in January 2005 and ends in December 2013. Fixed effects are either included ("Yes"), not included ("No") or spanned by another set of effects ("-"). Standard errors are triple-clustered at bank, security and time level, and are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 8: Economic Forces: Evidence from the Franchise Value

Dependent Variable:	Net Buys $_{s,b,t}$							
	High Franchise Value Subsample				Low Franchise Value Subsample			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Capital*Risk*Financial Stress	2.597***	2.579***	2.818***	2.625***	-0.435	-0.339	-0.340	-0.201
	(0.449)	(0.509)	(1.008)	(0.939)	(0.971)	(0.943)	(0.954)	(1.035)
Interbank*Risk*Financial Stress	0.023	0.055	0.039	0.029	0.065	0.101	0.157	0.146
	(0.170)	(0.145)	(0.145)	(0.150)	(0.208)	(0.149)	(0.133)	(0.128)
Capital*Risk	0.112	0.084	0.036	0.122	0.327***	0.311***	0.252**	0.158
	(0.084)	(0.074)	(0.098)	(0.093)	(0.117)	(0.106)	(0.121)	(0.119)
Interbank*Risk	-0.020***	-0.017***	-0.008	-0.008*	-0.015	-0.016	0.001	-0.000
	(0.005)	(0.003)	(0.006)	(0.004)	(0.033)	(0.017)	(0.018)	(0.019)
Capital*Financial Stress	0.218	0.124	1.399	1.562	1.837	1.302	0.198	0.821
	(0.721)	(1.153)	(1.039)	(1.336)	(2.191)	(2.129)	(1.773)	(2.017)
Interbank*Financial Stress	-0.313	-0.339*	-0.343**	-0.312*	-0.341	-0.336	-0.139	-0.125
	(0.262)	(0.175)	(0.161)	(0.175)	(0.295)	(0.283)	(0.322)	(0.359)
Macro Controls	Yes	-	-	-	Yes	-	-	-
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	No	Yes	-	-	No	Yes	-	-
Security*Time Fixed Effects	No	No	Yes	Yes	No	No	Yes	Yes
Bank Fixed Effects	No	No	No	Yes	No	No	No	Yes
Observations	129533	129533	122332	122332	121178	121178	110942	110942

The table shows regressions of net buys of security *s* by bank *b* at time *t*, as a function of a set of security, macro and bank variables at time t-1. In this table we split the sample between observations where the Lerner Index is larger than the median (columns 1-4) and observations where the Lerner index is smaller than the median (columns 5-8). The variable Risk is the yield of the security. The variable Financial Stress is the monthly change in the Euribor-OIS spread. Macro controls include changes in Italian unemployment and Consumer Price Index and the variable Financial Stress non-interacted. Bank controls include capital, interbank, liquidity, bad loans/total assets and size. The definitions of the variables are reported in Table A1 in the Appendix. The sample period starts in January 2005 and ends in December 2013. Fixed effects are either included ("Yes"), not included ("No") or spanned by another set of effects ("-"). Standard errors are triple-clustered at bank, security and time level, and are reported in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 9: Concentration Risks: Bank Level Analysis

Dependent Variable:	Concentration Risk$_{b,t}$											
	Share of Italian Government				HHI Issuers				HHI Type of Instruments			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Capital* Financial Stress	-1.039	-1.159	-1.097	-1.224	89.698	58.245	87.688	54.712	165.661*	130.163	153.258*	117.350
	(0.869)	(0.813)	(0.918)	(0.864)	(87.478)	(88.214)	(87.867)	(88.635)	(89.319)	(89.793)	(85.356)	(85.318)
Interbank* Financial Stress			-0.097	-0.110			-3.352	-6.024			-20.687*	-21.846**
			(0.125)	(0.125)			(8.129)	(8.483)			(11.322)	(10.520)
Capital	0.433	0.807	0.438	0.813	25.796	101.770	25.972	102.114	22.260	80.763	23.345	82.009
	(0.701)	(0.773)	(0.703)	(0.775)	(57.734)	(67.257)	(57.798)	(67.405)	(52.330)	(50.613)	(52.484)	(50.813)
Interbank	-0.064	-0.097	-0.063	-0.096	4.555	3.328	4.568	3.352	9.257	6.948	9.333	7.034
	(0.220)	(0.219)	(0.221)	(0.220)	(16.353)	(17.004)	(16.360)	(17.007)	(13.473)	(14.052)	(13.467)	(14.042)
Macro Controls	Yes	-	Yes	-	Yes	-	Yes	-	Yes	-	Yes	-
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	6378	6366	6378	6366	6435	6423	6435	6423	6435	6423	6435	6423

The table shows regressions of Concentration Risks (proxied by the Share of Italian Government in columns 1-4, the HHI index of holdings by issuers in columns 5-8, and the HHI index of holdings by types of instrument in columns 9-12) by bank b at time *t*, as a function of a set of macroeconomic, and bank variables at time t-1 The variable Financial Stress is the monthly change in the Euribor-OIS spread. Macro controls include changes in Italian unemployment and Consumer Price Index and the variable Financial Stress non-interacted. Bank controls include liquidity, bad loans/total assets and size. The definitions of the variables are reported in Table A1 in the Appendix. The sample period starts in January 2005 and ends in December 2013. Fixed effects are either included ("Yes"), not included ("No") or spanned by another set of effects ("-"). Standard errors are double-clustered at bank and month level, and are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 10: Evidence from the Recent COVID-19 Shock

Dependent Variable:	Net Buys $_{s,b,t}$					
	Post COVID-19 Starting in March 2020			Post COVID-19 Starting in February 2020		
	(1)	(2)	(3)	(4)	(5)	(6)
Capital*Risk*Post COVID-19	0.810**	0.775**	0.883**	0.944**	0.985**	0.854**
	(0.395)	(0.388)	(0.378)	(0.377)	(0.378)	(0.418)
Capital*Risk	-0.135	-0.141	-0.132	-0.451	-0.526	-0.244
	(0.425)	(0.428)	(0.398)	(0.387)	(0.403)	(0.341)
Capital*Post COVID-19	0.307	0.311	0.335	0.606	0.655*	0.753
	(0.431)	(0.431)	(0.424)	(0.375)	(0.382)	(0.510)
Interbank*Risk*Post COVID-19		0.099	0.105		-0.182	-0.101
		(0.107)	(0.107)		(0.136)	(0.140)
Interbank*Risk		0.072	0.050		0.307**	0.165
		(0.157)	(0.157)		(0.124)	(0.126)
Interbank*Post COVID-19		-0.038	-0.011		-0.233	-0.183
		(0.159)	(0.166)		(0.146)	(0.184)
Security*Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	24682	24682	23491	24467	24467	23332

The table shows regressions of net buys of security *s* by bank *b* at time *t*, as a function of a set of security, macro and bank variables at time t-1. The variable Risk is the yield of the security. The variable Post COVID-19 is equal to 1 for the months starting in March 2020 in the first three columns and starting in February 2020 in the last three columns, and 0 otherwise. The sample includes in the first the three columns the months from September 2019 to August 2020, in the last three columns the months from August 2019 to July 2020. All bank variables are fixed in the last available quarter before the shock (December 2019). In columns 3 and 6 we fix the yield of the security in the last month before the shock (January 2020). The definitions of the variables are reported in Table A1 in the Appendix. Standard errors are double-clustered at bank and security level. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

APPENDIX A

Table A1: Description of Variables

Variable	*Description*	*Source*
Security Holdings		
Net Buys	Net buys of security *s*, by bank *b* during the month *t*. This growth rate is symmetric around 0 and it lays in the closed interval [-200,200] with final sales (initial purchases) corresponding to the left (right) endpoint (Davis and Haltiwanger, 1992)	Security Register
Δ Log (Holdings)	The difference between the logarithm of (holdings of security *s*, by bank *b* at time *t)* and the logarithm of (holdings of security *s*, by bank *b* at time *t-1)*. When the holdings are equal to zero we set the logarithm of holdings equal to zero	Security Register
Security Characteristics		
Yield	Yield to redemption ("RY" in Datastream) minus the overnight interest rate for the EURO area (EONIA), in percentage	Datastream
Ratings	Ratings issued by Moody's	FactSet
Italian	Dummy equal to 1 if the nationality of the issuer is Italian	FactSet
Bank Characteristics		
Capital	Capital (shares subscribed, book value of equity plus retained earnings) in excess of the regulatory minimum divided by total assets, in percentage	Supervisory Reports
Leverage Ratio	Equity (shares subscribed, book value of equity plus retained earnings) divided by total assets, in percentage	Supervisory Reports
Net Worth	Leverage ratio plus ROA, in percentage	Supervisory Reports
Tier 1 Ratio	Equity (shares subscribed, book value of equity plus retained earnings) divided by risk-weighted assets, in percentage	Supervisory Reports
Precrisis Capital	Average of Excess Capital between January 2005 and June 2007, in percentage	
Interbank	Ratio of total borrowing from other banks to total assets, inclusive of deposits and repos from other banks, exclusive of deposits from the ECB or other national central banks, in percentage	Supervisory Reports
Liquidity	Sum of cash holdings and sovereign bonds divided by total assets, in percentage	Supervisory Reports
Size	Logarithm of total assets	Supervisory Reports
Bad Loans/Total Assets	Percentage of bad loans ("crediti in sofferenza") out of total bank assets, in percentage	Supervisory Reports
Share of Italian Government	Amount of Italian government bonds, divided by total securities	
HHI Issuers	HHI index of holdings by issuers	Security Register
HHI Type of Instruments	HHI index of holdings by type of instruments (mutual funds, abs, shares of Italian financial companies, shares of foreign financial companies, shares of Italian non financial companies, shares of foreign non financial companies, bonds of foreign financial companies, bonds of Italian financial companies, bonds of foreign non financial companies, bonds of Italian non financial companies, Italian government bonds, foreign government bonds)	Security Register
Financial Stress Variables		
Δ Euribor-OIS Spread	Monthly change in the three months Euribor-OIS Spread	Bank of Italy
Dummy for Sovereign Crisis	This variable takes the value of one for the months between June 2011 and December 2012 and 0 otherwise	
Δ Euro Area Systemic Stress Index	Monthly change in the Euro Area Composite Indicator of Systemic Stress (CISS)	ECB
Δ Euro Area Systemic Stress Index, Bond Market	Monthly change in the Euro Area Composite Indicator of Systemic Stress (CISS), subindice Bond Market	ECB
Δ Euro Area Systemic Stress Index, Money Market	Monthly change in the Euro Area Composite Indicator of Systemic Stress (CISS), subindice Money Market	ECB
Δ European CDS Index	Monthly change in the European Markit iTraxx Credit Default Swap Index (5 years)	EIKON Thomson Reuters
Macro Variables		
Δ CPI	Monthly change in the Italian Consumer Price Index	Bank of Italy
Δ Unemployment	Monthly change in the Italian unemployment rate	Bank of Italy
EONIA	Overnight interest rate for the EURO area	Bank of Italy
LTRO Dummy	Dummy equal to 1 in the months of November 2011 and February 2012	

The table describes the main dependent and control variables we use in the paper.

Table A2: Alternative Dependent Variable: Change in Log (Holdings)

Dependent Variable:			Δ Log (Holdings)$_{s,b,t}$			
	(1)	(2)	(3)	(4)	(5)	(6)
Capital*Risk*Financial Stress	5.925**	5.469**	6.050***	7.645**	6.154**	5.686**
	(2.379)	(2.275)	(2.205)	(3.087)	(2.575)	(2.444)
Capital*Risk	0.352	0.256	0.287	0.204	0.192	0.182
	(0.270)	(0.289)	(0.245)	(0.289)	(0.290)	(0.292)
Financial Stress*Risk	0.578	-1.400	-3.022	13.177*		
	(5.887)	(4.498)	(2.916)	(7.880)		
Capital*Financial Stress	1.347	1.833	0.834	-0.062	3.142	5.331
	(2.903)	(3.289)	(3.514)	(4.520)	(3.615)	(4.551)
Financial Stress	-0.778	2.904				
	(11.997)	(11.793)				
Macro Controls	Yes	Yes	-	-	-	-
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes
Security Fixed Effects	No	Yes	No	No	-	-
Time Fixed Effects	No	No	Yes	-	-	-
Rating*Maturity*Time Fixed Effects	No	No	No	Yes	-	-
Security*Time Fixed Effects	No	No	No	No	Yes	Yes
Bank Fixed Effects	No	No	No	No	No	Yes
Observations	304568	304568	304568	232162	304568	304568

The table shows regressions of changes in Log (holdings) of security *s* by bank *b* between *t* and *t-1* as a function of a set of security, macro and bank variables at time t-1. The variable Risk is the yield of the security. The variable Financial Stress is the monthly change in the Euribor-OIS spread. Macro controls include changes in Italian unemployment and Consumer Price Index. Bank controls include capital, interbank, liquidity, bad loans/total assets and size. The definitions of the variables are reported in Table A1 in the Appendix. The sample period starts in January 2005 and ends in December 2013. Fixed effects are either included ("Yes"), not included ("No") or spanned by another set of effects ("-"). Standard errors are triple-clustered at bank, security and time level, and are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table A3: Alternative Definitions of Capital

Dependent Variable:	Net Buys $_{s,b,t}$		
	Leverage Ratio (1)	Net Worth (2)	Tier 1 Ratio (3)
Capital*Risk*Financial Stress	1.320***	1.621***	0.530***
	(0.456)	(0.585)	(0.136)
All the Double Interactions	Yes	Yes	Yes
Bank Controls	Yes	Yes	Yes
Security*Time Fixed Effects	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes
Observations	304830	303866	304568

The table shows regressions of net buys of security *s* by bank *b* at time *t*, as a function of a set of security, macro and bank variables at time t-1. In column 1 the variable Capital is the Leverage Ratio. In column 2 the variable Capital is the Net Worth. In column 3 the variable Capital is the Tier 1 Ratio. The variable Risk is the yield of the security. The variable Financial Stress is the monthly change in the Euribor-OIS spread. Bank controls include capital, interbank, liquidity, bad loans/total assets and size. The definitions of the variables are reported in Table A1 in the Appendix. The sample period starts in January 2005 and ends in December 2013. Standard errors are triple-clustered at bank, security and time level, and are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table A4: Further Controls

Dependent Variable:	Net Buys $_{s,b,t}$			
	(1)	(2)	(3)	(4)
Capital*Risk*Financial Stress	1.423***	1.116**	1.450***	1.532***
	(0.518)	(0.534)	(0.548)	(0.525)
Size*Risk*Financial Stress		-1.062*		
		(0.624)		
Capital*Risk*LTRO			0.428**	
			(0.212)	
Capital*Risk*EONIA				-0.080
				(0.071)
All the Double Interactions	Yes	Yes	Yes	Yes
Bank Controls	Yes	Yes	Yes	Yes
Security*Time Fixed Effects	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes
Control for the Existing Portfolio	Yes	No	No	No
Observations	304568	304568	304568	304568

The table shows regressions of net buys of security *s* by bank *b* at time *t*, as a function of a set of security, macro and bank variables at time t-1. The variable Risk is the yield of the security. The variable Financial Stress is the monthly change in the Euribor-OIS spread. Bank controls include capital, interbank, liquidity, bad loans/total assets and size. In column 1 we include additional controls for the existing portfolio of each bank at the beginning of each month, by including the shares of the bank portfolios invested in different type of securities according to the issuer: Italian government, foreign governments, Italian banks, foreign banks, Italian non-financial corporations, foreign non-financial corporations. In column 2 we add the triple (and double) interactions between Size, Yield and Financial Stress. In column 3 we add the triple (and double) interactions between Capital, Yield and LTRO. In column 4 we add the triple (and double) interactions between Capital, Yield and EONIA. The definitions of the variables are reported in Table A1 in the Appendix. The sample period starts in January 2005 and ends in December 2013. Fixed effects are either included ("Yes") or not included ("No"). Standard errors are triple-clustered at bank, security and time level, and are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table A5: Pre-crisis Capital, TBTF, Additional Fixed Effects and Rating

Dependent Variable:	Net Buys $_{s,b,t}$					
	(1)	(2)	(3)	(4)	(5)	(6)
Capital*Risk*Financial Stress	1.215**	1.198*	1.158**	1.155***	0.822**	
	(0.616)	(0.689)	(0.521)	(0.418)	(0.337)	
Capital*Rating*Financial Stress						-57.400*
						(30.087)
All the Double Interactions	Yes	Yes	Yes	Yes	Yes	Yes
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes
Security*Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	No	Yes	-	Yes	-	Yes
Bank*Time Fixed Effects	No	No	Yes	No	Yes	No
Security*Bank Fixed Effects	No	No	No	Yes	Yes	No
Observations	290074	235181	304536	301627	301601	232315

The table shows regressions of net buys of security *s* by bank *b* at time *t*, as a function of a set of security, macro and bank variables at time t-1. The variable Risk is the yield of the security. The variable Financial Stress is the monthly change in the Euribor-OIS spread. Bank controls include capital, interbank, liquidity, bad loans/total assets and size. In column 1 we fix capital at a pre-crisis level (we take an average of capital between 2005 and the summer of 2007). In column 2 we exclude observations from the three largest Italian banks. In column 3 we include bank*time fixed effects. In column 4 we include security*bank fixed effects. In column 5 we include bank*time and security*bank fixed effects. In column 6 we use rating instead of yield as a measure of riskiness of the security (higher rating means lower risk). The definitions of the variables are reported in Table A1 in the Appendix. The sample period starts in January 2005 and ends in December 2013. Fixed effects are either included ("Yes") or not included ("No") or spanned by another set of effects ("-"). Standard errors are triple-clustered at bank, security and time level, and are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table A6: Supervision: Evidence from Subsample of Better (Higher Median) Capitalized Banks

Dependent Variable:	Net Buys $_{s,b,t}$			
	(1)	(2)	(3)	(4)
Capital*Risk*Financial Stress	1.980**	2.221**	2.842**	2.679**
	(0.904)	(0.951)	(1.252)	(1.257)
Interbank*Risk*Financial Stress	-0.045	-0.023	0.022	0.050
	(0.171)	(0.146)	(0.173)	(0.170)
All the Double Interactions	Yes	Yes	Yes	Yes
Macro Controls	Yes	-	-	-
Bank Controls	Yes	Yes	Yes	Yes
Time Fixed Effects	No	Yes	-	-
Security*Time Fixed Effects	No	No	Yes	Yes
Bank Fixed Effects	No	No	No	Yes
Observations	152173	152173	144683	144683

The table shows regressions of net buys of security *s* by bank *b* at time *t*, as a function of a set of security, macro and bank variables at time t-1. We restrict the sample to observations where capital is larger than the median. The variable Risk is the yield of the security. The variable Financial Stress is the monthly change in the Euribor-OIS spread. Macro controls include changes in Italian unemployment and Consumer Price Index and the variable Financial Stress non-interacted. Bank controls include capital, interbank, liquidity, bad loans/total assets and size. The definitions of the variables are reported in Table A1 in the Appendix. The sample period starts in January 2005 and ends in December 2013. Fixed effects are either included ("Yes"), not included ("No") or spanned by another set of effects ("-"). Standard errors are triple-clustered at bank, security and time level, and are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table A7: Concentration Risks: Dummies of Italian issuers

Dependent Variable:	Net Buys $_{s,b,t}$							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Capital*Italian*Financial Stress	-2.005	-2.261	-1.523	-0.870	1.773	1.497	-0.593	-0.209
	(2.543)	(2.529)	(2.927)	(2.989)	(3.290)	(3.276)	(2.821)	(2.858)
Interbank*Italian*Financial Stress	0.362	0.321	0.307	0.354	0.418	0.434	-0.091	-0.097
	(0.452)	(0.444)	(0.505)	(0.499)	(0.628)	(0.607)	(0.638)	(0.631)
Capital*Italian	0.477	0.504	0.590*	0.553*	0.883	0.972	0.893**	1.120***
	(0.366)	(0.329)	(0.327)	(0.282)	(1.000)	(1.020)	(0.369)	(0.412)
Interbank*Italian	0.033	0.026	0.043	-0.045	-0.183	-0.176	-0.038	-0.059
	(0.062)	(0.059)	(0.052)	(0.070)	(0.277)	(0.271)	(0.065)	(0.067)
Capital*Financial Stress	2.254**	2.074*	2.322*	2.546*	-0.440	-0.289	2.104	1.631
	(0.907)	(1.079)	(1.349)	(1.383)	(2.104)	(2.097)	(2.275)	(2.311)
Interbank*Financial Stress	-0.357	-0.296	-0.209	-0.173	-0.425	-0.413	0.142	0.164
	(0.218)	(0.209)	(0.239)	(0.224)	(0.489)	(0.477)	(0.522)	(0.521)
Macro Controls	Yes	-	-	-	Yes	-	-	-
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	No	Yes	-	-	No	Yes	-	-
Security*Time Fixed Effects	No	No	Yes	Yes	No	No	Yes	Yes
Bank Fixed Effects	No	No	No	Yes	No	No	No	Yes
Observations	304568	304568	304568	304568	304568	304568	304568	304568

The table shows regressions of net buys of security *s* by bank *b* at time *t*, as a function of a set of security, macro and bank variables at time t-1. In the first four columns the Italian dummy is equal to 1 if the issuer of the security is the Italian government and 0 otherwise. In the last four columns the Italian dummy is equal to 1 if the nationality of the issuer of the security is Italian (either corporate or government) and 0 otherwise. The variable Financial Stress is the monthly change in the Euribor-OIS spread. Macro controls include changes in Italian unemployment and Consumer Price Index and the variable Financial Stress non-interacted. Bank controls include capital, interbank, liquidity, bad loans/total assets and size. The definitions of the variables are reported in Table A1 in the Appendix. The sample period starts in January 2005 and ends in December 2013. Fixed effects are either included ("Yes"), not included ("No") or spanned by another set of effects ("-"). Standard errors are triple-clustered at bank, security and time level, and are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1

APPENDIX B

Proofs of Section 4

Proof of Proposition 1. When $b_0 = 0$, the banks' problem is simply to choose the optimal portfolio to maximize value:

$$V_0 = Max_{x \in [0,a_0]} \quad x \cdot E[r] + (a_0 - x) \cdot r_f + V_2$$

And it is straightforward that $x^* = a_0$ if $E[r] - r_f > 0$, $x^* = 0$ if $E[r] - r_f < 0$, and the bank is indifferent when expected returns are equal. On the other hand, if $b_0 \geq \frac{n_0 \cdot r_f + \phi \cdot V_2}{r_b - r_f} \equiv \bar{b}$ the bank defaults with probability one if it does not invest in risky assets. In this scenario, the objective function of the bank increases in x *, as investing in risky projects increases the probability of receiving positive cashflows as it reduces the likelihood of default. Therefore, by continuity of the bank's objective function in debt level b_0 and in portfolio choice x , thresholds $0 \leq \underline{B} \leq \overline{B} < \bar{b}$ exist. Note that $\underline{B} = \overline{B} = 0$ implies that $E[r] \geq r_f$ and that the bank always invests all its assets in the risky project, while $\underline{B} = \overline{B} > 0$ implies that $E[r] \leq r_f$ and that the bank invests all of its assets in the safe project if $b_0 \leq \underline{B}$ and in the risky project otherwise.

Proof of Proposition 2.

First, consider the case of $\underline{B} = \overline{B}$. In this scenario, it is clear that for all $b_0 < \overline{B}$ the bank invests all of its assets in the safe or in the risky projects, and thus the result is trivial, as the bank does not adjust its portfolio in response to a (relatively small) fall in net worth.

Second, consider the more interesting case of $\underline{B} < \overline{B}$, which requires that $E[r] \geq r_f$.

We begin by characterizing the shape of the banks' objective as a function of investment in risky projects. Recall that given b_0 and r_b, the problem of the bank at $t = 0$ is to choose how much to invest in risky projects x to maximize bank value V_0:

$$\max_x \int_{\underline{r}(b,x)}^{\infty} \left[x \cdot (r - r_f) + (n_0 + b_0) r_f + b_0 \cdot r_b + V_2\right] \cdot dF(r)$$

$$s.t\ n_0 + b_0 \geq x \geq 0 \quad (\gamma_u, \gamma_\ell)$$

When $x = 0$, as $b_0 < \overline{b}$ we have that $\underline{r}(b, 0) = 0$ and that

$$V_{0|_{x=0}} = (n_0 + b_0) \cdot r_f + V_2 - b_0 \cdot r_b > 0.$$

Define x^{int} as

$$x^{int} = \max\left\{x \in [0, a_0]: \underline{r\ (b_0, x)} = 0\right\},$$

which is given by

$$x^{int} = \frac{a_0 \cdot r_f + \phi \cdot V_2 - b_0 \cdot r_b}{r_f}.$$

Then we have that $\frac{dV_0}{dx}|_{x<x^{int}} = E[r] - r_f > 0$. At $x = x^{int}$, however, there is a kink in the objective function as:

$$\frac{dV_0}{dx} = \int_{\underline{r}(b_0,x)}^{\infty} \left(r - r_f\right) \cdot dr - (1-\phi) \cdot V_2 \cdot \frac{d\underline{r}}{dx}$$

And the $\lim_{\hat{x}\downarrow x^{int}} \frac{d\underline{r}}{dx}|_{\hat{x}} = \frac{a_0 \cdot r_f + \phi \cdot V_2 - b_0 \cdot r_b}{\left(x^{int}\right)^2} > 0$, but it is equal to zero for $x < x^{int}$. Moreover, for $x > x^{int}$, the objective function is convex as:

$$\frac{dV_0^2}{dx^2}|_{x>x^{int}} = -\left(\underline{r}(b,x) - r_f\right) \cdot \frac{d\underline{r}}{dx} - (1-\phi) \cdot V_2 \cdot \frac{d^2\,\underline{r}}{dx^2} > 0$$

as $\underline{r}(b, x) - r_f < 0$ for $b_0 < \overline{b}$ and $\frac{d^2\underline{r}}{dx^2} < 0$. It follows that there are two possible solutions to the bank's problem: $x^* = x^{int}$ or $x^* = a_0$.

Note that $x^{int} < a_0$ requires $b_0 r_b - \phi V_2 > 0$, otherwise it fall into the case $\underline{B} = \overline{B}$.

$$V\left(x^{int}\right) - V(a_0)$$

$$= \left(\frac{a_0 r_f + \phi V_2 - b_0 r_b}{r_f}\right)\left(E[r] - r_f\right) + a_0 r_f - b_0 r_b + V_2 - \int_{\underline{r}(b_0,a_0)}^{\bar{R}} a_0 r\, dF(r)$$

$$- \left(1 - F\left(\underline{r}(b_0, a_0)\right)\right)(V_2 - b_0 r_b)$$

$$= a_0 \int_0^{\underline{r}(b_0,a_0)} r\, dF(r) - (b_0 r_b - \phi V_2)\left(\frac{E[r]}{r_f} - 1\right) + F\left(\underline{r}(b_0, a_0)\right)(V_2 - b_0 r_b)$$

$$= (b_0 r_b - \phi V_2)\left(\frac{(2-\phi)V_2 - b_0 r_b}{2a_0\bar{R}} - \left(\frac{E[r]}{r_f} - 1\right)\right)$$

As $b_0 r_b - \phi V_2 > 0$, the sign is determined by the second term, hence $V(x^{int}) - V(a_0) > 0$ when:

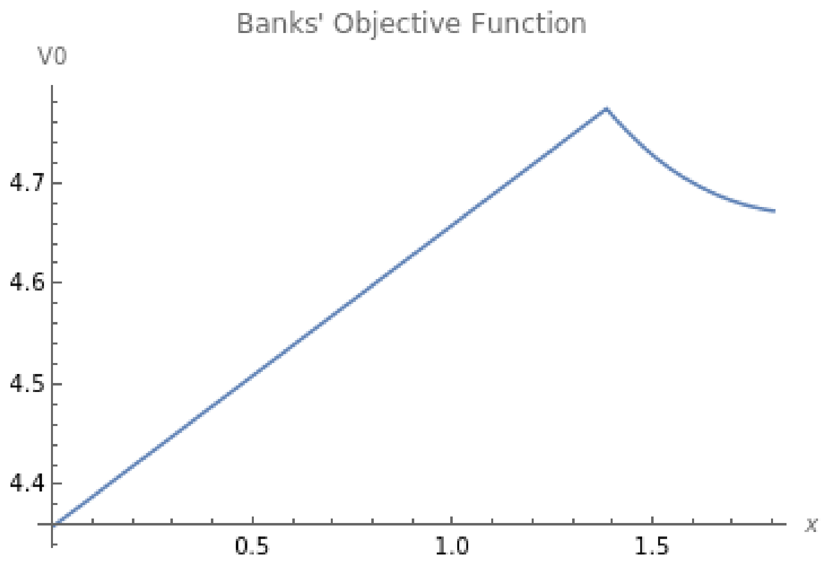
$$\frac{(2-\phi)V_2 - b_0 r_b}{2(n_0 + b_0)\bar{R}} - \left(\frac{E[r]}{r_f} - 1\right) > 0$$

$$b_0 < \frac{(2-\phi)V_2 r_f - 2n_0\bar{R}\,(E[r] - r_f)}{r_b r_f - 2\bar{R}(E[r] - r_f)} := \xi$$

Hence for $b_0 \in (\frac{\phi V_2}{r_b}, \xi)$ the bank's optimal choice is x^{int}, and for $b_0 > \xi$ the optimal choice is a_0, hence ξ identifies the threshold $\bar{B}$. Moreover, when $b_0 < \frac{\phi V_2}{r_b}$, the bank can always rollover debt and never defalts, hence it will choose the highest NPV project. Hence $\frac{\phi V_2}{r_b}$ defines the threshold $\underline{B}$, which is not affected by n_0.

With this, the result follows straightforwardly: as long as $b_0 < \bar{B}$ the bank responds to a negative shock in net worth by decreasing its exposure to risk as $\frac{d\,x^{int}}{d\,n_0} > 0$. Note that when n_0 descreases $\bar{B}$ increases. Finally, it is clear that $\bar{B}$ is increasing in V_2.

Finally, it can be shown numerically that for a large range of parameter values $V_0(x^{int}) - V_0(a_0) > 0$ see for example the following illustration of the value funcion as a function of x:



Which is computed for $b_0 = 0.8;\ n_0 = 1;\ r_f = 1.2;\ r_b = 1; \phi = 0.1;\ V_2 = 3;\ X = 3$. Next, to conclude that the solution goes from x^{int} to $x = a_0$ as b_0 in creases (and does not jump back), it remains to show that $V_0\left(x^{int}\right) - V_0(a_0)$ increases and is concave in b_0

$$\frac{d\left(V_0\left(x^{int}\right) - V_0(a_0)\right)}{db_0}$$

$$= \left(r_f - r_b\right) \cdot \frac{E[r]}{r_f}$$

$$-\left(\int_{\underline{r}(b_0,a_0)}^{\infty} (r - r_b) \cdot dF(r) - (1-\phi) \cdot V_2 \cdot \frac{d\underline{r}(b_0,a_0)}{db_0} \cdot f\left(\underline{r}(b_0,a_0)\right)\right)$$

$$\frac{d^2\left(V_0\left(x^{int}\right) - V_0(a_0)\right)}{db_0^2} =$$

$$= -\left(-\left(\underline{r}(b_0,a_0) - r_b\right)\right) \cdot \frac{d\underline{r}(b_0,a_0)}{db_0} \cdot f\left(\underline{r}(b_0,a_0)\right) - (1-\phi) \cdot V_2 \cdot \frac{d\underline{r}^2(b_0,a_0)}{db_0^2} \cdot f\left(\underline{r}(b_0,a_0)\right) < 0$$

as $\underline{r}(b_0,a_0) < r_b$, $f\left(\underline{r}(b_0,a_0)\right) = \frac{1}{R}$, and:

$$\frac{d\underline{r}(b_0,a_0)}{db_0} = \frac{n_0 \cdot r_b + \phi \cdot V_2}{(b_0 + n_0)^2} > 0$$

$$\frac{d\underline{r}^2(b_0,a_0)}{db_0^2} = -2\,\frac{n_0 \cdot r_b + \phi \cdot V_2}{(b_0 + n_0)^3} < 0$$