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Securities Trading by Banks and Credit Supply: Micro-Evidence

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Abstract

We analyze securities trading by banks and the associated spillovers to the supply of credit. Empirical analysis has been elusive due to the lack of securities register for banks. We use a unique, proprietary dataset that has the investments of banks at the security level for 2005-2012 in conjunction with the credit register from Germany. Analyzing data at the security level for each bank in each period, we find that during the crisis, banks with higher trading expertise increase their overall investments in securities, especially in those that had a larger price drop. The quantitative effects are largest for trading-expertise banks with higher capital and in securities with lower rating and long-term maturity. In fact, there are no differential effects for triple-A rated securities. Moreover, banks with higher trading expertise reduce their overall supply of credit in crisis times – i.e., for the same borrower at the same time, trading-expertise banks reduce lending relative to other banks. This effect is more pronounced for trading-expertise banks with higher capital, and the credit reduction is binding at the firm level. Finally, these differential effects for trading-expertise banks are not present outside the crisis period.

JEL codes: G01, G21, G28.
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1. Introduction

The role of securities trading by banks has assumed significant importance in the modern financial system (Langfield and Pagano, 2014). Commercial banks today hold a significant amount of securities in their asset portfolios (e.g., 20% in the US and 19% in Germany). In the aftermath of the financial crisis, there is considerable debate both in academic and policy circles about the implications of securities trading by banks for credit supply and securities markets. A recurrent argument is that during the crisis, banks' securities trading activities led to a reduction in credit supply (Stein, 2013).[1] Moreover, there have been several policy initiatives to impose restrictions on banks' trading activities (the Volcker rule in the US, the Liikanen Report in the EU, and the Vickers Report in the UK). However, empirical analysis is scant due to the lack of comprehensive micro datasets on securities holdings by banks in conjunction with bank credit – i.e., both security and credit registers for banks. In this paper, we empirically analyze securities trading by banks and the associated spillovers to the supply of credit to the real sector.

On the theoretical front, there is a growing literature that analyzes the role of securities trading by banks and its implications for credit supply and securities markets. Diamond and Rajan (2011) show that during a crisis, fire sales in securities markets can lead banks that have higher expertise in securities trading to increase their investment in securities and reduce the supply of credit to the real sector. In effect, they argue that in the presence of funding constraints, banks with trading expertise may reduce credit supply as they withdraw funds from lending to profit from trading opportunities. Shleifer and Vishny (2010) show that during a crisis, as a result of fire sales in securities markets, the returns from investing in distressed securities are higher than the returns from lending. In sum, these theories highlight an externality, from security investments of banks during a crisis to a reduction in the supply of credit to the real sector.

Despite the importance for theory and policy of understanding banks' securities investments during a crisis and its implications for credit supply, the empirical analysis has

[1] "*Adverse spillovers from a fire sale of this sort may also take the form of a credit crunch that affects borrowers more generally. Such a credit crunch may arise as other financial intermediaries (e.g., banks) withdraw capital from lending, so as to exploit the now-more-attractive returns to buying up fire-sold assets. Ultimately, it is the risk of this credit contraction, and its implications for economic activity more broadly, that may be the most compelling basis for regulatory intervention*" Jeremy C. Stein, Governor of the Federal Reserve Board.

been elusive. The main constraint that has hampered empirical research is the lack of comprehensive micro data at the security level on banks' trading activities. Comparing aggregate data on banks' securities holdings does not present a precise, clear picture of investment behavior as it does not take into account the time-varying, unobservable heterogeneity in security characteristics (e.g., risk, liquidity, outstanding volumes, etc.).[2]

In this paper, we use a unique, proprietary dataset from the Bundesbank (the German central bank) that provides information on *security-level* holdings for all banks in Germany, a bank-dominated system, at a quarterly frequency for the period between 2005 and 2012. Each security is also matched with security-level information, notably price, rating, coupons, and maturity. Importantly, not only do we have the security-level holdings of each bank, but also the credit register containing information on the individual loans made by banks. The security and credit registers are matched with comprehensive bank balance sheet information.

The main testable hypothesis, which we motivate in the paper with a simple, stylized theoretical model, is that during a crisis, banks with higher trading expertise will increase their investments in securities, especially in securities that had a (larger) price drop, to profit from the trading opportunities, thereby withdrawing funds from lending. To examine this channel, we first examine the investment behavior of banks that are most active in securities markets. The idea being that banks that are generally active in securities markets are better at identifying trading opportunities during a crisis, as compared to other banks that do not routinely engage in high levels of securities trading. To proxy for active presence and expertise in securities markets, we use membership of banks to the largest fixed-income trading platform in Germany (Eurex Exchange), as banks that trade actively would have direct membership rather than use an intermediary. We also further analyze heterogeneous effects based on bank capital and security characteristics, notably rating and maturity.

For identification, we analyze the data at the *security-quarter-bank* level and include *security*time* fixed effects to account for the unobserved time-varying heterogeneity across securities, e.g., risk, liquidity, outstanding volumes, etc. Thus, we

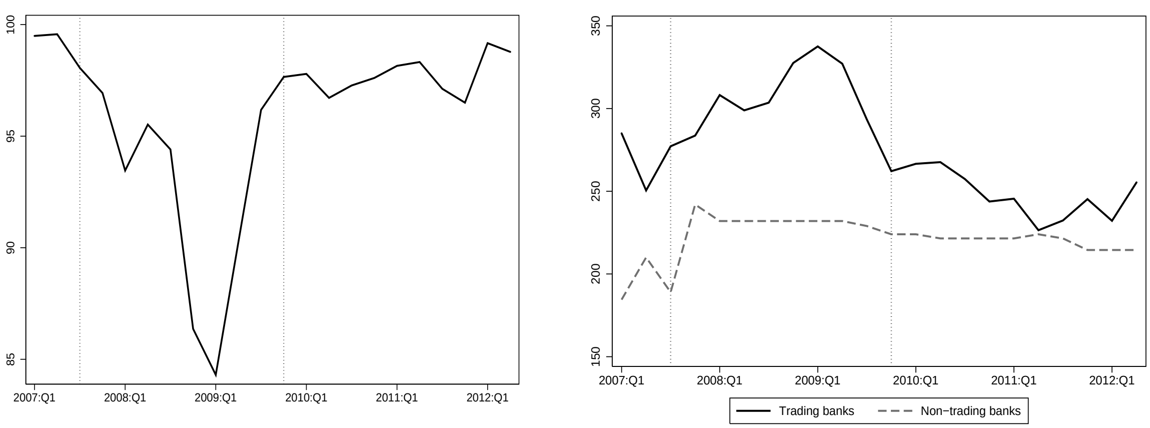
[2] Aggregate data may show that two banks have very similar overall level of security investments, however, risk, maturity, coupons, and other characteristics of these securities could be very different. Moreover, in crisis times, as some securities are more affected than others (even within a same rating category), comparison of bank holdings even within the same rating category using aggregate data becomes difficult.

examine the changes in level of holdings for the same security at the same time by different banks. Furthermore, to isolate compositional effects (based on security price changes), we can include bank*time (or bank) fixed effects to control exhaustively for time-varying heterogeneity across banks. Finally, we identify the associated lending behavior of banks by analyzing borrower-quarter-bank level data and controlling for time-varying, unobserved firm fundamentals that proxies for credit demand using borrower*time fixed effects (see, e.g., Khwaja and Mian, 2008). Thus, we compare lending by different banks to the same firm during the same time period.

In crisis times, we find that banks with higher trading expertise ("trading banks") increase their level of security investments as compared to other banks ("non-trading banks").[3] Trading banks especially buy more of the securities that had a larger drop in price. Moreover, the investment in securities that had a larger drop in price is primarily concentrated in lower-rated and long-term securities.

FIGURE 1[4]

(a) Market price of a seven-year JP Morgan note (b) Securities holdings of the seven-year JP Morgan note



The investment behavior of banks can be illustrated by the following example. One can see from Figure 1 (left panel) that after the failure of Lehman Brothers in September

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[3] For trading banks, securities as a fraction of total assets increases from 19% in the pre-crisis period to 23% during the crisis, whereas there is no significant change for non-trading banks. Note that securities as a fraction of total assets for non-trading banks are not trivial (18% on average), though these banks buy and sell a substantially lower fraction of their securities in each period as compared to trading banks. We define the crisis period starting in the third quarter of 2007, when banking problems surfaced, to the last quarter of 2009, when Germany came out of the economic recession. The results are not sensitive to the way we define crisis period.

[4] Subfigure (a) shows the monthly price development of the seven-year JP Morgan medium-term floating rate note. Subfigure (b) depicts the euro-denominated holdings (in millions) of this security by trading banks and non-trading banks. The first vertical line refers to the start of the financial crisis in 2007:Q3, and the second vertical line denotes 2009:Q4, the end of the crisis in Germany.

2008, there is a sharp drop in the price of JP Morgan medium-term note (falls from 100 to 85 Euro cents). Around this period, German banks with higher trading expertise increase their holdings of this JP Morgan note (right panel). After the price rebounds back to 100 over the subsequent quarters, they reduce their holdings.[5] In contrast, other banks do not increase their holdings around the Lehman crisis (dashed line).

While trading banks in general buy more of securities that had a larger fall in price, we also find that the capital level of banks plays an important role. The level of investments in securities is increasing in the level of capital for trading banks. Furthermore, trading banks with a higher level of equity capital buy a greater volume of securities that had a larger price drop in the previous quarter. We then examine how these effects vary based on credit ratings and maturity. We find the strongest quantitative impact of capital on investments for securities with credit ratings below triple-A and with residual maturity higher than one year. In fact, we do not find differential effects for triple-A rated securities. These effects are robust to inclusion of bank*time fixed effects that control for overall time-varying heterogeneity in bank characteristics.

Moreover, we also find that the prices of securities revert over the subsequent quarters. Thus, trading banks invest more in securities with higher ex-ante yield (proxied by previous fall in price, especially in securities with lower ratings and long-term maturity) and obtain higher ex-post returns. Finally, during the crisis we do not find any significant differences in selling behavior across securities that had a larger drop in price, either based on trading expertise or on the level of bank capital. We also find that banks sell more of securities where they have higher accumulated losses. This effect is more pronounced for non-trading banks with a higher level of capital.

While we find that trading banks invest more in securities that had a larger price drop, a crucial question that arises is whether this has any spillovers on the supply of credit to the real economy. One could be concerned that trading banks lend to corporate borrowers who have different fundamentals such as risk, size, and growth opportunities. We use borrower*time fixed effects to control for time-varying, unobserved borrower fundamentals that proxies for credit demand. Thus, we examine – at the same time for the same borrower – whether there is differential lending behavior by banks based on their

[5] See also Figure A1 in the Appendix for investments in Greek government bonds by trading and non-trading banks. We find increasing investments by trading banks in these securities at the point when CDS spreads of Greece were widening.

trading expertise. In addition, given that for trading banks, capital significantly affects the level of securities investment, we also examine whether the level of bank capital matters for the supply of credit to firms.

We find that trading banks decrease their supply of credit to non-financial firms during the crisis as compared to other banks – i.e., for the same borrower at the same time, trading banks reduce lending relative to other banks. Furthermore, there is a larger drop in credit supply by trading banks with a higher level of capital. That is, for trading banks, a higher level of capital is associated with a larger reduction in lending as compared to other banks. These results are the mirror opposite of results for security investments by banks with trading expertise.[6]

The results are robust to the inclusion of bank*firm fixed effects (in addition to firm*time fixed effects) to account for time-invariant bank characteristics and bank-firm relationships.[7] In addition, controlling for accumulated gains/losses on banks' existing securities portfolio (which controls for potential hangover of losses on existing investments or profits from trading in the crisis) does not alter the results. In fact, we find that banks with higher unrealized gains on existing investments lend less than other banks. The previous finding and the finding that trading banks with a higher level of capital decrease their lending by more while investing more in securities that had a larger drop in price are more consistent with the securities channel crowding out credit rather than the accumulated losses channel.[8]

We also do not find any differences in the subsequent default rates for borrowers between trading and non-trading banks. Thus, there is no differential risk-taking in terms of lending associated with banks based on trading expertise. Moreover, the results on credit availability are binding at the firm level, which suggests that firms cannot compensate for

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[6] As discussed later in the model, and also in other papers cited in this Introduction, during a crisis, in the presence of funding constraints, increasing investment in securities by some banks can lead to a reduction in credit supply by these banks.

[7] We also find that the main bank coefficient is almost identical in value (and statistically not different) if we do not control for borrower*time fixed effects, despite that the R-squared decreases by almost 40 points. This suggests that the covariance between bank characteristics (trading and capital) and unobserved firm fundamentals is zero.

[8] If hangover of losses on existing investments was the main reason for lower credit supply, one would expect the overall effect of trading banks on credit reduction to be smaller (not higher) for banks with a higher level of capital, and that banks with unrealized losses on investment to lend less (not more).

the reduction in credit by trading banks with credit from other banks.[9] Note also that credit from trading banks constitutes an important fraction of the total lending in the economy and, therefore, our results could have important macro effects. Finally, in contrast to the crisis, in the pre-crisis and post-crisis periods, all the main effects of trading versus non-trading banks are not present for credit and investments.[10]

We examine several potential alternative channels (see robustness section) and find that the above results are most consistent with trading banks increasing their investments in securities during the crisis to profit from the trading opportunities, which results in crowding out of credit supply by five percentage points.[11] We find that the average realized returns (annualized) on investments made, especially after the failure of Lehman Brothers, are approximately 12.5% over the next year.[12] The finding that banks with higher capital buy more of securities that had a larger price drop is consistent with these banks having higher risk-bearing capacity to absorb negative shocks in case the price of securities drops below their purchase price.

Our results contribute to the literature that shows that securities trading by banks during a crisis can affect credit supply (Shleifer and Vishny, 2010; Diamond and Rajan, 2011). Given that we find that banks with higher trading expertise withdraw funds from lending, our results also contribute to the literature that analyses liquidity provision by private intermediaries to firms and the role of government intervention (Holmstrom and Tirole, 1998). In addition, our results also contribute to theories that highlight strong synergies between the assets and liabilities of banks (Diamond and Dybvig, 1983; Diamond and Rajan, 2001; Kashyap, Stein, and Rajan, 2002; Gennaioli, Shleifer, and Vishny, 2013;

[9] Some of the largest firms could substitute credit with debt securities, though evidence using our dataset on fixed-income securities does not support this. Note that Germany is a bank-dominated system with bank credit being the main source of finance.

[10] While we find that trading banks buy and sell more of securities in the pre-crisis and post-crisis periods, they do not increase their overall investments in securities as a fraction of total assets. This is consistent with the idea that, in general, when security prices are not very depressed (and also when funding constraints are not binding), there is no significant crowding out of lending due to securities investment.

[11] In the periodic survey conducted by ECB, most banks reported funding constraints as an important factor affecting banking operations mainly in the middle of the crisis.

[12] See Figure 4. As discussed later, we compute realized returns in several different ways and find magnitudes between 12% and 15%. We also find that trading banks report higher net profits and income from trading, which suggests that these trading activities are not a part of a hedge. Moreover, though we do not have the loan rate at the loan level, the average loan rate in our credit data was approximately 5% during the crisis, thus significantly lower than the return on securities by banks.

Hanson, Shleifer, Stein, and Vishny, 2014).[13] Our results highlight these synergies as banks with a higher level of capital (stronger liabilities) buy riskier securities in the crisis (securities that had a larger drop in price, especially those with long-term maturity and lower rating).

Given our findings on bank capital and securities trading, our results are consistent with models of financial intermediation where the capital level of banks affects asset demand (Xiong, 2001; Gromb and Vayanos, 2002; Brunnermeier and Pedersen, 2009; Adrian and Shin, 2010; He and Krishnamurthy, 2013; Brunnermeier and Sannikov, 2014). Our results suggest that in a crisis, the capital level of banks plays an important role in their investments in securities markets. Our results suggest that trading banks with higher capital can buy more of the securities that had a larger drop in price, especially lower-rated and long-term securities, as higher equity capital provides buffers to absorb potential negative shocks in these riskier securities. Moreover, the results are also consistent with models of fire sales and lack of arbitrage capital (Shleifer and Vishny, 1992, 1997; Allen and Gale, 1994, 1998, 2005; Duffie, 2010; Acharya, Shin, and Yorulmazer, 2013).

Our results also add to the literature that examines investment behavior of banks in sovereign debt during the European sovereign crisis (Acharya and Steffen, 2014; Battistini, Pagano, and Simonelli, 2014; Drechsler et al., 2014).[14] The main focus of these papers is to examine risk-shifting incentives and financial repression by euro area governments.[15] One limitation of these papers is that they only have data on investments in sovereign securities in some particular periods or only collateral posted by the banks with the European Central Bank. In addition, these papers do not focus on credit supply during the crisis.

Finally, our results also contribute to the literature that examines the effects on credit supply during a crisis (see e.g. Ivashina and Scharfstein, 2010; Iyer et al., 2014;

[13] Hanson et al. (2014) analyze synergies between bank assets and liabilities and argue that safer financial institutions with stronger liabilities (e.g., banks with higher capital) have a comparative advantage in crisis times at holding relatively illiquid, fixed-income assets with substantial transitory price volatility.

[14] See also Becker and Ivashina, 2015 for evidence on search for yield by insurance companies.

[15] These papers examine sovereign debt investments of banks during the sovereign debt crisis (corresponding to the post-crisis period in our data). Acharya and Steffen (2014) find that weakly capitalized banks increase their investments in risky sovereign debt consistent with risk shifting and moral suasion (using a sample of euro area banks). Drechsler et al. (2014) examine the collateral posted by banks in the euro area to avail liquidity from ECB and find evidence consistent with risk-shifting incentives of weakly capitalized banks. Note, however, that these papers do not find risk-shifting behavior in the period after the failure of Lehman Brothers. We instead find that the banks that buy securities that had a larger price drop (especially securities with lower rating and long-term maturity) are the banks with higher capital, although these results are mainly for the 2008-2009 period.

Jiménez et al., 2012, 2014). These papers document a decrease in lending by banks during the crisis, especially those banks more exposed to the shock. To the best of our knowledge, we are the first paper that uses detailed data on both security investments and credit – i.e., a security register and a credit register – which are crucial for comprehensive empirical analysis of the trading behavior of banks in the crisis and the associated effects on the supply of credit to the real sector.

The remainder of the paper is structured as follows. Section 2 presents the data and the testable hypotheses using a stylized theoretical model. Section 3 presents the estimation approach and discusses the results. Section 4 concludes.

2. Data and hypotheses

In this section we present the data and a simple model to guide the empirical analysis.

2.1. Data

We use the proprietary security and credit registers from the Deutsche Bundesbank, which is the micro and macro-prudential supervisor of the German banking system.[16] We have access to the micro data on securities investments of banks (negotiable bonds and debt securities, equities, and mutual fund shares) at the security level for each bank in Germany, on a quarterly frequency from the last quarter of 2005 to the last quarter of 2012.[17] For each security, banks report the notional amount they hold at the end of each quarter (stock of individual securities at the end of each quarter). We use the unique International Security Identification Number (ISIN) associated with every security to merge the data on security investments with (i) the Eurosystem's Centralized Securities Database (CSDB) to obtain further information regarding the issuer of the security (domicile country and sector); (ii) Bloomberg to obtain price data (nominal currency, market price);[18] (iii) FactSet to obtain security-level information on rating, coupons, and maturity. Moreover, we supplement this database on security investments with confidential supervisory monthly balance sheet

[16] For micro-prudential regulation the responsibilities are shared with 'BaFin'.

[17] The reporting requirement specifies that securities holdings, which are passed on or acquired as part of a repo contract, are not double-counted in the securities database. Thus, the transactions captured in analysis are not a mechanical artifact of repo transactions. Also, securities holdings of banks in special purpose vehicles are not reported, as these are off-balance sheet items.

[18] We verified the accuracy of the price data from Bloomberg for a subset of securities using the price data that is reported by CSDB.

statistics at the bank level. In particular, we collect monthly balance sheet items such as each bank's equity capital, total assets, Tier 1 capital ratio, interbank borrowings, and savings deposits.

Finally, we obtain data on individual loans made by banks from the German credit register maintained by the Deutsche Bundesbank. Banks must report on a quarterly frequency all borrowers whose overall credit exposure exceeds EUR 1.5 million. Note that lending to small and medium-sized firms is not fully covered by this dataset. However, the credit register covers nearly 70% of the total credit volume in Germany. The credit register provides information on the amount of loans outstanding at the borrower level for each bank. In addition, it also provides information on the date of default (where applicable). The credit register, however, does not record the maturity and interest rate associated with the loans.

The complete securities holdings data consists of all securities held by 2,057 banks in the German banking system. We prune this data as follows. We consider only debt securities and exclude equities and shares of mutual funds. As a fraction of total holdings of securities, fixed income securities comprise 99% of the investments. Then, we delete the securities for which the total holdings for the entire banking sector were below EUR 10 million.[19] The resulting set of securities comprise 95% of the total holdings. We also exclude from the analysis banks with total assets below EUR 1 billion. In addition, we exclude Landesbanks and mortgage banks from the analysis.[20] The final sample consists of 504 banks holding 89% of the securities holdings of the total banking system.

2.2. Hypotheses

Before we present the results, and as a complement to the theoretical papers we highlighted in the Introduction, we present a simple model to guide the empirical analysis. The main intuition behind the model is the following. In a crisis, when the expected returns from investing in securities are high, banks with higher trading expertise invest more in securities and cut back on credit in the presence of funding constraints (see Diamond and

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[19] We do this for computational reasons. These securities also account for a very small fraction of the overall asset holdings. We also drop banks below EUR 1 billion in total assets. These banks are generally not active in securities markets and account for a small fraction of the aggregate securities holdings and credit.

[20] Landesbanks are (at least partly) owned by the respective federal state and thus considered to enjoy an implicit fiscal guarantee. Law prohibits mortgage banks to engage in (risky securities) investments. The results are robust to including these banks in the sample.

Rajan, 2011; Shleifer and Vishny, 2010).[21] In addition, trading banks with higher risk-bearing capacity (higher capital ratio) will invest even more in securities and further decrease the supply of credit (much in line with He and Krishnamurthy, 2013). We now proceed to a more detailed exposition.

Assume a two-period world with one security that has random returns. We denote the security's price at $t = 0$ as P_0. At $t = 1$, P_1 can be either S_H or S_L, with probability $1/2$ (without loss of generality, we assume $S_H > S_L$). Banks receive a private signal at $t = 0$ regarding the price of the security at $t = 1$. The signal can have two values: σ_H and σ_L. We assume that the signal is informative: $\Pr(\sigma = \sigma_H \mid S_H) = \theta = \Pr(\sigma = \sigma_L \mid S_L) > 1/2$. We interpret the precision of the signal, θ, as the "trading expertise" of banks. That is, banks that have trading expertise receive signals with lower noise.

After receiving the private signal, banks decide on how much to invest in securities at the given price P_0. If a bank receives a good signal, σ_H, then it buys n units of this security (otherwise the bank does not buy any unit of the security). If the price of the security at $t = 1$ is S_H, the bank obtains the amount $n(S_H - P_0)$. The probability of this event happening is $\Pr(S = S_H \mid \sigma = \sigma_H) = \theta$. The bank also obtains $n(S_L - P_0)$ with probability $1 - \theta$.

The bank's optimization problem can be summarized as follows:

$\max_n n(\theta S_H + (1-\theta)S_L - P_0) - \frac{1}{\tau} Var\left(n(\hat{S} - P_0)\right) + g(L)$ subject to the following funding constraint: $P_0 n + L \leq W$

where n is the amount invested in securities, L is the credit supplied to the real economy, and W is the available funding. The first part of the objective function is the expected return of the risky security, the second part is the variance of this return, and the last part, $g(L)$, is the payoff from the lending investment. τ can be interpreted as the risk-bearing capacity of the bank, which can come from capital constraints stemming from the market or regulation or from risk aversion (see He and Krishnamurthy, 2012, 2013). We assume that the budget constraint W in the model is binding during a crisis – i.e., banks cannot easily

[21] The assumption is that expertise is required to identify profitable trading opportunities in securities market during the crisis. See also Gorton and Metrick (2012) and Dang, Gorton and Holmstrom (2013) for papers that argue about breakdown in trading of debt securities during a crisis due to lack of expertise to evaluate the quality of the debt securities.

raise more funds to invest.[22] Therefore, banks need to choose how much of their funds (W) to allocate to investments in securities ($P_0 n$) and how much to allocate to lending (L).

The first order condition, assuming that the funding constraint is binding, is:

$\theta S_H + (1-\theta)S_L - P_0 - \frac{2n}{\tau}(1-\theta)\theta(S_H - S_L)^2 + g'(W - P_0 n) = 0$. Solving for the optimal n[23]: $n^* = \frac{\tau}{2}\frac{\theta S_H + (1-\theta)S_L - P_0(1+c)}{(1-\theta)\theta(S_H - S_L)^2}$ and $L^* = W - P_0 n^*$

Given these optimality conditions, we obtain the following testable predictions:

Proposition 1: $\frac{\partial n^*}{\partial \theta} > 0$, $\frac{\partial L^*}{\partial \theta} < 0$. *Banks with higher trading expertise have higher investment in securities and reduce the supply of credit as compared to banks with lower trading expertise.*

Proposition 2: $\frac{\partial^2 n^*}{\partial \theta \partial \tau} > 0, \frac{\partial^2 L^*}{\partial \theta \partial \tau} < 0$. *The trading ability and risk-bearing capacity reinforce each other with regard to investment in securities and consequently, this implies further reduction in credit supplied. Thus, the effects are reinforced with higher bank capital.*

Proposition 3: $\frac{\partial n^*}{\partial P_0} < 0, \frac{\partial L^*}{\partial P_0} > 0$. *A decrease in the initial security price (increases in expected return) increases the overall investment in securities and decreases lending.*[24]

Proposition 4: $\frac{\partial^2 n^*}{\partial P_0 \partial \tau} < 0$, $\frac{\partial^2 n^*}{\partial P_0 \partial \theta} < 0$, $\frac{\partial^2 L^*}{\partial P_0 \partial \tau} > 0$, $\frac{\partial^2 L^*}{\partial P_0 \partial \theta} > 0$. *The effects described in Proposition 3, both in terms of securities investments and lending, are stronger for banks with higher trading expertise and higher risk-bearing capacity.*

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[22] In the periodic survey conducted by ECB, most banks reported funding constraints as an important factor affecting banking operations in the middle of the crisis.

[23] To derive this equation, we have assumed linear loan returns: $g(L) = cL$. We have assumed that loans are riskless with constant returns to scale (marginal profit equals c). Note that as long as the volatility of a loan portfolio is sufficiently low with respect to the volatility of securities' returns, the main propositions would hold. Note also that we take prices and returns as given in the model and ignore other equilibrium considerations. We also assume that capital and level of funding constraints are independent (see, e.g., He and Krishnamurthy, 2013, and Brunnermeier et al., 2012, for models that relate both).

[24] To get this relation, one needs to further assume that gross returns from investing in securities are below twice of those from investing in loans ($(\theta S_H + (1-\theta)S_L)/P_0 < 2(1+c)$). To obtain an interior solution, we also need $0 \leq n^* \leq W/P_0$. The first condition, $0 \leq n^*$, is satisfied as long as the return in securities is higher than the return in lending: $\theta S_H + (1-\theta)S_L - P_0 \geq P_0 c$. The second condition only states that the bank needs to have enough funds to finance its investment in securities. In other words, the returns from securities investments need to be higher than those from lending so that there is positive investment in securities, but not too high so that there is still some lending.

It is important to highlight that the negative externality from securities investment by banks to lending relies on three features: (1) an increase in expected returns from investing in securities; (2) funding constraints; and (3) securities markets and lending markets have some degree of segmentation (i.e., that loan rates do not adjust immediately to be equal to security returns). See Stein (2013) and Diamond and Rajan (2011) for a discussion of the externalities.[25]

To examine whether the testable predictions of the model are borne out in the data, we analyze the crisis, when there was a sudden shock to the securities markets and there were constraints to bank funding. We first analyze security investments by banks with higher trading expertise and examine how it varies based on their level of capital. In particular, we examine investments in securities that were most affected by the crisis, i.e. those had a large drop in price. Moreover, we identify the associated lending behavior of trading banks and the effects based on their level of capital. Finally, we analyze these results outside the crisis period when securities markets were less volatile and funding constraints were lower.

3. Results

In this section, we first discuss the summary statistics. We then present the equations that we use for the estimation along with the results for both the securities and credit analyses. Finally, we discuss other potential alternative channels and further robustness.

3.1. Summary statistics and initial results

Table 1, Panel A, presents the summary statistics of the portfolio holdings of banks with (higher) trading expertise decomposed into three subsamples covering the key time periods. We denote the period from 2005:Q4 until 2007:Q2 as the pre-crisis period, while we define the subsample 2007:Q3 – 2009:Q4 as the crisis period.[26] Since 2009:Q4 is the last quarter with year-to-year negative GDP growth in Germany, we refer to the period thereafter as the post-crisis sample. To empirically proxy for trading expertise of banks, we

[25] Note that it is also difficult for banks to increase interest rates substantially to compensate for the returns from security investments due to the risk of adverse selection and moral hazard that arise in lending (Stiglitz and Weiss, 1981).

[26] For references that the financial crisis starts in Europe in 2007:Q3, see Iyer et al. (2014) and the references therein.

create a dummy that takes the value of one when a bank has membership to the largest fixed-income trading platform in Germany (Eurex Exchange).[27] The idea is that banks that are generally more active and with higher expertise in securities trading will have membership to the trading platform rather than using an intermediary. Supporting this classification, we find that banks with trading expertise buy and sell a significantly larger fraction of securities (relative to other banks reported in Panel B of Table 1). Both the amount of securities bought and sold (as a fraction of total assets) are consistently larger for banks with trading expertise across all the periods.

Interestingly, looking at the securities to total assets, we find that trading banks increase their securities holdings in the crisis period. The fraction of securities to total assets goes up from 19% in the pre-crisis period to 23% during the crisis and then comes down to 22% in the post-crisis period. We do not find any significant difference for non-trading banks (from 18% to 19%).[28] Thus – unconditionally – trading banks on average increase their securities holdings in the crisis period.

While the securities holdings of trading banks increase during the crisis, loans as a fraction of total assets decreases. From the pre-crisis level of 67%, it decreases to 64% in the crisis. In contrast, for the non-trading banks, loans as a fraction of total assets increases from 69% to 70%. Note that, in general, the quality of loans in Germany was not bad and also Germany had a faster recovery from the crisis as compared to other European countries.[29]

All in all, the summary statistics reported above suggest that trading banks increase their overall level of security investments in the crisis and decrease credit. These patterns appear clearly in the data – i.e., comparing only trading banks across the pre-crisis and crisis period, or comparing trading versus non-trading banks in the crisis period with respect to the pre-crisis period.

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[27] Eurex Exchange is a German trading platform for bonds, repo, and other alternative asset classes.

[28] Note that our classification does not exhaust the entire set of banks that have trading expertise. Thus, it is possible that there are other banks in the group classified as non-experts that also have trading ability. This classification bias should reduce the likelihood of us finding any significant differences across the two groups.

[29] The average default rate on loans at the peak of the crisis was 1.1%. Some of the German banks (mainly Landesbanks) experienced problems due to investments in securities originated by banks from other countries and not from defaults arising from loans to German borrowers. As discussed earlier, we exclude Landesbanks from the main analysis.

A very similar picture also emerges from a graphical representation of the main variables of interest. Figure 3 presents the investments in securities by trading banks as compared to non-trading banks. Trading banks invest more in securities, especially during the crisis period. Furthermore, in line with Figure 1 (discussed earlier in the introduction) there is a sharp spike in their security investments in the period after the failure of Lehman Brothers. In contrast, an opposite picture emerges when we look at credit growth (Figure 4). We see that during the crisis, trading banks decrease their credit growth relative to non-trading banks.

Examining the composition of securities holdings of banks, we see that for trading banks, the fraction of triple-A securities to total securities holdings decreases from 49% in the pre-crisis period to 37% in the crisis and then increases to 55% in the post-crisis period; instead, for non-trading banks, the fraction of triple-A securities remains stable at around 44% across the three different periods. Therefore, there are substantial differences in composition of securities across different ratings for trading and non-trading banks. In particular, trading banks not only substantially increase their overall securities holding during the crisis, but they add more of non-triple-A securities.

For trading banks, the ratio of long-term securities goes up from 71% in the pre-crisis period to 78% in the crisis (and further to 86% in the post-crisis period); instead, for the non-trading banks, the fraction of long-term securities remains stable in the pre-crisis and crisis periods at 78%. Thus, trading banks also buy relatively more of long-term securities. Thus, trading banks increase overall investments in the crisis, and especially in lower-rated and long-term securities (looking only at trading banks across periods or comparing trading versus non-trading banks across periods).

Moreover, for trading banks, the fraction of domestic securities to total securities decreases from 64% to 49% and increases to 57% in the post-crisis period, and the fraction of sovereign securities held decreases from 37% in the pre-crisis period to 31% during the crisis, increasing to 42% in the post-crisis period. Instead, for the non-trading banks, the fraction of sovereign securities is at around 23% in the pre-crisis, 22% in the crisis period, and at 23% in the post-crisis period, and the fraction of domestic securities is 79% in the pre-crisis, 72% in the crisis, and further decreases to 67% in the post-crisis period. In terms of size, trading banks vis-à-vis other banks are on average larger, and we also find that during the crisis, both trading and non-trading banks increase in size.[30] The average capital ratio (equity to total assets) is 4.8% for trading banks in the pre-crisis period and remains at the same level in the crisis (4.81%), increasing to 5.44% in the post-crisis period; for non-trading banks, the capital ratio is 5.07% in the pre-crisis and crisis periods and 5.22% in the post-crisis period.

In terms of the prices of securities, Figure 2 presents the evolution of prices over the sample period. There is a wide variation in the prices of securities. We find large price drops in the crisis period (2007:Q3 to 2009:Q4), though there is also a recovery of prices. On average, in some quarters, the average prices of securities drop by around 20% (annualized price change). However, there is also wide heterogeneity in the price changes across different securities. One can see that there are hardly any significant price drops for securities that are rated triple-A and securities with maturity lower than one year (non-triple-A and long maturity securities have the largest price drops). This again highlights the importance of examining investment behavior at the security level, since using aggregate data would mask these differences and could be misleading.

3.2. Securities analysis

We now examine the investment behavior in securities using the micro data. The summary statistics and graphs presented above suggest that in the crisis period, trading banks increase investments in securities and decrease credit as compared to non-trading banks. However, to understand the underlying mechanism, and for empirical identification, one needs to analyze data at the micro level (both for securities and credit). We formally examine the differential behavior of trading banks relative to non-trading banks using a regression framework. Table 2 reports the results for banks' investment behavior in the crisis period based on trading expertise.[31]

Before we move to the security-level data, we start by examining whether trading banks increase their overall fraction of investments in securities relative to non-trading banks. In column 1 of Panel A, we examine at the bank level the change in the level of securities holdings as a fraction of total assets in the crisis period. We find that trading

[30] A similar pattern is also reported (He, Khang and Krishnamurthy, 2010) for U.S banks. In all the specifications, we control for bank characteristics.

[31] In some of the estimations the number of observations varies due to missing data. However, this does not affect the robustness of the results.

banks increase their level of securities holdings relative to non-trading banks over the crisis period. This result lines up with the summary statistics and Figure 3, where we find that trading banks increase their securities holdings in the crisis. Therefore, both conditionally (controlling for other bank characteristics in Table 2) and unconditionally (without any control in Table 1 and Figure 3), we find that trading banks increase their level of investments during the crisis.

We then move on to separately examining buying and selling behavior across securities. Our model for buying and selling behavior is at the security-quarter-bank level (to be able to control for time-varying, unobserved heterogeneity in securities) and takes the following form:

$$Log\ (Amount^{buy/sell})_{ibt} = \beta\ Trading\ expertise_b + \alpha_{it} + Controls_{t-1} + \varepsilon_{ibt} \quad (1)$$

where *Amount* refers to the nominal amount bought ('buy') or sold ('sell') of security 'i' by bank 'b' at quarter 't', 0 otherwise – i.e., when there is a buy, we calculate the nominal amount by calculating the absolute difference in the holdings between quarter 't' and quarter 't-1' and then taking the logarithm of this amount. For example, when examining buying behavior, the dependent variable takes a positive value if the bank has a net positive investment in the particular security and zero if there is no change in the level of holdings or if there is a net sell of the security. We also include security*time fixed effects (α_{it}) to control for time-varying, unobserved characteristics of individual securities.[32] Note that inclusion of security*time fixed effects controls for all unobserved and observed time-varying heterogeneity, including all the price variation in securities, thus the estimated coefficients are similar whether we use nominal holdings or holdings at market value as a dependent variable.

We use equation (1) as a baseline and modify it based on the hypothesis we are testing. In some estimations, we exploit interactions of bank variables (trading and capital) and security variables (e.g., price variation in the previous quarter) and thus modify the equation accordingly. Furthermore, we can also include bank (or bank*time) fixed effects to account for time-invariant (time-varying) heterogeneity in bank characteristics.

[32] The inclusion of security*time fixed effects also helps us to control – in each time period – for how much of *each security* is issued and outstanding and, therefore, isolate the demand of securities. Also, when we use security*time fixed effects, we do not control for security-level variables as these are absorbed by the fixed effects.

In columns 2 and 3, Panel A, we examine, respectively, the overall buying and selling behavior of banks at the security-quarter-bank level. We find that trading banks in general buy and sell more of securities as compared to non-trading banks (nearly twice as much, with a higher coefficient for buying than selling).[33] These results from columns 2 and 3 further help validate our classification of banks with higher trading expertise.[34] In columns 4 and 5, Panel A, we add security*time fixed effects and find similar coefficients as in columns 2 and 3. We also find a similar pattern when we examine buying behavior across securities with different ratings and maturity (see Appendix, Panel A). We further examine whether there are differences in the composition of investments, conditional on buying (see Panel B of Table 2). Based on the theoretical model described earlier, one would expect that, conditional on buying, banks with higher trading expertise would selectively increase investments in securities that had a larger price drop (in the previous period) as compared to other banks. To examine this, we estimate equation (1), restricting the sample to securities and banks where there are only buys.

In column 1, we find that trading banks buy more of the securities that had a larger percentage drop in price in the previous quarter (interaction of trading expertise dummy and lagged percentage change in price). Note that we introduce bank fixed effects, in addition to security-time fixed effects, to take into account time-invariant heterogeneity in bank characteristics and to isolate the compositional effects of buys. In columns 2 to 5, we analyze compositional effects depending on rating and maturity. We find that the effects are not significant for triple-A and short-term securities, but are significant only for non-triple-A rated securities and securities with a maturity longer than one year.

In Panel C of Table 2, we examine whether trading banks differ in the composition of securities they sell. Panel C is identical to Panel B, the only difference being that we examine sells. As one can see, we do not find any significant differences in selling behavior for securities that had a larger drop in price across banks based on trading expertise. We also do not find any compositional effects depending on rating or maturity.

While the results above show that trading banks buy more of securities that had a larger percentage drop in price, an important question that arises is whether there are

[33] We also ran the estimations where the dependent variable takes the value of one if the bank has a net positive investment in a security and zero otherwise, and we find similar results.

[34] We also find similar results for the pre-crisis and post-crisis periods, though in these periods there is no higher overall investment in securities for trading banks, as Table 7, Panel B, shows.

differences in the level of investments based on bank capital. As discussed earlier, the capital level of banks could proxy for risk-bearing capacity. In Table 3, columns 1 to 4, we limit the analysis to banks with trading expertise. Thus, we examine whether trading banks differ in their investment behavior based on the level of capital. In column 1, we find that for trading banks, higher bank capital (lagged) not only implies a higher level of investments (buys), but also the coefficient on the interaction term with previous price change is negative and significant. Thus, trading banks with higher capital levels buy more of securities in general, especially those securities that had a larger drop in price.[35] In terms of economic magnitudes, a one percentage point increase in capital, on average, increases the amount of security bought by 11.1%. Furthermore, there is an additional 6.1% increase if the security fell in the previous quarter by one standard deviation. In column 2, we include both bank*time and security*time fixed effects to account for all time-varying heterogeneity in bank and security characteristics.[36] The results obtained are similar to those reported in column 1.

In column 3, we include as controls the lagged cumulative gains/losses for individual securities that are present in the banks' investment portfolios. We do not find that banks buy more of securities where they have higher accumulated losses. In fact, we do not find any significant effect. Moreover, the interaction term of cumulative gains with capital is also not significant. These findings do not support the view that banks buy securities that had a larger drop in price in an effort to increase the price of these securities to make their existing portfolio look better. Thus, this finding is not consistent with window dressing activities being the driver of banks' investment in securities that had a larger price drop. Also, as discussed later, we find that banks with a higher level of capital sell more of securities where they have larger accumulated losses in their existing investment portfolio. In column 4, we estimate the regressions conditional on the bank buying a security. We again find similar results to those reported earlier. In columns 5 to 8, we report the estimations for non-trading banks. For these banks, we find that the overall level of investment in securities is not increasing in the level of capital (column 5). The coefficient on capital is not statistically significant. Moreover, unlike for trading banks, we do not find

[35] We find similar results when we estimate the model without any bank fixed effects (not reported).

[36] The results are robust to inclusion of other interactions of bank characteristics with lagged percentage change in price. The results are also robust to inclusion of bank*security fixed effects and double clustering at the bank and security level.

that higher capital is consistently associated with a higher level of investments in securities that had a larger drop in price (column 8 is not significant). In addition, whenever it is significant, the estimated magnitude is very small – the coefficient is less than one quarter of the estimated coefficient for trading banks. We also do not find any effect of cumulative gains/losses on existing investments on buying behavior (column 7). In column 8, when we condition on securities where there is a buy by a bank, we do not find any relation between the amount bought of a security that had a larger price drop and the capital level.[37]

In Table 4, we further examine whether the buying behavior of banks differs across securities with different ratings and maturity. In Panel A, we report the results for trading banks. In columns 1, 2, and 3, we find that the coefficient on the interaction term is only significant for non-triple-A rated securities. These results show that across all categories (except for triple-A), trading banks with a higher level of capital invest more in securities that had a larger drop in price.

Examining the buying behavior across securities with different maturities presents a very similar pattern (columns 4, 5, and 6). The coefficients are larger for securities with maturities longer than one year and not significant for securities with maturity less than one year. These results suggest that banks with a higher level of capital buy more of securities whose prices have previously fallen, especially in investments with lower ratings and long-term maturity. In fact, there are not significant effects for triple-A rated securities or for securities with residual maturity less than one year.

In Panel B, we report the results for non-trading banks. Again, in line with the results reported in Table 3, we find that the coefficient on the interaction term for capital and percentage change in price is substantially smaller in magnitude relative to those reported for trading banks, not statistically significant from columns 2 to 6. It is only significant for triple-A category (column 1), just the opposite of trading banks.[38]

The results above capture the differential investment behavior of banks with different levels of capital for securities. Note that most banks in Germany follow the German local GAAP (HGB) for regulatory reporting and for reporting financial statements. Under HGB, historical cost accounting prevails in contrast to fair value accounting (IFRS),

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[37] This could be because of the small sample size in this estimation coupled with the large number of fixed effects. In fact, the cumulative gains cannot be estimated (we report the coefficients as 0.000).

[38] In general, we find that relative to non-trading banks, trading-banks buy more of securities across all different credit categories and maturities (see Appendix, Panel A).

which suggests that the association of capital and buying behavior is unlikely due to mark-to-market accounting concerns (Laux and Leuz, 2010).[39]

While in Tables 3 and 4 we examine the buying behavior of banks, it is also important to examine the selling behavior to understand whether banks are reluctant to book losses in their investment portfolios. Table 5 reports the regression results for the selling behavior of banks in the crisis period. In columns 1 through 4, we find that there is no significant effect of bank capital on selling behavior for trading banks. In column 3, we examine whether trading banks sell a higher volume of securities where they have larger accumulated gains or losses in their existing investment portfolio. We find that trading banks do not sell a higher volume of securities where they have larger accumulated losses. However, banks with higher levels of capital sell a higher volume of securities where they have larger accumulated losses. However, when we estimate the results conditional on only sells (column 4), we do not find significant effects.

Examining the selling behavior for non-trading banks (columns 5 to 8) across all different specifications, we find that they sell more of securities where they have higher accumulated losses. This effect is more pronounced for banks with a higher level of capital (column 8).

The overall results show that during a crisis, banks with higher trading expertise buy more of securities, especially those that had a larger fall in price. We also find that these effects are stronger for banks with higher capital levels. Furthermore, the strongest quantitative impact of capital on investments is for lower credit ratings (below triple-A) and for securities with residual maturity higher than one year. A crucial question that arises is whether these effects on securities trading by banks have spillovers on credit supply. That is, whether banks with higher trading expertise while increasing their investments in securities reduce their supply of credit to non-financial firms.

[39] Under HGB, securities must be written down to the market value only when the market value falls below the reported amortized cost (unlike mark-to-market accounting). This decrease of the market value below historical cost has a direct impact on net income (unlike under IFRS) except when securities are placed in the held-to-maturity category. We do not have the data on categorization for banks; however, based on some studies (see Georgescu and Laux, 2013), for German banks, the average in held-to-maturity category is quite low (lower than 2.17%).

3.3. Credit analysis

To examine whether banks with higher trading expertise reduce their supply of credit relative to other banks, we exploit the data at the borrower-bank-time level. We use the following estimation equation:

$$\Delta Log\ (loan\ credit)_{jbt} = \beta\ Trading\ expertise_{b} + \gamma_{jt} + Controls_{t-1} + \varepsilon_{jbt} \qquad (2)$$

where the dependent variable is the change in the log of credit granted by bank *b* to firm *j* during quarter *t*. We use borrower*time fixed effects (γ_{jt}) to control for time-varying, unobserved heterogeneity in borrower fundamentals (e.g., risk and growth opportunities) that proxy for credit demand (see e.g., Khwaja and Mian, 2008). Thus, we compare the change in the level of credit for the same borrower in the same time period across banks with different levels of trading expertise. Moreover, we also analyze the effect of bank capital on credit supply for trading and non-trading banks. In these regressions, we can use bank fixed effects to control for time-invariant heterogeneity in bank characteristics or include borrower*bank fixed effects to additionally control for different banking relationships for a firm. Finally, we also analyze whether there are implications for credit availability at the firm level (using aggregate changes in firm credit).

In Table 6, column 1, we start with examining the lending behavior of banks based on trading expertise and capital relative to other banks. We find that, in the crisis period, banks with (higher) trading expertise lend less to the same borrower (firm) at the same time as compared to other banks. The lending by trading banks is five percentage points lower than that of non-trading banks. In column 2, we examine whether trading banks with higher capital reduce lending by more. For banks with higher trading expertise, we find that higher capital is associated with a larger decline in credit. Thus, consistent with the model discussed earlier, trading banks with higher capital invest more in securities and also reduce the supply of credit by more. Note that the coefficient of non-trading banks and capital has the opposite sign than that for trading banks (higher capital implies more lending), although it is not statistically significant.

In column 3, we introduce controls for other bank characteristics and find that the coefficients reported in column 2 are almost identical and still remain statistically significant. In column 4, we control for the accumulated losses or potential gains on the existing security investments of banks. For instance, one could be concerned that trading banks reduce credit supply primarily due to losses on existing investments. While this argument does not explain why banks with higher trading expertise and a higher level of capital cut back more on credit, it is still important to examine the effects after controlling for unrealized losses or gains on a bank's investment portfolio. Again, we find that controlling for unrealized losses or gains does not change the magnitude or significance of the estimated coefficients.[40] Interestingly, we find that banks with higher unrealized gains on existing securities investments lend less relative to other banks (columns 5 to 7), although the result is not robust.

While the results above compare the lending behavior of two banks to the same firm at the same time period, one could still be concerned about borrowers matching with banks differentially. To analyze this differential matching channel, in columns 5 and 6, we run the estimation including bank(lender)*firm(borrower) fixed effects. The inclusion of bank fixed effects also helps to account for all time-invariant characteristics of banks. In column 5, even after controlling for bank*borrower fixed effects, we find that trading banks with a higher level of capital decrease supply of credit relative to other banks. Also, we find that the main bank coefficient remains very similar in magnitude to the earlier estimations. Moreover, in column 6, we also find that non-inclusion of borrower*time fixed effects does not alter at all the magnitude of the coefficients on the bank capital for trading banks, despite substantially reducing the R-squared from 64% to 27%. These results suggest that the covariance between bank capital for trading banks (supply) and firm fundamentals (demand) is negligible, thus suggesting that differential borrower demand arising due unobserved matching between banks and borrowers is unlikely to be the driver of the results. It also suggests that our main bank variable coefficients are exogenous to a large set of unobserved borrower fundamentals (see Altonji, Elder and Taber, 2005).[41]

To examine whether banks differentially take incremental risk in loans, we also examine the interaction of trading banks with future loan defaults (two years down). Column 7 reports the results from this estimation. We find that the coefficient on the interaction term of trading banks with future default is not significantly different from

[40] The results are also robust to controlling for realized gains and losses, though given that sells are low, the majority of gains and losses are unrealized.

[41] We also estimated the regressions controlling for the loan exposures of banks to different sectors, and the results remain unchanged (not reported). The results are also robust to double clustering at the bank and borrower level.

zero.[42] These results suggest that trading banks did not differentially take on more risk in loans.

Finally, in column 8, we examine whether firms can substitute the decrease in credit supply from trading banks by borrowing more from other banks. For instance, imagine a firm that had two banking relationships before the crisis, one with a trading bank, and the other with a non-trading bank. Can the firm increase the credit from the non-trading bank and not suffer any overall restriction of credit? To examine this issue, we first create the fraction of borrowing of a firm from banks with trading expertise before the crisis (2007:Q2). This variable does not vary at the firm level and therefore we cannot introduce firm fixed effects (credit change is at the firm level). In column 8, we find that for firms with a higher fraction of borrowing from trading banks, the total change in credit is negative and significant. Moreover, we also construct other measures of a firms' exposure to trading banks (such as higher than 50% of the firms total borrowing, or weighted averages based on the capital level of trading banks) and find similar results (not reported). Note that this specification (column 8), unlike the ones reported earlier (columns 1 to 7), does not account for firm fundamentals, but the results in previous columns suggest that the main bank variables are not correlated with firm heterogeneity.

These results suggest that firms that were borrowing more from banks with higher trading expertise faced a higher reduction in total credit (from banks). While we do not find firms issuing debt securities to compensate for the reduction in bank credit, we cannot observe whether they substitute from other sources such as trade credit. To the extent that this is not the case, which seems plausible given that Germany is a bank-dominated system, there could be real effects.

3.4. Further robustness

While the results above show that in the crisis period, banks with higher trading expertise (especially the ones with higher capital) increase their investments in securities and reduce the supply of credit to non-financial firms, analysis of the pre-crisis and the post-crisis periods can help further shed light on the main mechanism. The main channel highlighted in the theoretical models described earlier relies on a large shock to securities markets (returns) during the crisis and the presence of bank funding constraints. This also

[42] Loan defaults without the interaction is absorbed by the firm*time fixed effects, as we have loan defaults at the firm-time level.

suggests that in periods when there are no large shocks to securities markets or bank funding constraints are not binding, one would not expect to find similar results as in the crisis period. Note that even if returns from investing in securities markets are high, if the bank funding constraints are less binding, the spillover effects of higher investment in securities on credit supply should be lower or non-existent.

In Table 7, Panel A, we examine the lending behavior of banks in the pre-crisis and post-crisis periods. For both these periods, we do not find any significant difference in supply of credit by trading banks as compared to non-trading banks. In addition, the coefficient on capital for trading banks is not significant. In fact, in columns 2 and 3, for the pre-crisis period, the coefficient is positive, although not significant at conventional levels. Finally, there are also no significant differences in future default rates in these periods between banks with trading expertise relative to other banks (columns 3 and 6).

In Panel B, we examine the investment in securities in the pre-crisis and post crisis periods. While banks with higher trading expertise buy and sell more securities in general across all the periods (see summary statistics in Table 1), we do not find them substantially changing the proportion of investments in securities in the pre-crisis and post-crisis periods (columns 1 and 2 of Table 7, Panel B). In the post crisis period, we see that there is some volatility in securities markets, especially around the initial Greek crisis and also in 2011:Q2. It is interesting to note that trading banks buy into Greek bonds at the time when their spreads are widening but before the worst moments of the Greek crisis (see Figure A1 in the Appendix).[43] However, we do not find a significant reduction in credit supply relative to other banks (also not significantly different from the coefficient in the pre-crisis period). Note that as compared to the crisis period, when most banks report capital and wholesale funding constraints as important factors affecting business operations, this is substantially less the case during the post-crisis period, especially in Germany (see Bundesbank and the ECB survey of Euro area banks).[44] Also, banks equity capital base is higher, at 5.4%, in the

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[43] When we examine these particular quarters, we again see that there is a significant increase in securities as a fraction of total assets for trading banks as compared to other banks. See the spike in change in total securities for trading banks in Figure 2 for mid-2010.

[44] Though the bank liquidity problems can be solved with the ECB liquidity assistance, bank capital problems are not eliminated by ECB liquidity assistance. See Bernanke (1983) and Freixas and Rochet (2008) for discussion on why bank capital is costly, especially in crisis times. Admati and Hellwig (2013) question part of these costs.

post-crisis period as compared to 4.8% in the crisis (see summary statistics in Table 1), thus also suggesting that capital constraints are less binding.

A crucial quantitative question is, what are the *ex-post* returns that banks with higher trading expertise obtain in the crisis? To do this, we examine the average return on a portfolio of securities formed by mimicking the investments of banks with higher trading expertise. We create a portfolio by selecting the same securities (that had fallen in price) and the same timing of investments. Using this method, we find that the realized returns (annualized) on investments made after the failure of Lehman Brothers are approximately 12.5% over the subsequent quarters (see Figure 4). The realized return on investments in securities with maturity of more than five years is higher at approximately 21% and non-triple-A is at 15%.[45]

While the results above are consistent with banks with higher trading expertise increasing their investment in securities during the crisis to profit from trading opportunities, thereby reducing the supply of credit, we examine several other alternative explanations. The first channel is through liquidity preference. That is, trading banks have a preference for liquid assets like securities as compared to loans. Based on this explanation, one should expect trading banks to buy more of securities that are liquid. However, this explanation is difficult to reconcile with the finding that trading banks with higher capital buy more of securities that are long-term rather than short-term and securities with lower ratings as compared to triple-A securities. For example, trading banks invest more in Greek sovereign debt exactly at the point when the spreads widen, which is difficult to reconcile with a purely liquidity preference based explanation. Note that liquidity preference by itself is not inconsistent with the banks trying to exploit trading opportunities in securities markets. For instance, several theoretical papers (Allen and Gale, 1998; Diamond and Rajan, 2011; Acharya, Shin, and Yorulmazer, 2013) argue that banks will hoard on liquidity rather than lock funds into loans, in anticipation of making high returns from acquiring securities in fire sales.[46]

We also investigate whether gains from trading act as a hedge against lending income. The idea being that trading banks expect future interest rates to be low, which in

[45] We assume that the securities are sold in 2009:Q4. We also estimated the realized returns using the actual buying and selling behavior of banks. For the 2009:Q2, we find that returns are approximately 11.9%.

[46] See Allen and Carletti (2008) for a recent overview of the issues.

turn reduces their income from lending. Therefore, trading banks may invest in securities whose prices rise with lower interest rates, thus acting as a hedge against drop in lending income. To examine this channel, we use the data on lending income and trading income at the bank level from 1998 and find that they are positively correlated. This suggests that trading income from securities does not provide a hedge against lending income declines. In addition, while during a crisis there is generally a flight to highly rated securities, (e.g., holding high quality, German sovereign bonds provides a hedge), this is not generally the case for securities with long-term maturity and lower ratings. Thus it is difficult to explain the increase in investments in securities that had a larger price drop (especially in lower-rated and long-term maturity) and a reduction in credit supply purely by a hedging based explanation. The example that we discussed in the Introduction on the JP Morgan bond is illustrative of the trading opportunities for banks with higher trading expertise to obtain high returns on investments.

Another possible channel is that banks that have higher trading expertise buy more of securities that had a larger drop in price due to their market making activities and hence cut back on credit. While this explanation again suggests that banks reduce their credit supply to profit from income from market making, the channel is different from directly investing for trading purposes. Firstly, if market making was the main driver, one should also find trading banks selling more of the securities that had a larger price drop (or differential selling depending on the maturity and rating), whereas we only find results related to buys and not to sells. Also, we do not find these effects in the other periods. Furthermore, we find that the estimated gains from investments in securities that had a larger drop in price are positively correlated with trading income and net profits that banks report. This suggests that banks directly benefit from their trading activities.[47]

Finally, we also find similar results for investments in securities and reduction in credit for trading banks when we use Tier 1 capital ratios. Column 1 of Panel B in the Appendix reports the results for buying behavior of trading banks using Tier 1 capital ratios. Similar to the results reported earlier (Table 3, column 1), we find that banks with a higher level of Tier 1 capital buy more of securities. Furthermore, investment in securities that had a larger price drop is increasing in the level of Tier 1 capital. We also find that trading

[47] The finding that estimated gains from security investments are positively correlated with net profits that banks report also suggests that these security investments are not simply hedges.

banks with higher Tier 1 capital decrease their credit supply by more (column 2). The economic magnitudes are also similar to the ones reported earlier.[48] Moreover, another concern could be that some loans in the sample are under a model-based approach implemented under Basel II, which came into force in Germany before the crisis period. Thus, to make sure that the results are not driven by pro-cyclicality of lending that could arise due to Basel II, we estimate the results excluding these loans.[49] We find similar results to those reported earlier. The estimated coefficient (not reported) on trading banks is -0.079, and the interaction of trading expertise and capital is -0.03, both statistically significant and slightly higher in absolute value than the ones for the whole sample in Table 6.

In sum, the results are most consistent with banks that have higher trading expertise increasing their investments in securities to profit from the trading opportunities and withdrawing funds from lending.[50] Furthermore, banks with higher capital increase their investments by more and also reduce their credit supply by more. We also find that the capital level of banks plays an important role in their securities investment behavior. We find that banks with a higher level of capital buy more of the securities that had a larger drop in price. These results are consistent with equity capital providing buffers to absorb risk in case the price of securities further drops below their purchase price (and affects profits and capital).

4. Conclusion

We analyze security-trading activities of banks during a crisis and the associated spillovers to the supply of credit. Empirical analysis has been elusive due to the lack of comprehensive securities register for banks. We overcome this problem by using a proprietary dataset of the *investments* of banks at the *security-level* for each bank in each quarter for the period between 2005-2012, in conjunction with the credit register from Germany.

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[48] The standard deviation of Tier 1 capital ratio is nearly twice that of the ratio of capital/total assets. Hence, they have similar economic effects.

[49] Under model-based regulation, banks report probability of default for loans using internal models, which affects risk weights. For loans under standard approach, the risk weights are static.

[50] See also Chakraborty, Goldstein and MacKinlay (2014) for evidence on banks reducing commercial lending when the increase their mortgage lending portfolio.

We find that banks with higher trading expertise increase their overall investments in securities during a crisis, especially in securities that had a larger drop in price. Furthermore, this effect is more pronounced for banks with a higher level of capital and in lower-rated and long-term securities. In fact, we do not find significant differential effects for triple-A rated securities. Interestingly, the overall ex-post returns are about 12.5% for trading-expertise banks in the crisis. In contrast to behavior in securities markets, banks with higher trading expertise reduce their overall supply of credit in crisis times. The estimated magnitude of decrease in lending is approximately five percentage points. The reduction in credit supply is more pronounced for trading banks with higher capital. We also find that the credit reduction is binding at the firm level. Given that credit from banks with trading expertise constitutes a large fraction of overall credit in Germany, and that Germany is a bank-dominated economy, the results suggest that this could have a significant impact on the availability of credit to firms during the crisis at the macro level.

The question that this naturally raises is whether banks should engage in securities trading. While there has been a move by some regulators to limit proprietary trading activities of banks, the welfare consequences are not clear. Our results suggest that during a crisis, securities trading by banks can crowd out lending. However, at the same time, we also find that banks buy securities that had a larger drop in price (especially long-term and lower-rated securities), in turn acting as risk absorbers. Importantly, the trading banks with higher capital are the ones that buy more of these securities, which is contrary to claims that banks with low capital engage more in risk-taking through securities investment. Thus, to the extent that banks are large players in these markets, the results suggest that restrictions on securities trading by banks could affect the liquidity of these markets. The lingering questions that remain are, absent banks, would other intermediaries/governments be able to absorb the risk and provide liquidity to the securities markets? To what extent do the benefits associated with securities trading by banks outweigh the costs arising due to reduction in credit supply and the potential increase in systemic risk?[51] While these questions are beyond the scope of this paper, addressing them is an important avenue for future research.

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[51] See Brunnermeier et al. (2012), Saunders et al., (2014), and Freixas et al. (2015) for analyses of systemic risk implications of bank trading activities.

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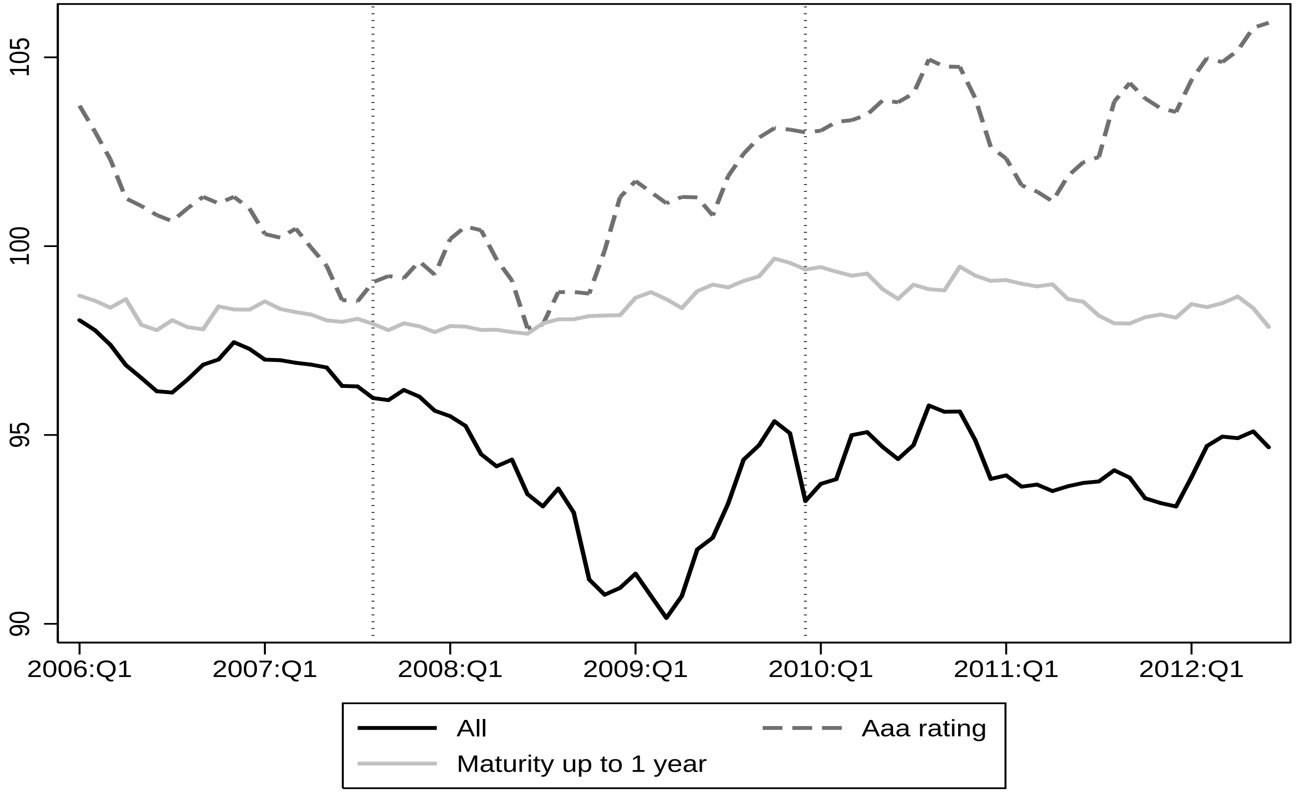
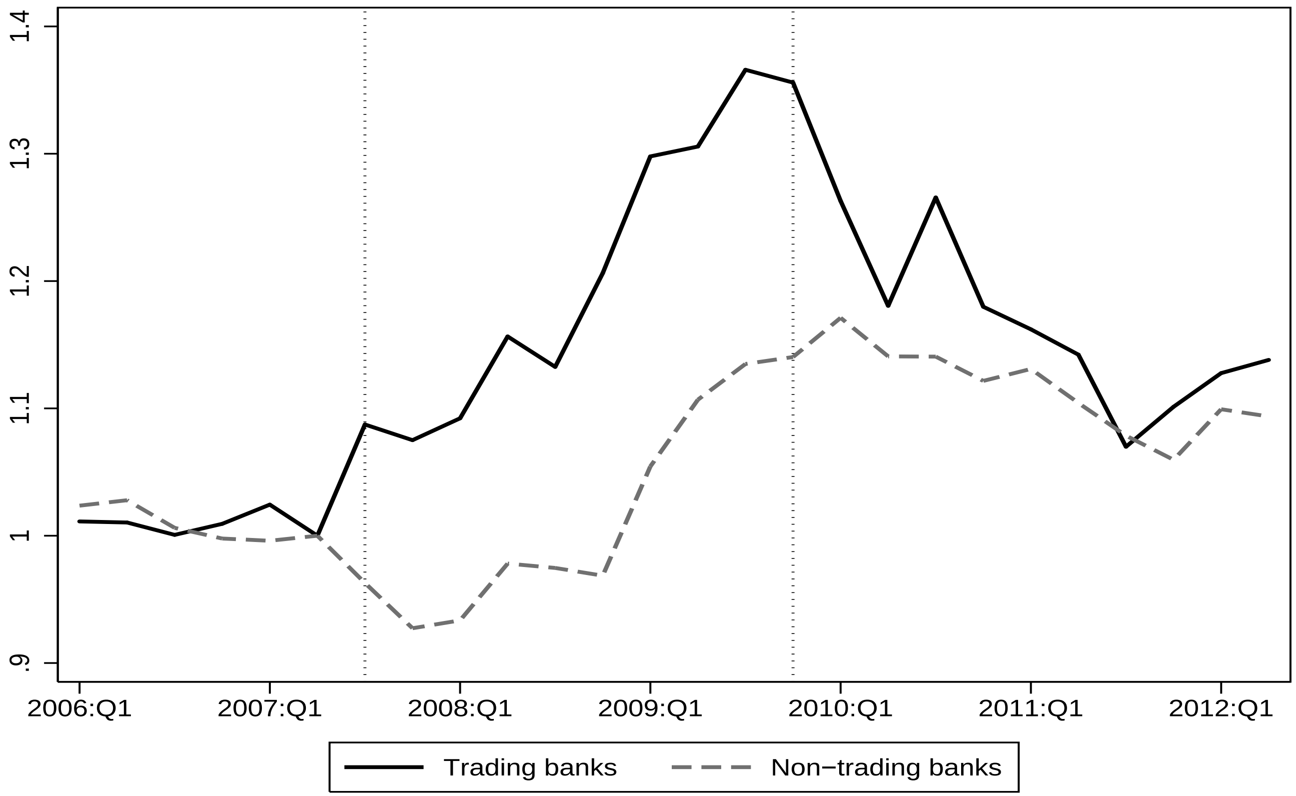
Figures

Figure 2: Security Prices



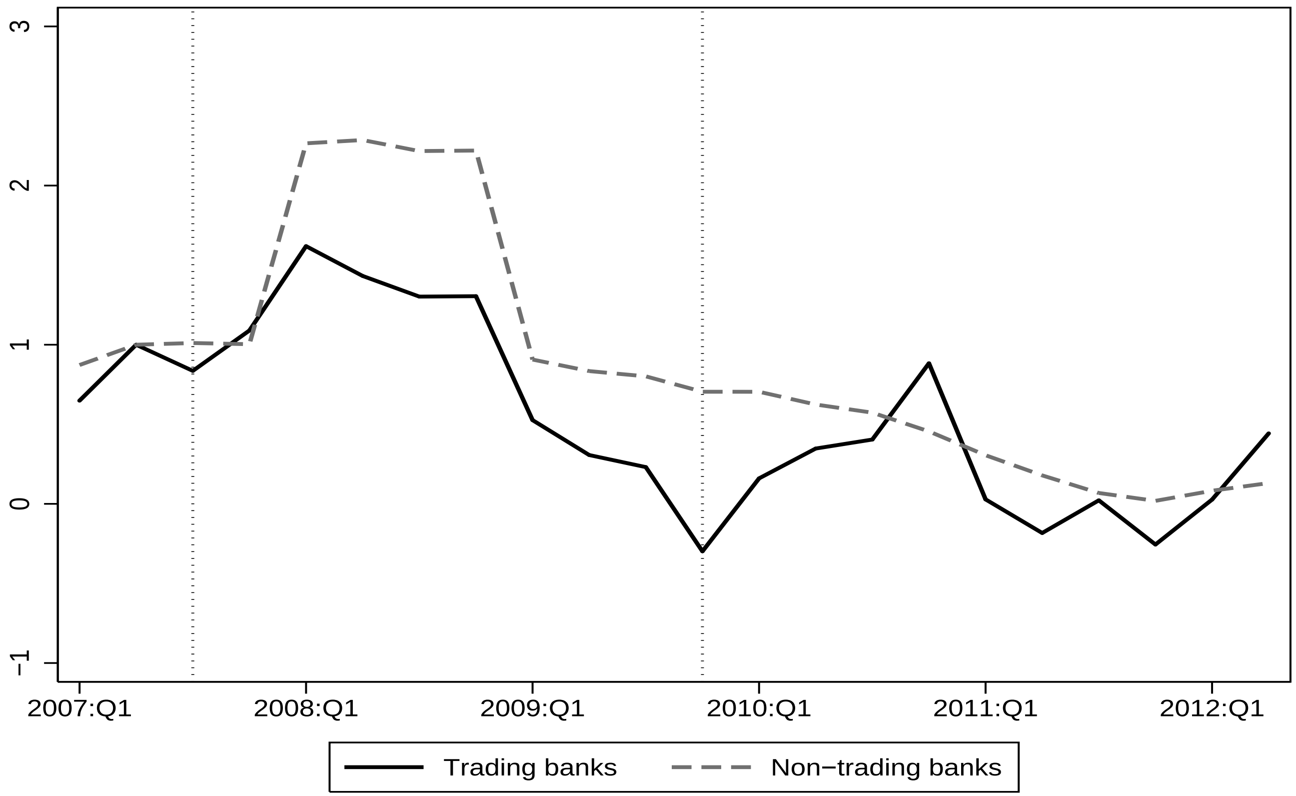
This figure depicts the monthly average price (equally weighted) of all securities in our sample (black solid line) for the period from 2006:Q1 through 2012:Q4. It also shows the average price of Aaa-rated securities (gray dashed line) and securities with remaining residual maturity below one year (gray solid line). The first vertical line refers to the start of financial crisis in 2007:Q3, and the second vertical line denotes 2009:Q4, the end of the crisis in Germany.

Figure 3:
Security Holdings



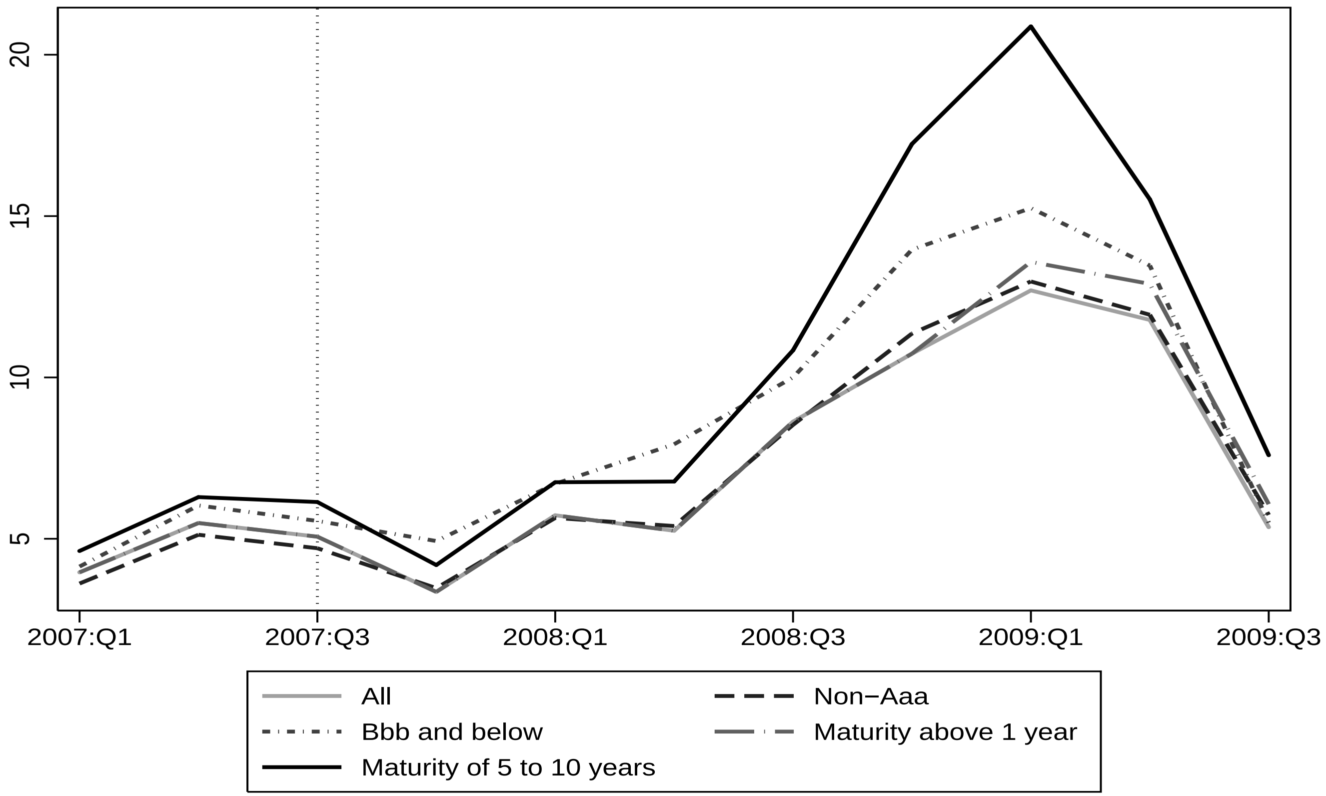
This figure presents the evolution of total security holdings as a fraction of total assets (normalized to 2007:Q2). The black solid line refers to 'Trading banks' and the gray dashed line represents 'Non-trading banks'. We classify a bank as a 'Trading bank' (higher trading expertise) when it has membership to the largest fixed income platform in Germany (Eurex Exchange). The first vertical line refers to the start of financial crisis in 2007:Q3, and the second vertical line denotes 2009:Q4, the end of the crisis in Germany.

Figure 4:
Credit Growth



This figure shows the evolution of the annualized credit growth for borrowers (firms) across the sample period (normalized to 2007:Q2). The black solid line refers to 'Trading banks' and the gray dashed line represents 'Non-trading banks'. We classify a bank as a 'Trading bank' (higher trading expertise) when it has membership to the largest fixed income platform in Germany (Eurex Exchange). The first vertical line refers to the start of financial crisis in 2007:Q3, and the second vertical line denotes 2009:Q4, the end of the crisis in Germany.

Figure 5:
Returns from Security Investments



This figure shows the average annualized returns from investments in securities that fell in price (in %). We compute returns by mimicking the investments of banks with (higher) trading expertise in securities that had a fall in price. We consider the buys of the securities that have fallen in price in the previous quarter and assume that banks hold these securities until 2009:Q4. The return for each security (at a point in time) equals the annualized percentage difference in price from that quarter in which it is purchased and 2009:Q4, plus the coupon of the security. The average is a simple average across all securities bought in a given quarter. We do this including securities that have different ratings and maturity. The vertical line refers to the start of the financial crisis in 2007:Q3.

Tables

Table 1: Summary statistics

Panel A: Trading banks

	Pre-crisis			Crisis			Post-crisis		
	Mean	Std.	Obs.	Mean	Std.	Obs.	Mean	Std.	Obs.
Securities holdings/TA	0.19	0.12	150	0.23	0.14	296	0.22	0.13	353
% Aaa securities	0.49	0.97	150	0.37	2.17	295	0.56	0.26	353
% domestic securities	0.64	0.28	150	0.58	0.30	296	0.49	0.53	348
% long-term securities	0.72	0.34	150	0.78	0.22	292	0.86	0.41	353
% sovereign securities	0.37	0.44	134	0.32	0.32	284	0.42	0.44	353
Buys/TA	0.035	0.035	150	0.039	0.046	296	0.029	0.030	353
Sells/TA	0.017	0.022	150	0.011	0.015	296	0.013	0.016	353
Loans/TA	0.67	0.13	150	0.64	0.15	296	0.61	0.15	353
Capital/TA	4.80	3.88	150	4.81	3.98	296	5.44	5.48	353
Size	16.65	1.91	150	16.80	1.88	296	16.85	1.94	353

Panel B: Non-trading banks

	Pre-crisis			Crisis			Post-crisis		
	Mean	Std.	Obs.	Mean	Std.	Obs.	Mean	Std.	Obs.
Securities holdings/TA	0.18	0.11	2513	0.19	0.10	4983	0.20	0.11	5979
% Aaa securities	0.45	0.23	2281	0.44	0.25	4451	0.43	0.22	5491
% domestic securities	0.79	0.21	2503	0.72	0.25	4974	0.67	0.27	5941
% long-term securities	0.78	0.18	2502	0.78	0.20	4923	0.84	0.23	5950
% sovereign securities	0.24	0.19	1981	0.22	0.19	3634	0.23	0.19	4977
Buys/TA	0.019	0.042	2513	0.022	0.026	4983	0.015	0.018	5979
Sells/TA	0.007	0.037	2513	0.004	0.008	4983	0.003	0.007	5979
Loans/TA	0.69	0.12	2513	0.70	0.11	4983	0.68	0.12	5979
Capital/TA	5.07	1.31	2513	5.07	1.32	4983	5.22	1.34	5979
Size	14.46	0.84	2513	14.55	0.81	4983	14.65	0.78	5979

This table reports the summary statistics of the variables used in the paper, across three periods. We define pre-crisis (2006:Q1 - 2007:Q2), crisis (2007:Q3 - 2009:Q4), and post-crisis (2010:Q1 - 2012:Q4). Panel A reports the summary statistics for 'Trading banks'. Panel B reports the summary statistics for 'Non-trading banks'. We classify a bank as a 'Trading bank' (higher trading expertise) when it has membership to the largest fixed income platform in Germany (Eurex Exchange). 'Aaa' refers to the rating of securities. Domestic securities are securities where the issuer is German. Long-term securities are securities that have a remaining residual maturity higher than one year. Sovereign securities are securities issued by countries. 'Capital/TA' measures the book value of equity as a fraction of total assets (in %) for bank b. 'Size' refers to the logarithm of total assets (in EUR thousands) for bank b. The definition of the other variables can be found in the Appendix.

Table 2 Panel A: Trading behavior during the crisis

	Dependent variable:				
	ΔSec/TA	Buys	Sells	Buys	Sells
	(1)	(2)	(3)	(4)	(5)
Trading bank$_b$	5.215**	2.419***	2.255***	2.043***	1.837***
	(2.563)	(0.571)	(0.54)	(0.475)	(0.411)
Bank controls	Y	Y	Y	Y	Y
Security*Time fixed effects	N	N	N	Y	Y
Bank fixed effects	N	N	N	N	N
Observations	504	248,399	258,731	248,399	258,731
R-squared	0.073	0.114	0.088	0.323	0.476

The dependent variable in column 1 is the change in Securities holdings/TA for each bank from 2007:Q2 to 2009:Q4. The dependent variable for the 'Buys' is $Log(Amount)_{i,b,t}$, which is the logarithm of the amount bought (in nominal value) by bank b of security i during quarter t, and zero otherwise. For the 'Sells', the dependent variable is the logarithm of the amount sold (in nominal value) by bank b of security i during quarter t, and zero otherwise. 'Trading bank' is a binary variable that equals the value of one when bank b has membership to the largest fixed income platform in Germany (Eurex Exchange), and zero otherwise, which proxies for banks with higher trading expertise. All regressions are estimated using ordinary least squares. Lagged, time-varying bank controls (Size, Capital/TA, Interbank borrowing/TA, Deposits/TA) are either included ('Y') or not included ('N'). The definition of the main independent variables can be found in the Appendix. A constant is included, but its coefficient is left unreported. Fixed effects are either included ('Y'), not included ('N'), or spanned by another set of fixed effects ('-'). Robust standard errors clustered at bank level following Arellano (1987) are reported in parentheses. ***: Significant at 1 percent level; **: Significant at 5 percent level; *: Significant at 10 percent level.

Table 2 Panel B:
Buying behavior during the crisis across securities

	Dependent variable: Buys				
	All	Aaa-rated	Below Aaa-rated	Up to 1 Year	Above 1 Year
	(1)	(2)	(3)	(4)	(5)
Trading bank$_b$*Δprice$_{i,t-1}$	-0.231**	-0.160	-0.241*	0.164	-0.248***
	(0.113)	(0.159)	(0.138)	(0.748)	(0.113)
Bank controls	Y	Y	Y	Y	Y
Security*Time fixed effects	Y	Y	Y	Y	Y
Bank fixed effects	Y	Y	Y	Y	Y
Observations	36,885	11,918	24,967	6,336	30,549
R-squared	0.703	0.682	0.721	0.714	0.708

The estimations report the buying behavior of banks across different securities *conditional on buying*. The dependent variable is $Log(Amount)_{i,b,t}$, which is the logarithm of the amount bought (in nominal value) by bank b of security i during quarter t. The splits are based on ratings and remaining residual maturity of the securities. 'Trading bank' is a binary variable that equals the value of one when bank b has membership to the largest fixed income platform in Germany (Eurex Exchange), and zero otherwise, which proxies for banks with higher trading expertise. All regressions are estimated using ordinary least squares. The percentage price change of security i, 'Δprice$_{i,t-1}$', is demeaned by the sample mean and standardized using the standard deviation of the respective subset of securities in the crisis sample. Lagged, time-varying bank controls (Size, Capital/TA, Interbank borrowing/TA, Deposits/TA) are either included ('Y') or not included ('N'). The definition of the main independent variables can be found in the Appendix. A constant is included, but its coefficient is left unreported. Fixed effects are either included ('Y'), not included ('N'), or spanned by another set of fixed effects ('-'). Robust standard errors clustered at bank level following Arellano (1987) are reported in parentheses. ***: Significant at 1 percent level; **: Significant at 5 percent level; *: Significant at 10 percent level.

Table 2 Panel C:
Selling behavior during the crisis across securities

	Dependent variable: Sells				
	All	Aaa-rated	Below Aaa-rated	Up to 1 Year	Above 1 Year
	(1)	(2)	(3)	(4)	(5)
Trading bank$_b$*Δprice$_{i,t-1}$	0.073	0.159	0.057	0.162	0.058
	(0.075)	(0.258)	(0.085)	(0.188)	(0.086)
Bank controls	Y	Y	Y	Y	Y
Security*Time fixed effects	Y	Y	Y	Y	Y
Bank fixed effects	Y	Y	Y	Y	Y
Observations	48,546	14,682	33,864	16,055	32,491
R-squared	0.658	0.663	0.665	0.620	0.688

The estimations report the selling behavior of banks across different securities *conditional on selling*. The dependent variable is $Log(Amount)_{i,b,t}$, which is the logarithm of the amount sold (in nominal value) by bank b of security i during quarter t. The splits are based on ratings and remaining residual maturity of the securities. 'Trading bank' is a binary variable that equals the value of one when bank b has membership to the largest fixed income platform in Germany (Eurex Exchange), and zero otherwise, which proxies for banks with higher trading expertise. The percentage price change of security i, 'Δprice$_{i,t-1}$', is demeaned by the sample mean and standardized using the standard deviation of the respective subset of securities in the crisis sample. All regressions are estimated using ordinary least squares. Lagged, time-varying bank controls (Size, Capital/TA, Interbank borrowing/TA, Deposits/TA) are either included ('Y') or not included ('N'). The definition of the main independent variables can be found in the Appendix. A constant is included, but its coefficient is left unreported. Fixed effects are either included ('Y'), not included ('N'), or spanned by another set of effects ('-'). Robust standard errors clustered at bank level following Arellano (1987) are reported in parentheses. ***: Significant at 1 percent level; **: Significant at 5 percent level; *: Significant at 10 percent level.

Table 3: Buying behavior during the crisis based on capital

	Dependent variable: Buys							
	Trading banks				Non-trading banks			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Capital/TA$_{b,t-1}$	0.111*				0.027			
	(0.061)				(0.068)			
Capital/TA$_{b,t-1}$*Δprice$_{i,t-1}$	-0.061***	-0.049*	-0.049*	-0.061**	-0.013***	-0.010***	-0.010***	-0.035
	(0.018)	(0.027)	(0.027)	(0.025)	(0.005)	(0.003)	(0.003)	(0.101)
Cumulative gains/TA$_{b,i,t-1}$	6.184	6.380	6.227	6.663	0.0125	0.369	0.307	0.000
	(5.444)	(5.817)	(5.824)	(13.98)	(0.356)	(0.356)	(0.364)	0.000
Capital/TA$_{b,t-1}$*Cumulative gains/TA$_{b,i,t-1}$			-0.166	5.776			-0.176	0.000
			(0.585)	(8.482)			(0.139)	(0.000)
Bank controls	Y	-	-	-	Y	-	-	-
Security*Time fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Bank fixed effects	Y	-	-	-	Y	-	-	-
Bank*Time fixed effects	N	Y	Y	Y	N	Y	Y	Y
Observations	90,167	90,167	90,167	20,088	141,430	141,430	141,430	8,051
R-squared	0.502	0.507	0.507	0.793	0.340	0.375	0.375	0.958

The dependent variable is the $Log(Amount)_{i,b,t}$, which is the logarithm of the amount bought (in nominal value) by bank b of security i during quarter t, and zero otherwise, and column 4 and 8 report the results of the estimations conditional on buying a security. Columns 1 to 4 report the results for trading banks, and columns 5 to 8 for the other banks. 'Capital/TA$_{b,t-1}$' measures the book value of equity as a fraction of total assets (in %) for bank b in quarter $t-1$. The percentage price change of security i, 'Δprice$_{i,t-1}$', is demeaned by the sample mean and standardized using its standard deviation in the crisis sample. All regressions are estimated using ordinary least squares. Lagged, time-varying bank controls (Size, Capital/TA, Interbank borrowing/TA, Deposits/TA) are either included ('Y') or not included ('N'). The definition of the main independent variables can be found in the Appendix. A constant is included, but its coefficient is left unreported. Fixed effects are either included ('Y'), not included ('N'), or spanned by another set of effects ('-'). Robust standard errors clustered at bank level following Arellano (1987) are reported in parentheses. ***: Significant at 1 percent level; **: Significant at 5 percent level; *: Significant at 10 percent level.

Table 4: Buying behavior during the crisis across different types of securities based on capital

Panel A: Trading banks

	Dependent variable: Buys					
	Trading banks					
	Aaa-rated	Aa to A rated	Bbb-rated and below	Up to 1 Year	1 to 5 Year	5 to 10 Year
	(1)	(2)	(3)	(4)	(5)	(6)
Capital/TA$_{b,t-1}$*Δprice$_{i,t-1}$	0.023	-0.085***	-0.062**	-0.037	-0.102***	-0.111***
	(0.038)	(0.032)	(0.030)	(0.045)	(0.028)	(0.032)
Security*Time fixed effects	Y	Y	Y	Y	Y	Y
Bank*Time fixed effects	Y	Y	Y	Y	Y	Y
Observations	29,037	25,791	23,860	17,615	52,182	21,603
R-squared	0.417	0.486	0.533	0.497	0.468	0.452

Panel B: Non-trading banks

	Dependent variable: Buys					
	Non-trading banks					
	Aaa-rated	Aa to A rated	Bbb-rated and below	Up to 1 Year	1 to 5 Year	5 to 10 Year
	(1)	(2)	(3)	(4)	(5)	(6)
Capital/TA$_{b,t-1}$*Δprice$_{i,t-1}$	-0.086*	-0.011	-0.001	-0.007	-0.010	-0.021
	(0.045)	(0.025)	(0.005)	(0.006)	(0.008)	(0.014)
Security*Time fixed effects	Y	Y	Y	Y	Y	Y
Bank*Time fixed effects	Y	Y	Y	Y	Y	Y
Observations	35,679	41,539	40,181	27,094	87,135	29,164
R-squared	0.516	0.456	0.490	0.530	0.415	0.516

The dependent variable is the $Log(Amount)_{i,b,t}$, which is the logarithm of the amount bought (in nominal value) by bank b of security i during quarter t, and zero otherwise. The splits are based on ratings and remaining residual maturity of the securities. Panel A shows the results for trading banks and Panel B for the other banks. 'Capital/TA$_{b,t-1}$' measures the book value of equity as a fraction of total assets (in %) for bank b in quarter $t-1$. The percentage price change of security i, 'Δprice$_{i,t-1}$', is demeaned by the sample mean and standardized using the standard deviation of the respective subset of securities in the crisis sample. All regressions are estimated using ordinary least squares. Lagged, time-varying bank controls (Size, Capital/TA, Interbank borrowing/TA, Deposits/TA) are either included ('Y') or not included ('N'). The definition of the main independent variables can be found in the Appendix. A constant is included, but its coefficient is left unreported. Fixed effects are either included ('Y'), not included ('N'), or spanned by another set of effects ('-'). Robust standard errors clustered at bank level following Arellano (1987) are reported in parentheses. ***: Significant at 1 percent level; **: Significant at 5 percent level; *: Significant at 10 percent level.

Table 5:
Selling behavior during the crisis based on capital

	Dependent variable: Sells							
	Trading banks				Non-trading banks			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Capital/TA$_{b,t-1}$	0.011				0.013			
	(0.054)				(0.128)			
Capital/TA$_{b,t-1}$*Δprice$_{i,t-1}$	0.0002	-0.005	-0.003	0.008	-0.025**	-0.003	0.001	-0.024
	(0.026)	(0.033)	(0.033)	(0.018)	(0.010)	(0.009)	(0.008)	(0.054)
Cumulative gains/TA$_{b,i,t-1}$	0.054	-0.097	-0.227	-0.949	-0.248***	-0.171*	-0.221*	-2.391***
	(0.326)	(0.312)	(0.328)	(0.675)	(0.094)	(0.098)	(0.130)	(0.335)
Capital/TA$_{b,t-1}$*Cumulative gains/TA$_{b,i,t-1}$			-0.136**	-0.027			-0.139	-0.419**
			(0.064)	(0.312)			(0.119)	(0.171)
Bank controls	Y	-	-	-	Y	-	-	-
Security*Time fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Bank fixed effects	Y	-	-	-	Y	-	-	-
Bank*Time fixed effects	N	Y	Y	Y	N	Y	Y	Y
Observations	96,033	96,033	96,033	30,877	146,708	146,708	146,708	13,781
R-squared	0.537	0.542	0.542	0.722	0.639	0.678	0.678	0.893

The dependent variable is the $Log(Amount)_{i,b,t}$, which is the logarithm of the amount sold (in nominal value) by bank b of security i during quarter t, and zero otherwise, and columns 4 and 8 report the results of the estimations conditional on selling a security. 'Capital/TA$_{b,t-1}$' measures the book value of equity as a fraction of total assets (in %) for bank b in quarter $t-1$. The percentage price change of security i, 'Δprice$_{i,t-1}$', is demeaned by the sample mean and standardized using its standard deviation in the crisis sample. All regressions are estimated using ordinary least squares. Lagged, time-varying bank controls (Size, Capital/TA, Interbank borrowing/TA, Deposits/TA) are either included ('Y') or not included ('N'). The definition of the main independent variables can be found in the Appendix. A constant is included, but its coefficient is left unreported. Fixed effects are either included ('Y'), not included ('N'), or spanned by another set of effects ('-'). Robust standard errors clustered at bank level following Arellano (1987) are reported in parentheses. ***: Significant at 1 percent level; **: Significant at 5 percent level; *: Significant at 10 percent level.

Table 6:
Lending behavior during the crisis

	Dependent variable: Change in credit							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Trading bank$_b$	-0.050*	-0.061**	-0.058**	-0.058**				-0.022***
	(0.027)	(0.026)	(0.026)	(0.026)				(0.002)
Trading bank$_b$*Capital/TA$_{b,t-1}$		-0.014**	-0.014***	-0.014***	-0.017*	-0.018**	-0.017*	
		(0.006)	(0.005)	(0.005)	(0.009)	(0.007)	(0.010)	
Non-trading bank$_b$*Capital/TA$_{b,t-1}$		0.0041	0.0039	0.0039	0.0094	0.002	0.0094	
		(0.003)	(0.003)	(0.003)	(0.025)	(0.028)	(0.025)	
Trading bank$_b$*Future default$_{j,t}$							-0.0863	
							(0.070)	
Cumulative gains/TA$_{b,t-1}$				0.002	-0.005**	-0.003**	-0.005**	
				(0.003)	(0.002)	(0.001)	(0.002)	
Bank controls	N	N	Y	Y	Y	Y	Y	N
Borrower*Time fixed effects	Y	Y	Y	Y	Y	N	Y	N
Bank*Borrower fixed effects	N	N	N	N	Y	Y	Y	
Time fixed effects	-	-	-	-	-	Y	-	Y
Observations	502,243	502,243	502,243	501,786	501,786	501,786	501,786	228,547
R-squared	0.499	0.499	0.499	0.5	0.642	0.272	0.636	0.003

The dependent variable from columns 1 to 7 is Δ $Log(\text{Credit})_{b,j,t}$, which is the change in the log of credit granted by bank b to firm j during quarter t, whereas in column 8, the dependent variable is the change in log of the total firm credit of firm j during quarter t by all banks. The independent variable for column 8 is the fraction of borrowing of a firm from banks with trading expertise before the crisis (2007:Q2). 'Trading bank' is a binary variable that equals the value of one when bank b has membership to the largest fixed income platform in Germany (Eurex Exchange), and zero otherwise, which proxies for banks with higher trading expertise. 'Non-trading banks' is a binary variable that equals the value of one when bank b does not have a direct Eurex Exchange membership and zero otherwise. 'Capital/TA$_{b,t-1}$' measures the book value of equity as a fraction of total assets (in %) for bank b in quarter $t-1$. All regressions are estimated using ordinary least squares. Lagged, time-varying bank controls (Size, Capital/TA, Interbank borrowing/TA, Deposits/TA) are either included ('Y') or not included ('N'). The definition of the main independent variables can be found in the Appendix. A constant is included, but its coefficient is left unreported. Fixed effects are either included ('Y'), not included ('N'), or spanned by another set of effects ('-'). Robust standard errors clustered at bank level following Arellano (1987) are reported in parentheses. ***: Significant at 1 percent level; **: Significant at 5 percent level; *: Significant at 10 percent level.

Table 7:
Lending and Investment behavior in the pre-crisis and post-crisis period

Panel A: Lending behavior

	Dependent variable: Change in credit					
	Pre-crisis			Post-crisis		
	(1)	(2)	(3)	(4)	(5)	(6)
Trading bank$_b$	-0.007			-0.007		
	(0.0066)			(0.005)		
Trading bank$_b$* Capital/TA$_{b,t-1}$	-0.001	0.014	0.012	-0.0001	-0.001	0.001
	(0.002)	(0.014)	(0.020)	(0.002)	(0.003)	(0.004)
Non-trading bank$_b$* Capital/TA$_{b,t-1}$	0.001	-0.016	-0.022	0.001	-0.0001	0.006
	(0.002)	(0.010)	(0.013)	(0.001)	(0.003)	(0.003)
Trading bank$_b$* Future Default$_{j,t}$			0.018			-0.004
			(0.039)			(0.021)
Cumulative Gains/TA$_{b,t-1}$	-0.795	-0.619	-0.933	0.273	-0.233	-0.002
	0.558	(1.559)	(1.930)	(0.191)	(0.355)	(0.004)
Bank controls	Y	Y	Y	Y	Y	Y
Borrower*Time fixed effects	Y	Y	Y	Y	Y	Y
Bank fixed effects	N	Y	N	N	Y	N
Observations	192,051	192,051	192,051	689,124	689,124	689,124
R-squared	0.546	0.548	0.673	0.533	0.535	0.613

Panel B: Investment behavior

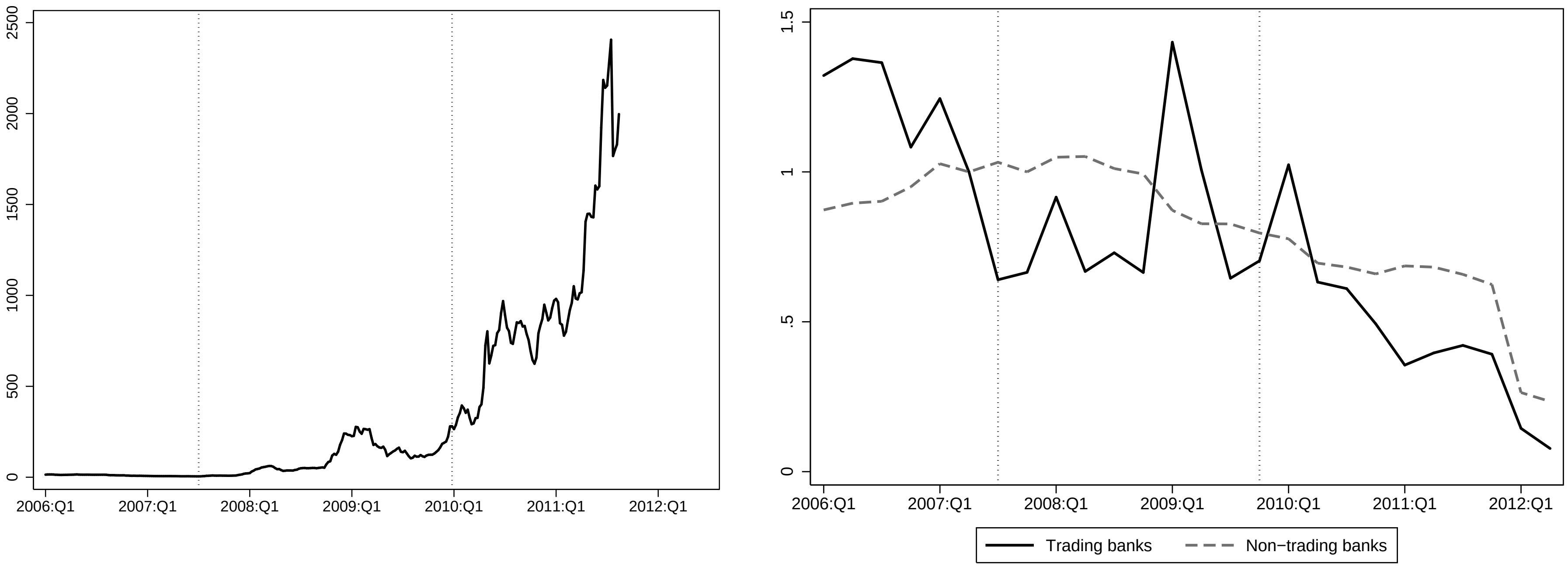
	Dependent variable: ΔSec/TA	
	Pre-crisis	Post-crisis
	(1)	(2)
Trading bank$_b$	-1.596	1.670
	(1.559)	(1.806)
Bank controls	Y	Y
Observations	502	501
R-squared	0.026	0.013

The dependent variable in Panel A is $\Delta\ Log(\text{Credit})_{b,j,t}$, which is the change in the log of credit granted by bank b to firm j during quarter t. In Panel B, the dependent variable is the change in Securities/Total Assets for each bank over the respective period. 'Trading bank' is a binary variable that equals the value of one when bank b has membership to the largest fixed income platform in Germany (Eurex Exchange), and zero otherwise, which proxies for banks with higher trading expertise. 'Non-trading banks' is a binary variable that equals the value of one when bank b has not a direct Eurex Exchange membership, and zero otherwise. 'Capital/TA$_{b,t-1}$' measures the book value of equity as a fraction of total assets (in %) for bank b in quarter $t-1$. All regressions are estimated using ordinary least squares. Lagged, time-varying bank controls (Size, Capital/TA, Interbank borrowing/TA, Deposits/TA) are either included ('Y') or not included ('N'). The definition of the main independent variables can be found in the Appendix. A constant is included, but its coefficient is left unreported. Fixed effects are either included ('Y'), not included ('N'), or spanned by another set of effects ('-'). Robust standard errors clustered at bank level following Arellano (1987) are reported in parentheses. ***: Significant at 1 percent level; **: Significant at 5 percent level; *: Significant at 10 percent level.

Appendix

Figure A1:
Greek Government Bonds

(a) 5-year Greek sovereign CDS spread (in basis points) **(b) Security holdings**



Subfigure (a) shows the spreads (in basis points) of a 5-year Greek sovereign CDS. Subfigure (b) reflects the total notional amount of Greek sovereign bonds as a fraction of total assets for the period from 2006:Q1 through 2012:Q4 (normalized to 2007:Q2). The black solid line refers to 'Trading banks' and the gray dashed line represents 'Non-trading banks'. We classify a bank as a 'Trading bank' (higher trading expertise) when it has membership to the largest fixed income platform in Germany (Eurex Exchange). The first vertical line refers to the start of financial crisis in 2007:Q3, and the second vertical line denotes 2009:Q4, the end of the crisis in Germany.

Table A1: Investment and Lending behavior during the crisis

Panel A: Buying behavior across different ratings and maturities

	Dependent variable: Buys					
	Aaa-rated	Aa to A rated	Bbb-rated and below	Up to 1 Year	1 to 5 Year	5 to 10 Year
	(1)	(2)	(3)	(4)	(5)	(6)
Trading bank$_b$	1.936***	1.873***	2.337***	2.369***	1.874***	2.063***
	(0.522)	(0.456)	(0.586)	(0.460)	(0.503)	(0.533)
Bank Controls	Y	Y	Y	Y	Y	Y
Security*Time fixed effects	Y	Y	Y	Y	Y	Y
Observations	64,716	67,330	64,041	44,709	139,317	50,767
R-squared	0.322	0.301	0.335	0.352	0.307	0.302

Panel B: Investment and lending behavior based on Tier 1 capital ratio

	Dependent variable:		
	Buys		Change in credit
	(1)		(2)
Tier 1/RWA$_{b,t-1}$	0.058*	Trading bank$_b$	-0.065*
	(0.035)		(0.035)
Tier 1/RWA$_{b,t-1}$*$\Delta price_{i,t-1}$	-0.024*	Trading bank$_b$* Tier 1/RWA$_{b,t-1}$	-0.008*
	(0.015)		(0.005)
		Non-trading bank$_b$* Tier 1/RWA$_{b,t-1}$	0.001
			(0.003)
Bank controls	Y		Y
Security*Time fixed effects	Y		
Bank fixed effects	Y		N
Borrower*Time fixed effects			Y
Observations	83,635		488,726
R-squared	0.506		0.505

Panel A reports the estimations reported in Table 2, Column 4, split by different ratings and maturities. Panel B presents the estimates of the investment regression reported in Table 3, Column 1 and the credit regression reported in Table 6, Column 4 using *Tier 1 capital ratios*. See the description of the econometric specifications in the corresponding tables. Lagged, time-varying bank controls (Size, Capital/TA, Interbank borrowing/TA, Deposits/TA) are either included ('Y') or not included ('N'). The definition of the main independent variables can be found in Table A2. A constant is included, but its coefficient is left unreported. Fixed effects are either included ('Y'), not included ('N'), or spanned by another set of effects ('-'). Robust standard errors clustered at bank level following Arellano (1987) are reported in parentheses. ***: Significant at 1 percent level; **: Significant at 5 percent level; *: Significant at 10 percent level.

Table A2:
Definition of main independent variables

Variable name	Definition
Trading bank$_b$	Binary variable that equals the value of one when bank b has membership to the largest fixed income platform in Germany (Eurex Exchange), and zero otherwise.
Non-trading bank$_b$	Binary variable that equals the value of one when bank b does not have membership to the largest fixed income platform in Germany (Eurex Exchange), and zero otherwise.
$\Delta price_{i,t-1}$	Percentage price change of security i from $t-2$ to $t-1$.
Capital/TA$_{b,t-1}$	Measures the book value of equity as a fraction of total assets (in %) for bank b in quarter $t-1$.
Cumulative gains$_{b,i,t-1}$	Unrealized gains/losses (in EUR) as a fraction of total assets that a bank b generates with holding the security i in quarter $t-1$. We compute profits by multiplying the change of the market-to-book ratio of security i with the amount held (in nominal values) by bank b in quarter $t-1$. We further cumulate the profits of this security from the quarter, in which it has been purchased, until quarter $t-1$.
Cumulative gains$_{b,t-1}$	Unrealized gains/losses (in EUR) as a fraction of total assets that a bank generates from all its securities holdings on quarter $t-1$. We compute this by aggregating the cumulative gains for individual securities held by the bank (described above) at the bank level.
Future default$_{j,t}$	Binary variable that equals the value of one when borrower j defaults on its loan at any point in time during the lifetime of the credit contract after quarter t, and zero otherwise.
Rating$_{i,t}$	Rating of security i in quarter t, where rating equals a numeric scale of Moody's rating codes that range from category 'Aaa' through 'C'.
Maturity$_{i,t}$	Number of months remaining (residual maturity) from quarter t onwards until security i matures.