Securities' Trading by Banks: Micro-Evidence

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Abstract

We analyze security-trading activities of banks in the crisis, and the associated spillovers to the supply of bank credit. Empirical analysis has been elusive due to the lack of comprehensive securities register for banks. We use a unique proprietary dataset of *investments* of banks at the *security-level* for the period between 2005-12 in conjunction with the credit register from Germany. We find that banks with higher levels of capital increase their overall investments in securities during the crisis. Effects are quantitatively stronger in securities whose prices have previously fallen, especially in investments with lower ratings and longer maturity. However, there is no differential effect for securities without market prices (non-traded securities). Finally, these banks reduce their overall supply of credit in crisis times, with stronger effects when overall securities prices fall more.

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1. Introduction

The role of security trading by banks has assumed significant importance in the modern financial system. Commercial banks today hold a significant amount of securities in their asset portfolio (e.g., 20% in USA and 19% in Germany). In the aftermath of the current financial crisis, there is considerable debate both in academic and policy circles about the implications of security trading by banks' for asset markets and credit supply. A recurrent argument has been that securities trading activities by banks have led to a reduction in credit supply and to an increase in the risk of the financial system.[1] In fact, there have been several policy initiatives to impose some restrictions on banks' trading activities (Volcker rule in USA, the Liikanen Report in Europe and the Vickers Report in the UK). However, empirical analysis has been elusive due to the lack of comprehensive micro datasets. Therefore, it is of utmost importance to empirically analyze security-trading activities of banks, and the associated spillover to the supply of credit to the real sector.

On the theoretical front there is a growing literature that analyses the role of security trading by banks and its implications for credit supply and asset markets. For example, Diamond and Rajan (2011) show that, during a crisis, the anticipation of fire sales in asset markets by distressed banks can lead well capitalized banks to hoard liquidity to acquire these assets in the future, thus leading to a reduction in the supply of credit. Shleifer and Vishny (2010) show that, during a crisis as a result of fire sales in asset markets, the return from engaging in trading activities are higher than lending. Thus, in a crisis, banks allocate scare equity capital to security trading leading to a reduction in credit supply. Hanson et al. (2014) analyze synergies between bank assets and liabilities. They show that safer financial institutions with stronger, more stable liabilities (banks with higher capital) have a comparative advantage in crisis times at holding relatively illiquid fixed-income assets with substantial transitory price volatility.

Despite the importance for theory and policy of understanding banks' investments in securities and its implications for credit supply, the empirical identification has been

[1] "*Adverse spillovers from a fire sale may take the form of a credit crunch that a effects 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 (2013).

elusive. The main constraint that has hampered empirical research is lack of comprehensive micro data at the security level on banks' trading activities. Comparing aggregate data on security holdings of banks does not present a clear picture about investment behavior, as it does not take into account the security characteristics (riskiness, liquidity, level of issuance etc.). For instance, imagine two banks holding the same overall nominal level of securities, but one holds entirely Aaa rated securities, while the other holds securities that are below investment grade; examining aggregate data would therefore be misleading as the overall level of investments are the same, but the composition of risk is very different.[2]

In this paper, we overcome this hurdle using a unique, proprietary dataset from the Bundesbank (the German central bank) that provides us with information on all the security level holdings of 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, we not only have the security 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 and supervisory information.

Motivated by the theoretical literature discussed above, we primarily focus on the effects of bank capital on security trading activities and, the associated spillovers on credit supply. We first examine whether there are differences in the level of investments in securities based on the level of bank capital. We do this analysis for overall investments, and also for the intensity of buys and sells. Importantly, we analyze compositional effects of investment with respect to risk proxied by previous price changes, and also how these effects vary depending on fundamental credit and liquidity risk. Finally, we also analyze effects on securities without market prices.

For identification, we analyze the data at the security-bank-quarter and control for security*time fixed effects to account for unobserved time-variant heterogeneity across securities, e.g. risk and level of issuance. Thus, we examine the changes in level of holdings for the same security by different banks based on their capital levels. Moreover, we also

[2] Furthermore, the maturity, coupon 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 using aggregate data becomes even more difficult. In addition, there may be more issuance of some securities and this may depend on the cycle and on the riskiness of the securities. Therefore, disaggregated micro data is essential.

control for bank fixed effects to account for time invariant heterogeneity across banks to account for different business models.[3] In addition, when analyzing compositional effects with respect to risk, we can also control for bank*time fixed effects to control exhaustively for overall effects and isolate only compositional effects on risk. Finally, we analyze the associated lending behavior of banks, controlling for time varying unobserved firm fundamentals that proxy for credit demand using borrower*time fixed effects (see e.g. Khwaja and Mian, 2008). Thus we compare lending by banks with different capital levels to the same firm at the same time period. Moreover, we analyze loan defaults to examine whether the differences in credit supply stem from differences in risk-taking in lending (as in Jiménez et al, 2014).

We find that during the crisis banks with higher level of capital have higher levels of overall net investments in securities.[4] More precisely, within a given financial security in a given quarter, we find that, on average higher levels of bank equity are associated with higher levels of net investments. The effects are mainly driven by buys of securities. Moreover, we find significant differences in the composition of investments with respect to risk. In the crisis, banks with higher level of equity buy a larger volume of securities whose price has previously fallen by more. Furthermore, these effects are stronger for banks with less stable liability structure, proxied by the level of savings deposits. Moreover, our findings suggest that the effects are not driven by banks with very low capital, which are more likely to be at the regulatory threshold; instead, effects are even strong for banks with above average level of capital.

We then examine how these effects vary based on fundamental risk (proxied by credit ratings) and liquidity risk (proxied by maturity). We find that the increase in investment in securities that experience a larger price drop is concentrated among securities that are rated below Aaa and securities that have longer maturity (longer than 1 year). The strongest quantitative impact of capital on investments is for lower credit ratings (Bbb and below) and for securities with residual maturity higher than 5 years. Thus, banks with higher level of capital increase their overall investment in securities in crisis times, and

[3] As discussed later, we also estimate the regressions without bank fixed effects and find similar results.

[4] We define the crisis period starting on July 2007 when problems in the banking sector 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. In addition we also report the results for each individual quarter over 2005-12.

effects are stronger for securities that experienced a larger price drop in the previous quarter. The effects are stronger especially in securities with higher credit risk (proxied by lower ratings) and higher liquidity risk (proxied by higher maturity). Interestingly, for securities that do not have a market price (non-traded securities), we find that there is *no* difference in the level of investments for banks based on their level of capital.

Examining these compositional effects individually across each of the quarters in the crisis, we find that in most of the quarters banks with higher level of capital increase their investments in securities that have a higher percentage drop in price in the previous quarter. The results are economically strong in the worst quarter of the crisis (after 30th of September to December 31st, 2008). Moreover, we also find that the prices of securities revert over the subsequent quarters, thus increasing the realized return on investments. Finally, during the crisis we also find that banks with higher level of capital sell more securities. However, the magnitude of difference is smaller as compared to buys. In addition, we find that banks with higher levels of capital sell a larger volume of securities in which they have higher accumulated losses.

While we find that banks with higher level of capital invest more in securities that have had a larger fall in price, an important question that arises is whether this has any effects on the supply of credit to the real economy. Therefore, to get a more complete picture of how banks adjust their assets, we examine the lending behavior of banks based on the level of bank capitalization. We use borrower*time fixed effects to control for time-varying unobserved borrower fundamentals (e.g. risk) that proxy for credit demand. Thus, we examine for the same borrower, in the same period, whether banks differ in their lending behavior based on the level of capitalization.

We find that banks with higher level of capital decrease their supply of credit to non-financial firms during the crisis as compared to other banks. Thus for the same firm, in the same period, we find that banks with higher level of capital lend less (controlling for observed and unobserved time variant firm fundamentals).[5] Moreover, the decrease in lending is more pronounced in periods when overall securities prices fall more (and banks with higher capital invest more in securities). We also do not find any differences in the

[5] Note that in general during a large part of the crisis, the credit to firms in Germany was increasing, thus the results we find should interpreted as relatively lesser supply of credit by banks with higher level of capital rather than a credit crunch.

subsequent default rate for borrowers. Thus, there is no differential risk taking in terms of lending associated with bank capitalization. This suggests that the differences in credit supply are not stemming from different bank risk-taking incentives arising from different capital levels. Moreover, the coefficient is almost identical in value (and statistically not different) if we do not control for borrower fixed effects, which suggest that the covariance between bank capital (supply) and firm fundamentals (demand) is zero. This suggests that the results are unlikely to be driven by differential matching of borrowers to banks. Finally, the results on credit supply are binding at the firm level, though with a smaller coefficient than in the loan level analysis, which suggest that the change in credit supply has a binding effect at the firm level on credit availability.[6]

We examine several possible channels that could be consistent with the findings reported above. Maybe banks buy these securities (whose price has fallen) to prop up the price to make their investment portfolio look better. If window dressing were a prime driver of banks' behavior, one would expect banks to buy more of the securities which prices have fallen more in their investment portfolio. However, examining the buying behavior, based on cumulative loses/gains on the securities already existing in the investment portfolio, we do not find any significant differences. In fact, as reported above, we find that banks with higher level of capital sell more of the securities where they have higher accumulated loses.

Another potential channel could be that banks with low levels of capital cannot buy securities whose prices have fallen due to regulatory scrutiny. Thus it could be possible that the results are primarily driven by regulatory scrutiny that is faced by banks with low levels of capital. To address this concern, we estimate the results for banks with capital levels above the average, and find similar behavior. These banks are less likely to face regulatory scrutiny as they have sufficient capital buffers.[7] In fact, we find no statistically significant association between the investments in securities that have fallen in price and the level of capital for banks with below average level of capital.

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[6] Some of largest firms could substitute with debt securities, though evidence using our dataset on fixed income securities does not support this. We cannot check for real effects, but the evidence that firm level credit is reduced suggest that real effects could be present.

[7] As discussed later in the results section, we also find similar results if we control the liquidity availed from the central bank. In fact higher central bank liquidity is not associated to the buying of assets that have previously fallen in price.

Another possible channel could be hedging. For example, banks with higher level of capital expect future interest rates to be low, which in turn reduces their lending income. Therefore, they invest more in securities so that the gains from securities can act as a hedge against the drop in lending income. Note that this explanation relies on the price of the securities rising in environments where interest rates are low. Though looking at the data on trading income and lending income (1998-2012), we find that this correlation is positive, and even higher for banks with higher level of equity. Therefore, it seems unlikely that hedging behavior of banks could account for the results.

Another possible channel is through differential trading abilities. Banks with higher level of capital (or capital increases) could be more skilled at trading in securities and, therefore, in a crisis, increase their investments in securities to profit from the trading opportunities. In the presence of capital constraints, this could lead to them reducing the supply of credit (Diamond and Rajan, 2011). On the other hand banks with lower level of capital that do not have the trading skills to invest in securities, continue to lend (hence the differential behavior). We find that the average realized returns on investments made, especially after the failure of Lehman Brothers yield an annualized return of approximately 10% over the next year. However, the finding that banks do not differ in their investment behavior for securities with no market price (non-traded securities) suggests that the differential trading ability cannot be the whole explanation.

Moreover, when we control fully for time variant unobserved bank characteristics (bank*time fixed effects), results point out that banks with higher capital take on higher level of risk (lower ratings and higher maturity). In sum, these results suggest than rather than just ability, capital constraints in the middle of the crisis, are also an important driver of the results.[8] In fact in crisis times, when raising equity capital for banks is difficult, the results suggest that banks allocate scarce equity capital to exploit trading opportunities with substantial returns, thus relatively decreasing their supply of credit. These results suggest that in times of crisis returns from investment in securities compete with returns from

[8] In the periodic survey conducted by ECB, a majority of banks report capital constraints as an important factor affecting banking operations in the middle of the crisis. See Freixas and Rochet (2008) for models and evidence on why bank capital is costly, especially in crisis times. Admatti and Helwig (2013) question part of these costs.

lending (Diamond and Rajan, 2011; Shleifer and Vishny, 2010).[9] Interestingly, even in some of the quarters in the pre-crisis and post-crisis period (when there was spike in the VIX), we find that banks with higher level of capital invest more in securities that had a larger fall in price. However, we do not find a differential effect for credit supply in these periods.[10]

In sum, the results are consistent with banks with higher level of capital buying more of the securities whose prices can fluctuate (can go down even more in the short term) as they have higher equity buffers to absorb negative shocks in case the price of securities drops below their purchase price. In contrast, banks with lower level of equity buy less of the securities that have a market price, especially the riskier ones (with previous lower prices, lower rating and long term maturity), as they have less equity buffers to take on similar risks.[11] Moreover, these differential effects are stronger for the set of banks with more reliance on wholesale borrowing. This suggests that risk-taking by banks with lower capital is even more difficult in these cases as fragility of wholesale funding is substantially higher than stable retail saving deposits.[12]

Our results contribute to several strands of the literature. Our results contribute to theories that highlight strong synergies between the asset and liability of banks (Diamond and Dybvig (1983), Diamond and Rajan (2001), Kashyap, Stein and Rajan (2002), Gennaioli, Shleifer and Visnhy (2013), Hanson et al., (2014)).[13] Our results highlight these synergies as banks with higher level of capital through their securities investments take on higher risk in crisis times. Banks with higher level of capital can take on higher risk because of their equity buffers. However, our results do not look consistent with theories of

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9 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 the incentive effects that arise in borrowers (Stiglitz and Weiss, 1981). In addition, the effects arising from competition can also affect adjustments in lending rates.

10 This is consistent with the idea that in general when equity constraints are not very binding (and also the security prices are not very depressed), there is no significant crowding out of lending due to security investments.

11 Note that banks with low level of capital do not differentially take on more risk on loans (future default rates are not different). Other papers like Drechsler et al (2014), Acharya and Steffen (2014) also do not find risk shifting for European banks (they examine sovereign investments) in the period after the failure of Lehman Brothers.

12 The largest quarter effect in the crisis is in 2007:Q3 when the ECB still did not have fixed rate full allotment policy and wholesale finance problems were important.

13 Gatev and Strahan (2006) provide evidence on the synergies between deposit taking and lending.

gambling for resurrection of lowly capitalized banks in the crisis period (Stiglitz et al, 2000). Moreover, our results also contribute to the literature that shows that security trading by banks can affect credit supply (Diamond and Rajan (2011), Shleifer and Vishny (2010)).

Given our findings on bank capital and asset trading, our results are consistent with models of financial intermediation where capital constraints of banks have effects on asset demand and liquidity (Fostel and Geanokoplos (2008), Adrian and Shin (2010), Brunnermeier and Pedersen (2009), Gromb and Vayanos (2002), Xiong (2001) and Brunnemeier and Sannikov (2014), He and Krishnamurthy (2013).[14] These models relate equity constraints to the prevalence of leverage constraints or to risk aversion. Our results are also consistent with models of fire sales and lack of arbitrage capital (Allen and Gale (2005); Shleifer and Vishny (1992, 1997)).[15]

Our results also add to the literature that examines investment behavior of banks in sovereign debt during the European sovereign crisis (Battestini, Pagano, and Simonelli (2014); Acharya and Steffen (2014); Drechsler et al (2014)). The main focus of these papers is to examine risk-shifting incentives and financial repression by Euro area governments.[16] Finally, our results also contribute to the literature that examines the effects on credit supply during a crisis (Ivashina and Scharfstein, 2010; Iyer et al., 2014; Acharya et al., 2014; Becker and Ivashina, 2014; Jiménez et al, 2014). These papers document a decrease in lending by banks during the crisis, especially those banks more exposed to the shock.

The remainder of the paper is structured as follows. Section 2 presents the institutional details and data. Section 3 discusses the empirical strategy and results. Section 4 concludes.

[14] See also Allen and Gale (1994), Holsmtrom and Tirole (1998) and Kashyap and Stein (2004) that share similar predictions.

[15] See also Gorton and Metrick (2012) and He and Xiong (2012).

[16] 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 find that weakly capitalized increase their investments in risky sovereign debt consistent with risk shifting and moral suasion (using a sample of Euro area banks). Dreschler 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 that these papers however do not find risk-shifting behavior in the period after the failure of Lehman.

2. Data

The proprietary security and credit data we use for the analysis is obtained from the Deutsche Bundesbank, which is the micro and macro-prudential supervisor of the German banking system. 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 each quarter. The data comprises of investments of German banks at the security-level on a quarterly frequency from the last quarter of 2005 to the last quarter of 2012.[17] For each security, banks report the number of units they hold (stock at the end of each quarter).[18] We use the unique International Security Identification Number (ISIN) associated with every security to merge the data on security investments with the Euro-systems centralized securities database (CSDB) to obtain further information regarding the issuer of the security (domicile country and sector). We obtain price data from Bloomberg (nominal currency, market price).[19] Furthermore, we also obtain security-level information on rating, coupons and maturity from FactSet.

We supplement this database on security investments with confidential supervisory monthly balance-sheet statistics at the bank level. In particular, we collect monthly balance sheet items such as each bank's equity capital, total assets, interbank borrowings and savings deposits. In addition, we include records of each bank's return on equity retrieved from the Bundesbank's annual statistic of the bank's profit and loss accounts.

Finally, we obtain data on individual loans made by banks from the German credit register maintained by the Deutsche Bundesbank. Banks have to 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).

[17] Note that 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 we capture 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] While we know the security holdings of the banks, we do not know whether they are classified as trading book assets, available for sale or held to maturity (fixed assets).

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

The credit register, however, does not record the maturity and interest rate associated with the loans.

The complete securities holdings data consists of the universe 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 security holdings for which the total holdings for the entire banking sector were below EUR 10 million.[20] The resulting set of securities comprises of 95% of the total holdings. We also exclude from the analysis banks with total assets below EUR 1 billion.[21] In addition, we exclude Landesbanks and Mortgage banks from the analysis.[22] The final sample consists of 540 banks holding 89% of security holdings of the total banking system.

3. Results

Table 1 panel A, presents the summary statistics of the security characteristics over the entire sample, and also decomposed into three subsamples covering the key periods of the crisis. We denote the period until 2007:Q2 as the pre-crisis period, while we define the subsample 2007:Q3 – 2009:Q4 as the crisis period.[23] 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. The average rating of the securities over the entire sample period is 24, which corresponds to a rating of AA. The average maturity of securities is 62 months and the average adjusted current yield of securities is 3.18%. Moreover, the average rating of securities are very similar in crisis and non-crisis periods (24 in each of the periods). In terms of maturity, we find that there is a drop in the average maturity of securities from the pre-crisis period to the post-crisis. The average maturity is 65 months in the pre-crisis

[20] We do this for computational reasons. These securities also account for a very small fraction of the overall asset holdings.

[21] Banks with size below 1 billion in total assets are generally not very active in securities markets and their holdings are a very small fraction of the aggregate security holdings of banks.

[22] Landesbanks are (at least partly) owned by the respective federal state and thus considered to enjoy an implicit fiscal guarantee. Mortgage banks are prohibited by law to engage in (risky securities) investments. As discussed later, the results are robust to including these banks in the sample.

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

period, 63 months during the crisis, and 60 months in the post-crisis period.[24] We also find that the average adjusted current yield declines from 4.4% in the pre-crisis period to 2.7% in the post-crisis period.[25]

In Table 1 panel B, we report the summary statistics of the main bank characteristics that we use in the paper. The average capital ratio (equity to total assets) is 5.12%. The average total assets of banks over the entire sample is 9.3 billion Euros, the average fraction of interbank borrowings to total assets is 18.1%, the average fraction of savings deposits to total assets and return-on-equity are 25.6% and 18% respectively. Examining the differences in bank characteristics across of each of the sub-periods, in terms of average equity to total assets, we do not find much of a difference in the pre-crisis and the crisis period (5% in each of the periods). However, in the post-crisis period, this ratio is higher at 5.24%. In addition, we find that there is an increase in average total assets of banks' from the pre-crisis to the post-crisis period. The average total assets of banks' are 7.9 billion Euros in the pre-crisis period, 9 billion Euros in the crisis period, and 10 billion Euros in the post-crisis period. The average return-on-equity is lower in the crisis period (17.4%) as compared to 18.9% in the pre-crisis period and 18.3% in the post-crisis period. The average fraction of interbank borrowings to total assets is similar in the pre-crisis and the crisis period (18%) and is lower at 17% in the post-crisis period. The average fraction of saving deposits to total assets drops from 28.2 % in the pre-crisis period, to 23.8% in the crisis period and then increases to 25.5% in the post-crisis period.

In panel C, we report the average fraction of securities holdings to total assets (at the bank level) and the composition of security holdings. The average fraction of security holdings to total assets of banks is 19.80%. Securities with Aaa rating on average account for 40% of the total securities. The average fraction of domestic securities to total security holdings is 79%, while long-term securities account for 79% of the total security holdings. The average fraction of sovereign debt to total securities is 12.5%. New investments (Buys) in securities as a fraction of total securities are on average 10.24%, while fraction of securities sold by banks is 2.32%. In the pre-crisis period, the average fraction of security holdings to total assets is 18.7%; this increases to 19% in the crisis and 21% in the post-

[24] However, this drop could be mechanical due to the decrease in the time to maturity of securities as we move along from the pre-crisis to the post-crisis periods.

[25] This drop could be attributed to the loose monetary policy conditions prevailing in the post-crisis periods.

crisis period. The average fraction of Aaa securities to total securities is 41.78% in the pre-crisis period, decreases to 39.51% in the crisis and then increases to 39.93% in the post-crisis period. The average fraction of domestic securities decreases from 82% in the pre-crisis period to 79.7% in the crisis and further decreases to 76.8% in the post-crisis period. On the other hand, the average fraction of long-term securities decreases from 77.25% in the pre-crisis period to 76.52% in the crisis and then increases to 83.23% in the post-crisis period. The average fraction of sovereign debt is 13.05% in the pre-crisis period. During the crisis, the fraction of sovereign holdings decreases to 10.21% and then increases back to 14.16% in the post-crisis period. New investments to total securities are on average 11.1% in the pre-crisis period. During the crisis, the fraction of new investments to total securities increases to 12.57%. This fraction decreases to 7.88% in the post-crisis period. The average fraction of securities sold to total securities is 3.8% in the pre-crisis period and decreases to 2.2% in the crisis and further decreases to 1.68% in the post-crisis period.

In terms of the prices of securities, figure 1 presents the evolution of prices over the sample period. We see that there is a wide variation in prices of securities over the sample period. We find large price drops in the crisis period (2007:Q3 to 2008:Q4). On average in some of the quarters, the average prices of securities drop by around 5% (annualized price change). However, there is also wide heterogeneity in the price changes across different securities. This again highlights the importance of examining investment behavior at the security level as using aggregate data would mask these differences and could be misleading.

We now move to the main question of interest. That is to examine whether there are differences in security trading activities of banks based on the level of capitalization. Before presenting the results from the regression analysis, we first present a graphical representation of the main results. Figure 2, presents the net investments in securities by banks based on the level of capitalization. We see that there is a difference in the level of investments in securities based on the level of bank capitalization. Banks with higher level of capitalization invest more in securities (net investments), especially during the crisis period. A similar picture emerges when we look at separately at the buying behavior of banks (figure 3). On the sell side, there does not appear to be much of a difference across banks based on the level of capitalization. In terms of credit supply (figure 4), we see that

during the crisis, banks with higher level of capital lend less to firms. While in the beginning of the crisis there is an aggregate decline in credit, however over the crisis period we see that there is an overall increase in lending. However banks with higher level of capital lend less relative to other banks.

While the above graphs suggest there are differences in investments in securities and lending by banks based on the level of capitalization, we formally examine these differences using a regression framework. We first discuss the main econometric specification that we use for the analysis. Below we present the model for examining the net investments. The models that we use for other estimations are minor variants of this model. Our model for net investments takes the following form:

$$\text{Log}(\text{Amount}^{\text{buy/sell}})_{ibt} = B_1' X_{b,(t-1)} + B_2' X_{b,(t-1)} Y_{i,(t-1)} + \alpha_b + \gamma_{it} + \varepsilon_{ibt} \qquad (1)$$

where *Amount* refers to the nominal amount purchased ('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. Similarly, if there is a sell, we do the same calculation, however we after taking the logarithm, we multiply the resulting value by -1. Thus, for buys the dependent variable takes a positive value and for sells it takes a negative value. The dependent variable takes the value of 0 if there is no change in the level of holdings. We use this specification instead of computing the difference in logarithms as in many cases the initial holdings of the security are negligible and there are large holdings in the next quarter. Thus, looking at the percentage change in holdings can be misleading as it places a lot of weight on these observations.[26] 'X' is a vector of bank specific monthly balance sheet variables such as capital as a fraction of total assets. The vector 'Y' captures security-level variables like percentage change in price. We use lagged values (from the previous quarter) for all the independent variables to ensure that these variables are pre-determined. To control for example for banks with different business model, we include a bank fixed effect (α_b) to account for time invariant heterogeneity in bank characteristics and also control for the overall investment position of *each bank*,

[26] We also ran the results reported later just using the difference in levels (without making any log transformations) and find similar results.

We also include security*time fixed effects (γ_{it}) to control for time variant unobserved characteristics of individual securities. The inclusion of security*time fixed effects also helps us to control for – in each time period – how much of *each security* is issued and outstanding and, therefore, isolate the demand of risky securities. The estimation approach we use compares, for two banks that buy the same security, whether the level of investments in the security differs based on the level of capitalization. A positive coefficient of B_1 implies that banks with higher levels of capital investment more in securities or sell less of securities relative to other banks. A negative coefficient on the interaction term (B_2) implies that banks with higher levels of capital increase their investments of securities that had a larger drop in price in the previous quarter or sell more of securities that had a larger price increase.[27] Note that inclusion of inclusion of security*time fixed effects captures all the price variation in securities, thus the estimated coefficients are similar whether we use nominal holdings or holding at market value as a dependent variable.

Table 2, reports the results for the differences in overall investments in securities in the crisis based on the different level of bank capitalization. We use lagged values of equity to total assets to avoid concerns of reserve causality. Furthermore, we examine whether there are differences in the composition of securities investments, through interacting the percentage price change of a security in the previous quarter with bank capital. We use lagged percentage price change as proxy for securities that have higher risk in the last period and potentially higher expected returns. The ratings, maturity and adjusted current yield of securities are taken into account by the security*time fixed effects, thus we analyze whether banks with different level of capital change their composition of investments, in particular related to higher risk. It is important to note that including interactions of bank capital with other security characteristics (like ratings, etc.) does not alter the results.[28]

We first begin by reporting the results from the regressions without any bank fixed effects. Column 1 and 2, we see that banks with higher level of equity have higher level of

[27] In some specifications, we also include both bank*time (on top of security*time) fixed effects and thus estimate only the coefficient on the interaction term (controlling perfectly for overall change in securities at the bank level in each period).

[28] We include other bank controls in the regressions but the coefficients are not reported. While some of the other bank variables are important in determining bank behavior, the estimated coefficients are not consistent across specifications and time periods.

investments in securities. We also find that banks with higher level of equity have higher level of investments in securities that had a larger drop in price in the previous quarter. In column 3 and 4, we report the results including bank fixed effects. Thus, we examine whether banks with increases in equity have higher investments in securities. On average there is significant variation in the equity to total assets for banks in the crisis. The within and between bank standard deviation of equity to total assets is 0.5 and 1.5 respectively. We find that using bank fixed effects gives similar results to that reported in column 1 and 2. The advantage of using bank fixed effects is that it takes into account time invariant heterogeneity in bank characteristics. This is important given that we have banks with different business models. In addition some banks might just hold high levels of equity due to other unobserved reasons. In column 5, we also include bank-time fixed effects to account for time varying heterogeneity in bank characteristics and again find similar coefficients for the interaction of bank capital and lagged percentage change in price.

One problem with the interpretation of the results from Table 2 is that a positive coefficient on the equity ratio could be due to additional investments by banks with higher level of capital in securities. Alternatively, the difference in overall level of investments could be due to banks with lower capital levels selling more securities in the crisis. Similarly, the negative coefficient on the interaction term of bank capital and percentage change in price, could be due to banks with higher capital buying more of the securities that had a larger drop in price. Or it could be due to banks with higher capital selling more of the securities that have had a larger price increase. We therefore examine, the intensity of buys and sells separately. For this estimation, we use a modified version of the model specified by equation (1). For the intensity of buys, the dependent variable remains the same as before when there is a buy but takes the value of 0 if the security has been sold or if there is no change in the level of holdings.

Table 3 presents the results for the intensity of buys. From column 1 and 2, we find that higher bank capital (lagged) not only implies higher level of investments (buys), but also the coefficient on the interaction term is negative and significant (at 1% significance level). Thus, banks with higher capital levels buy more of securities that had a larger drop in price. In column 3, we include both bank*time and security*time fixed effects to account for all time variant heterogeneity in bank and security characteristics. To examine, whether the

findings are driven by regulatory scrutiny, we estimate the results for banks with above average level of capital. The argument of regulatory scrutiny being that banks with higher levels of capital – as opposed to banks with lower capital levels – can in fact engage in the purchase of securities that experience a larger price drop because regulatory monitoring is less binding for them. In column 4, we estimate the interaction term using a sub-sample of banks with capital levels above average. For these banks, regulatory monitoring is unlikely to be binding. We find that even for this sub-sample, the coefficient on the interaction term is negative (-0.045) and significant at 1% level. This suggests that regulatory scrutiny is unlikely to be the main driver of the results. This finding, in addition to the results reported in Table 2 (where we do not use bank fixed effects) further adds to the robustness of the results. The reason being that with bank fixed effects, one might be concerned that for banks with low level of capital, a fixed effect model would deem these banks to be well capitalized even for small spikes in the level of equity (even though they have low levels of capital as compared to other banks). Thus, finding similar results for the sub-sample of banks with higher than average level of equity capital adds to the robustness of the results.[29] In fact, we find no statistical significant association between the investments in securities that have fallen in price and the level of capital for banks with below average level of capital (not reported).

In column 5, we examine the investment behavior of banks with more stable liability structure. Several theoretical arguments have been put forth that suggest that banks with more fragile structure (wholesale funding) might be reluctant to hold risky assets as losses (without enough equity buffers) could potentially trigger a run on their liabilities. Thus, especially for banks with high reliance on wholesale funding, investment in risky assets should be more sensitive to capital levels. In column 5, we examine split the sample based on the average level of savings deposit funding (insured funding). We find that again for banks with less reliance on deposit funding (more reliance on wholesale funding), the coefficient on the interaction term is larger (more sensitive to bank capital). While the result above result is consistent with the idea that investment in risky assets is more

[29] We also examined whether liquidity availed from the European Central Bank is an important driver of the results. We do not find any significant effect of the interaction of liquidity availed and percentage change in price. That is, banks that avail higher amounts of liquidity from the ECB do not buy larger amounts of securities that had a larger drop in price. More importantly, the coefficient on the interaction of bank capital and percentage change in price still remains significant (not reported).

sensitive to the level of bank capital for banks with more reliance on wholesale funding, one must keep in mind the caveat that these banks could be different in other dimensions as well.

Finally, in column 6 and 7, we examine whether banks with higher level of capital might buy securities that have a larger price drop in an effort to increase the price of these securities to make their existing portfolio look good. Thus, banks with higher level of capital might engage in window dressing activities to make their existing investment portfolio look better. To examine this explanation, we include in the estimation the lagged cumulative gains/losses of the existing securities in a banks' investment portfolio. From column 6 and 7, we do not see any significant effect of lagged cumulative gains/loses of the securities held by banks on the buying behavior of banks. Also, as discussed later, we in fact find that banks with higher level of capital sell more of securities where they have accumulated larger loses in their existing investment portfolio.

In table 4, we further examine whether the behavior of banks differs across securities with different ratings and maturity. This helps us examine whether banks differentially take on fundamental risk (proxied by ratings) and liquidity risk (proxied by maturity). From columns 1, 2 and 3, we see that the coefficient on the level and interaction term is significant for non-Aaa rated securities. These results show that across all categories (except Aaa), banks with higher level of capital invest more in securities that had a larger drop in price. Further the magnitudes higher for the lower credit rating categories. In fact, the difference in the magnitude of investments increases as we move to the lower credit categories. Interestingly, there are no differential effects (both on the level and the interaction coefficient) when we examine investments in Aaa sovereign securities (not reported). Examining the buying behavior across securities with different maturities, presents a very similar pattern (column 4, 5 and 6). These results suggest that banks with higher level of capital buy more of securities whose prices have previously fallen, especially in investments with higher fundamental risk (proxied by ratings) and higher liquidity risk (proxied by longer maturity).

The results above capture the differential investment behavior of banks with different levels of capital for securities that have a traded price. However, there are also several securities that do not have a readily available market price. In table 4, column 7, we

examine the buying behavior of banks for these securities and find no differential impact of capital on the level of buys of these securities. The question that arises is why are banks with low levels of capital more reluctant to buy securities that have a traded price as compared to banks with higher capital but do not differ in their investment behavior for non-traded securities. One possible channel could be the risk of writing down the security value when the market value falls below the reported amortized cost, which may imply a direct impact on net income (and on capital). In contrast, while the above principle also applies for non-traded securities, banks can rely on models to determine the price. Thus for traded securities the volatility of the security price could directly affect the net income (if the price falls below the purchase price). On the other hand, for securities that have no traded price, banks have more ability to manage the price (through the model) to minimize further price reductions or even impairment.[30]

So far, we have examined the differences in the composition of risk based on the level of bank capitalization. We now move on to examine the investment behavior individually in each of the quarters of the crisis. This helps serve two purposes. First, it helps understand whether the results are sensitive to the definition of the crisis. Second, and more importantly it helps in understanding investment behavior at different points in the crisis. Table 5 presents the results. We find that for most of the quarters in the crisis period (up to 2009:Q2) the coefficient on the interaction is negative and significant.[31] In the quarter with the highest drop in financial markets, following Lehman failed in October-December 2008,

[30] Most of the Banks in Germany follow the German local GAAP (HGB), however some banks also report under IFRS. Under HGB, securities have to be written down to the market value, when the market value falls below the reported amortized cost (strict lower of cost or market value principle). This decrease of the market value below historical cost has a direct impact on net income (unlike under IFRS). However, if the bank holds the securities in the fixed assets category (similar to held-to-maturity category), then the assets do not have to be written down (unless it is severely impaired). We do not have the data on this 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%). Note that even if the assets are held in the held-to-maturity category, if prices drop substantially below the historical cost price, there is an impairment. In addition, the assets in held-to-maturity category are substantially difficult to sell. Sell also Allen and Carletti (2009) for the role of mark-to-market accounting and liquidity pricing.

[31] Note that the when we estimate the interaction term for each quarter, we exploit the cross-sectional variation in bank capital. We include bank fixed effects and security fixed effects and thus we estimate only the interaction term.

and also in the initial period of the crisis (2007:Q3), we find that the coefficients on the interaction terms are highly economically and statistically significant.[32]

While in Table 3 and 4, we examine the buying behavior of banks, it is important to examine whether the levels and composition of securities sold by banks differs based on the level of capitalization. Note, that from the summary statistics reported in Table 1, we find that banks only sell a small fraction of their assets during the crisis. Table 6, reports the regression results for selling behavior of banks in the crisis period. From column 1 and 2, we see that there is higher volume of sells by banks with higher levels of capital. The coefficient on bank capital is 0.06 but smaller in magnitude relative to coefficient of 0.16 for buys reported earlier. The coefficient on the interaction of bank capital and lagged percentage fall in price is also not significant, even if we add bank*time (on top of security*time) fixed effects in column 3. Thus there is no difference in the volume of securities sold that had a larger drop in price based on the level of bank capitalization.

In column 4, we examine estimate the interaction term for banks with above average levels of capital. We find that banks with higher level of capital sell more of securities that have risen in price. In column 5, we examine whether banks sell higher volume of securities where they have larger accumulated gains or losses in their existing investment portfolio. We find that banks sell higher volume of securities where they have accumulated larger losses (column 5). Interestingly, this magnitude is higher for banks with higher levels of capital (column 6). This suggests that banks with higher levels of capital also are more likely to book loses in securities where they have large accumulated loses. Thus, these results suggest that banks with lower levels of capital are more likely to have a hangover of bad assets in their investment portfolio. Note that given the finding that German banks in general sell a very small fraction of their holdings, one could ask who are the sellers of the securities that these banks are buying. We do not have data at transaction level to identify the counterparties. These could be entities outside the German Banking system. However, we examine the ratio of aggregate holdings of all securities (below Aaa rating) by the German Banking system to the total overall outstanding amount of these securities in the market (using the data on outstanding amount of the security). We find this ratio increases

[32] We find similar results even for the non-Aaa rated securities and securities with residual maturity higher than one year.

in the crisis period and declines in the period after the crisis (figure A1, appendix). This suggests that the German banking system in the aggregate increases the holdings of these non-Aaa securities in the crisis period (on the other hand holdings of Aaa securities decrease). This suggests that there is relocation of non-Aaa assets to banking system in the crisis.

In Table 7, we examine the intensity of buys and sells during the pre-crisis and post-crisis period. Panel A presents the estimates for the pre-crisis and post-crisis period. As can be seen from column 1 to 4, we do not find significant differences in the level or composition of buys and sells across banks with different level of capitalization. Similarly, we also do not find any differences in the post-crisis period (column 5 to 8). While Panel A reports the results for the entire pre-crisis and post-crisis period, there are some quarters during this period where there is a substantial drop in prices, notably during the Greek crisis around mid 2010 and the Italian and Spanish crisis in 2011, and also during the first quarter of 2007 (in which the US subprime borrowers were already defaulting and real estate prices reducing). Thus, examining the composition of investments over the entire period could mask differences in individual quarters. In Panel B and C, we examine the composition of buys for each of the quarters in the pre-crisis and post-crisis period. We see that in general the coefficient on the interaction term of bank capital and lagged percentage price change is not significant in most of the quarters. However, there are some quarters where the interaction term is significant. Mapping the quarters to the graph of security price changes, we see that the interaction term is negative and significant in quarters where there is an average drop in prices of securities. In fact, these quarters are also quarters where there is a sharp spike in VIX (periods of high uncertainty).

The overall results discussed above suggest that banks with higher level of capital increase their holdings of securities and buy more of securities that have a larger fall in price. However, an important question that arises is whether the lending behavior of banks differs based on the level of capitalization. That is how do banks rebalance their loan portfolio based on their level of capitalization. Given that the equity capital of banks supports a given level of assets held on the balance sheet (securities and loans), it is possible that increase in investments in securities might lead to a rebalancing of the loan portfolio (in the presence of capital constraints). In Table 8, we examine the lending

behavior of banks based on the level of capitalization. We control for time varying credit demand and risk of borrowers using borrower*time fixed effects. Thus, we compare the change in the level credit for the same borrower across banks with different levels of capital, in the same time period.

From column 1, we find that in the crisis period, banks with higher level of capital lend less to the same borrower (firm) at the same time as compared to banks with lower capital. In column 2, we interact the level of capital with the average percentage change in prices of all securities in that quarter. The idea being that one would like to examine whether banks with higher level of capital lend less in quarters when the average security prices fall by more. We find that banks with higher capital not only reduce their overall supply of credit in crisis times, but the stronger effects are when overall securities prices fall more. In column 3, we examine the coefficient of the interaction term using lagged percentage change in price for all securities in the previous quarter (as opposed to the same quarter in column 2). We find similar results to that reported in column 2. Note that in these regressions we also control for borrow-time fixed effects, to make sure the results are not driven by time-varying credit demand from borrowers.

To examine whether banks differential take incremental risk in loans, we also examine the interaction of level of bank capital with future loan defaults (2 years down).[33] Column 4 reports the results from this estimation. We find that the coefficient on the interaction term of capital with future default is not significantly different from zero. These results suggest that banks did not differentially take on more risk in loans based on their level of capital. In column 5, we report the results for banks with above average level of equity capital. In line with the results reported for the securities regression, we find that the effect is significant for banks with above average level of capital. That is for banks with above average level of capital, increases in capital are associated with a decrease in credit supply.

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 firms matching with banks differentially. To investigate this differential matching channel, in column 6, we run the estimation without borrower fixed effects. We find non-inclusion of borrower fixed effects

[33] Weaker banks might take more credit risk by lending higher amounts to riskier borrowers. Thus, differences in level of credit might just arise due to different ways of taking on risk by banks with different levels of banks (see Jimenez et al, 2014).

does not alter the magnitude of the coefficients on the bank capital level but reduces the R-squared. If borrower demand was an important driver of the results, the coefficient on bank capital should be significantly different with and without borrower fixed effects. We also ran the estimations including bank-borrower fixed effects to control for match and find similar results (not reported). These results suggest that differential borrower demand arising due unobserved matching between banks and borrowers is unlikely to be a main driver of the results.

We also examined the robustness of the results on several other dimensions. We find similar results even if we do not include bank fixed effects. We also excluded savings banks from the analysis, as one could be concerned that these banks have different objectives, and find similar results. Finally, we estimated the regressions controlling for the loan exposures of banks to different sectors (and the results remain unchanged). Note that in general there was an increase in the supply of credit to firms in Germany during the crisis (except for the initial period). Thus, rather than a cut back in credit by banks with higher level of capital, the results should be interpreted as a lower supply of credit (lend less as compared to other banks).

In table 9, we examine whether firms can substitute the decrease in credit supply from banks with higher level of capital by borrowing more from other banks. For instance, imagine a firm that had two banking relationships before the crisis, one with a bank with higher level of capital, the other with a bank with a lower capital level. One could find that there is no reduction in total credit available for the firm by looking across all the loans given to the firm from all the different banks. To examine this issue, we first construct a measure of the average exposure to banks with different capital levels for each firm before the crisis. That is, for each firm we measure the (weighted) average of the capital level of banks that lend to that firm before the crisis (2007:Q2). From column 1 and 2, we see that firms that were borrowing more from banks with higher levels of capital faced a higher reduction in total credit from banks. Note that while we include firm fixed effects, this specification (column 2) unlike the one reported in Table 8, does not completely account for time variation in firm credit demand. In column 3 and 4, we also find that these effects are more pronounced in periods where the average security prices fall by more. While, we

do not observe whether these firms can substitute this reduction in bank credit from other sources like trade credit, to the extent that this is not case, there could be real effects.

In Table 10, we examine the lending behavior of banks in the pre-crisis period we find opposite results to that in the crisis. We find that banks with higher level of bank capital increase the supply of credit (column 1). In the post-crisis period, we do not find any differences in credit supply across banks with different levels of capital (column 5). We also do not find any significant effects of average security prices on credit supply in the pre-crisis and post-crisis periods (column 2 and 6). Furthermore, there are also no significant differences in interaction of level of capital and future default rates in these periods (column 3 and 7). We also do not find any difference in the level of total debt for a firm based on the average exposure to banks with different capital levels in these periods (column 4 and 8).

The question that still lingers is why are banks with higher level of capital increasing their investment in securities and decreasing supply of credit. We examine several potential explanations. The first channel we investigate is whether banks invest in securities as the gain from trading acts as hedge against lending income. The idea being that banks with higher level of capital expect future interest rates to be low which in turn reduces their income from lending. Therefore, banks invest in securities whose prices rise with lower interest rates thus acting as 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. In particular, we find that for banks with higher level of equity this correlation is positive and strong. 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, thus holding high quality sovereign assets can provide a hedge, this is not generally the case for securities that have higher credit risk. Thus it is difficult to explain our results purely by the hedging explanation.

Another possible channel is through differential trading abilities. Banks with higher level of capital (or capital increases) could be more skilled at trading in securities. Therefore in a crisis, where the gains from trading could be high for skilled investors, they increase their investments in securities to profit from the trading opportunities. If there were

no capital constraints, this would not lead to a reduction in credit supply as they could increase their investments and also raise additional leverage/equity to lend. However, the presence of capital constraints, could lead them to reduce the supply of credit as they increase their investments in securities (Diamond and Rajan, 2011). On the other hand, banks with lower level of capital (or capital decreases), if they do not have the trading skills will not invest in securities and instead lend. Note that this channel also leads to returns from securities trading compete with returns from lending.

Before, further examining whether this explanation, it is first important to examine whether the returns from investing in these securities are indeed high. We compute the realized return on investments by banks that have higher level of capital. To do this we examine the average return on a portfolio of securities formed by mimicking the investments of banks with high level of capital. We create a portfolio by selecting the same securities (that had fallen in price) and the same timing of investments, as banks with higher than average levels of capital. Using this method, we find that the realized returns on investments made after the failure of Lehman Brothers yield an annualized return of approximately 10% over the next year. However, as discussed earlier, we find that banks with lower level of capital do not differ in their investments in securities that have no traded price. This is seems less consistent with a purely ability based explanation. Moreover, the results reported earlier for different categories (where the differential effects were larger in the lower credit categories), point that banks with higher capital can take on higher risk.

These results suggest that a pure ability based explanation cannot fully account for the results, and suggest that capital buffers also play an important role in explaining the findings. The returns from trading in these securities (that have fallen in price) could be high but there is also the risk of the prices moving down further. Thus skills in trading per-se might not enough to invest in these securities, as one might need the equity cushion to absorb negative shocks that could arise. That is banks with higher capital invest more in securities (that have fallen in price) as they have the equity cushion to absorb the risk that could arise from investments in these securities.

Moreover the finding that banks do not differ in their investment behavior for securities with no market price (non-traded securities) reinforces the view that banks with higher level of capital can buy more of the securities whose prices can fluctuate. These

banks have higher equity buffers to absorb negative shocks in case the price of securities drops below their purchase price (and affects profits and capital). In contrast, banks with lower level of capital buy less of the securities that have a market price, especially the riskier ones (with previous lower prices, lower rating and long term maturity), as they have less equity buffers to take on similar risks. Note that we do not find that banks with lower level of capital take on higher risk through loans.[34] Moreover, these differential effects are stronger for the subset banks, which have more reliance on wholesale borrowing. This suggests that, in a crisis period, risk-taking by banks with lower level of capital is even more difficult in these cases, as the fragility of wholesale funding is substantially higher than stable retail saving deposits.

Like before, the capital buffer explanation does not imply a reduction in credit supply by banks with higher level of capital. If there were no equity capital constraints, banks with high level of capital could invest in these securities and also lend by raising additional leverage/equity. Some evidence that suggest that this could be the case comes from the European Central Bank survey of Euro area banks. Many banks report capital and wholesale funding constraints as important factors affecting business operations. Also, in the other periods pre-crisis and post-crisis, we find that banks with higher capital invest more in securities that have a larger drop in price, but there is no relative decrease in lending. This is again consistent with the idea that in other periods, when capital constraints are less likely to be binding, investment in securities does not crowd out lending.

4. Conclusion

We analyze security-trading activities of banks and the associated spillovers to the supply of credit along the cycle. Empirical analysis has been elusive due to the lack of comprehensive securities register for banks. We use a unique proprietary dataset of *investments* of banks at the *security-level* for the period between 2005-12, in conjunction

[34] The average default rate on loans in peak of the crisis was 1.1%. In terms of comparison, this corresponds approximate to default rate on a Aa rated security at that time. Also, note that in general the quality of loans in Germany was not bad. Germany was one the few countries in the Euro area whose economy was not doing badly and this was also reflected by the faster recovery from the crisis. Some of the German banks experienced problems due to investments is assets originated by banks from other countries and not from defaults arising from loans to German borrowers.

with the credit register from Germany. We examine the security trading activities of banks based on their level of capitalization.

The robust results suggest that banks with higher levels of capital increase their overall net investments in securities during a crisis. Furthermore, banks with higher level of capital buy more securities that had a larger drop in price, especially lower rated securities and securities with longer maturity. We do not have these differential effects for securities without a market price. Moreover, we find that banks with higher level of capital sell more of securities in the crisis, and the effects are higher for the securities that they have larger accumulated loses in their existing investment portfolio (as compared to banks with lower level of capital). These effects are not driven by banks with a below average level of capital, and effects are stronger for banks that rely more on wholesale finance. Finally, banks with higher level of capital reduce their supply of credit in crisis times, with stronger effects when overall securities prices fall more. We also find binding credit effects at the firm level.

Overall our results suggest that during a crisis, returns from investing in securities can crowd out lending and banks with higher levels of capital act as risk absorbers. The question that this naturally raises is whether, absent banks, would other intermediaries be able to absorb the risk and provide liquidity to the asset markets. While this is beyond the scope of this paper, there is some evidence that other intermediaries like shadow banks, were deleveraging during the crisis and selling risky assets. Thus, to the extent that banks are large players in these markets, our results suggest that restrictions on trading in securities by banks could affect markets.

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TABLE 1 - SUMMARY STATISTICS

	Overall			Pre-crisis			Crisis			Post		
	avg	**std**	**obs**	**avg**	**std**	**obs**	**avg**	**std**	**obs**	**avg**	**std**	**obs**
Panel A: Securities variables												
Adjusted Current Yield	3.64	4.69	166403	4.44	5.96	37258	4.42	4.89	52968	2.70	3.51	76177
Maturity	62.46	72.03	166403	65.01	75.68	37258	63.14	75.55	52968	60.74	67.52	76177
Rating	24.54	3.39	119498	24.44	3.16	25705	24.69	3.29	38366	24.47	3.56	55427
Panel B: Banks' BS variables												
Total Assets (TA)	9371	42600	15312	7962	30400	3696	9042	36000	5280	10500	52600	6336
Size (Logarithm of TA)	14.72	1.11	15312	14.61	1.13	3696	14.71	1.12	5280	14.80	1.09	6336
Capital / TA	5.12	1.70	15312	5.02	1.58	3696	5.05	1.59	5280	5.24	1.85	6336
Interbank Borrowing / TA	18.11	12.71	15312	18.72	13.01	3696	18.89	12.87	5280	17.10	12.32	6336
Savings Deposits / TA	25.62	12.65	15312	28.24	13.13	3696	23.88	12.22	5280	25.53	12.46	6336
Return on Equity	0.18	0.08	15271	0.19	0.08	3689	0.17	0.08	5270	0.18	0.08	6312
Loans / TA	56.40	15.64	15312	57.20	15.63	3696	55.54	15.53	5280	56.66	15.70	6336
Panel C: Banks' securities holdings												
Securities Holdings / TA	19.80	10.81	14772	18.61	10.65	3167	19.06	10.38	5276	21.02	11.13	6329
% Aaa securities	40.18	24.54	14658	41.78	25.00	3163	39.51	25.90	5223	39.93	23.06	6272
% domestic securities	78.94	21.23	14772	82.11	18.93	3167	79.67	20.74	5276	76.75	22.46	6329
% long-term securities	79.55	16.63	14709	77.25	17.06	3166	76.52	18.80	5246	83.23	13.48	6297
% sovereign securities	12.51	15.45	14772	13.05	15.92	3167	10.21	14.20	5276	14.16	15.98	6329
Buys / Securities Holdings	10.24	11.12	14772	11.10	11.75	3167	12.57	12.59	5276	7.88	8.76	6329
Sells / Securities Holdings	2.32	5.35	14772	3.80	7.52	3167	2.20	4.58	5276	1.68	4.42	6329

This table shows the summary statistics of the variables used in the paper. Panel A shows the summary statistics for security-level variables. Panel B shows the summary statistics for bank balance-sheet and income variables. Panel C shows the summary statistics at bank level of the holdings of securities. Domestic securities are securities issued by German issuers. Long-term securities refer to securities with remaining maturity of more than one year. Sovereign securities are securities issued by central governments. Buys / Securities and Sells / Securities express, in % over total securities holdings, the total gross investments and desinvestments, respectively.

TABLE 2. TRADING BEHAVIOR DURING THE CRISIS

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Capital / TA $_{(t-1)}$	0.034*	0.034*	0.204***	0.211***	0.252***	0.255***	
	(0.020)	(0.020)	(0.044)	(0.044)	(0.080)	(0.080)	
Capital / TA $_{(t-1)}$ * % Change in Price $_{(t-1)}$		-0.036**		-0.040***		-0.041***	-0.045***
		(0.015)		(0.013)		(0.013)	(0.013)
Observations	208,359	208,359	208,359	208,359	208,359	208,359	208,359
R-squared	0.273	0.273	0.053	0.053	0.275	0.275	0.283
Time FE	><	><	Y	Y	><	><	><
Security FE	N	N	Y	Y	><	><	><
Bank FE	N	N	Y	Y	Y	Y	><
Security * Time FE	Y	Y	N	N	Y	Y	Y
Bank * Time FE	N	N	N	N	N	N	Y

The dependent variable is the logarithm of investment (nominal value) in security *i* by bank *b* at time *t*. The estimated model is specified in equation (1) in the main text (empirical section). The table reports the estimated coefficients and robust standard errors (in parentheses) clustered at bank level estimated using least squares. The change in price is included in the regressions without Security * Time FE. All regressions include bank controls (Size, Interbank borrowing / TA, Deposits / TA, and Return on equity) and the interactions with the change in price. See Appendix for the exact definition. The change in price is normalized by its standard deviation. The within standard deviation of C/TA is 0.5 %. Fixed effects and other controls are included ("Y"), not included ("N"), or spanned by other fixed effects ("><"). ***: Significant at 1 percent level; **: Significant at 5 percent level; *: Significant at 10 percent level.

TABLE 3. BUYING BEHAVIOR DURING THE CRISIS

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Capital / TA $_{(t-1)}$	0.129***	0.157***					
	(0.024)	(0.034)					
Capital / TA $_{(t-1)}$ * % Change in Price $_{(t-1)}$	-0.043***	-0.050***	-0.050***	-0.045***	-0.050**	-0.043***	-0.042***
	(0.007)	(0.008)	(0.008)	(0.012)	(0.021)	(0.009)	(0.00883)
Cumulative Gains on the Security / TA $_{(t-1)}$						-0.948	-1.004
						(1.385)	(1.393)
Cumul. Gains on the Sec. / TA $_{(t-1)}$ * C / TA $_{(t-1)}$							-0.157
							(0.288)
Observations	208,359	208,359	208,359	118,298	149,078	200,460	200,460
R-squared	0.292	0.443	0.453	0.342	0.466	0.480	0.480
Sample of banks	All	All	All	C/TA above average	DEP/TA below average	All	All
Time FE	Y	><	><	><	><	><	><
Security FE	Y	><	><	><	><	><	><
Bank FE	Y	Y	><	><	><	><	><
Security * Time FE	N	Y	Y	Y	Y	Y	Y
Bank * Time FE	N	N	Y	Y	Y	Y	Y

The dependent variable is the logarithm of the amount bought (in nominal value) of security *i* by bank *b* at time *t*, 0 if there is no buy. The table reports the estimated coefficients and robust standard errors (in parentheses) clustered at bank level estimated using least squares. The change in price is included in the regressions without Security * Time FE. All regressions include bank controls (Size, Interbank borrowing / TA, Deposits / TA, and Return on equity) and the interactions with the change in price. See Appendix for the exact definition. The change in price is normalized its standard deviation. The within standard deviation of C/TA is 0.5 %. Fixed effects and other controls are included ("Y"), not included ("N"), or spanned by other fixed effects ("><"). ***: Significant at 1 percent level; **: Significant at 5 percent level; *: Significant at 10 percent level.

TABLE 4. BUYING BEHAVIOR DURING THE CRISIS FOR DIFFERENT TYPES OF SECURITIES

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Capital / TA $_{(t-1)}$	0.259**	0.232***	0.615***	0.243***	0.196**	0.594***	0.113
	(0.104)	(0.074)	(0.122)	(0.084)	(0.082)	(0.103)	(0.090)
Capital / TA (t-1) * % Change	-0.030	-0.035***	-0.047**	-0.020	-0.054***	-0.050***	
in Price (t-1)	(0.021)	(0.013)	(0.022)	(0.017)	(0.013)	(0.017)	
Observations	57,503	103,237	62,566	41,576	128,506	45,077	114,551
R-squared	0.392	0.372	0.382	0.421	0.366	0.369	0.737
Sample	Aaa rated securities	Aa to A rated securities	Below A rated securities	Below 1 year securities	1 to 5 year securities	5 to 10 year securities	No market price securities
Bank FE	Y	Y	Y	Y	Y	Y	Y
Security * Time FE	Y	Y	Y	Y	Y	Y	Y

The dependent variable is the logarithm of the amount bought (in nominal value) of security *i* by bank *b* at time *t*, 0 if there is no buy. The table reports the estimated coefficients and robust standard errors (in parentheses) clustered at bank level estimated using least squares. All regressions include bank controls (Size, Interbank borrowing / TA, Deposits / TA, and Return on equity) and the interactions with the change in price. See Appendix for the exact definition. The change in price is normalized by its standard deviation. The within standard deviation of C/TA is 0.5 %. Fixed effects and other controls are included ("Y"), not included ("N"), or spanned by other fixed effects ("><"). ***: Significant at 1 percent level; **: Significant at 5 percent level; *: Significant at 10 percent level.

TABLE 5. BUYING BEHAVIOR DURING THE CRISIS: QUARTER-BY-QUARTER

	2007Q3	2007Q4	2008Q1	2008Q2	2008Q3	2008Q4	2009Q1	2009Q2	2009Q3	2009Q4
Capital / TA $_{(t-1)}$ * % Change in Price $_{(t-1)}$	-0.126**	0.104	-0.072**	-0.078**	-0.000	-0.080***	-0.091***	-0.081***	-0.051	0.001
	(0.052)	(0.069)	(0.035)	(0.039)	(0.007)	(0.023)	(0.017)	(0.024)	(0.039)	(0.013)
Observations	21,121	21,737	21,026	20,702	20,628	20,342	19,772	19,843	22,010	23,623
R-squared	0.480	0.457	0.430	0.452	0.493	0.442	0.490	0.452	0.466	0.499

The dependent variable is the logarithm of the amount bought (in nominal value) of security *i* by bank *b* at time *t*, 0 if there is no buy. The table reports the estimated coefficients and robust standard errors (in parentheses) clustered at bank level estimated using least squares. All regressions include bank controls (Size, Interbank borrowing / TA, Deposits / TA, and Return on equity) and the interactions with the change in price. See Appendix for the exact definition. The change in price is normalized by its standard deviation. All regressions have Bank FE and Security FE. ***: Significant at 1 percent level; **: Significant at 5 percent level; *: Significant at 10 percent level.

TABLE 6. SELLING BEHAVIOR DURING THE CRISIS

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Capital / TA $_{(t-1)}$	0.084***	0.067**					
	(0.021)	(0.034)					
Capital / TA $_{(t-1)}$ * % Change in Price $_{(t-1)}$	0.009	-0.001	0.005	0.055***	0.031	0.009	0.012
	(0.013)	(0.013)	(0.014)	(0.018)	(0.029)	(0.014)	(0.014)
Cumulative Gains on the Security / TA $_{(t-1)}$						-3.946***	-4.285***
						(1.388)	(1.445)
Cumul. Gains on the Sec. / TA $_{(t-1)}$ * C / TA $_{(t-1)}$							-1.098*
							(0.656)
Observations	188,775	188,775	188,775	128,537	127,613	176,972	176,972
R-squared	0.261	0.394	0.417	0.529	0.456	0.432	0.432
Sample of banks	All	All	All	C/TA above average	DEP/TA below average	All	All
Time FE	Y	><	><	><	><	><	><
Security FE	Y	><	><	><	><	><	><
Bank FE	Y	Y	><	><	><	><	><
Security * Time FE	N	Y	Y	Y	Y	Y	Y
Bank * Time FE	N	N	Y	Y	Y	Y	Y

The dependent variable is the logarithm of the amount sold (in nominal value) of security *i* by bank *b* at time *t*, 0 if there is no sell. The table reports the estimated coefficients and robust standard errors (in parentheses) clustered at bank level estimated using least squares. The change in price is included in the regressions without Security * Time FE. All regressions include bank controls (Size, Interbank borrowing / TA, Deposits / TA, and Return on equity) and the interactions with the change in price. See Appendix for the exact definition. The change in price is normalized by its standard deviation. The within standard deviation of C/TA is 0.5 %. Fixed effects and other controls are included ("Y"), not included ("N"), or spanned by other fixed effects ("><"). ***: Significant at 1 percent level; **: Significant at 5 percent level; *: Significant at 10 percent level.

TABLE 7. BUYING AND SELLING BEHAVIOR OUTSIDE THE CRISIS

PANEL A: BUYING AND SELLING OUTSIDE THE CRISIS

	PRE-CRISIS				POST-CRISIS			
	BUYS		SELLS		BUYS		SELLS	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Capital / TA $_{(t-1)}$	-0.191*	0.124	0.088	0.107	-0.103	-0.114	0.056	0.063
	(0.115)	(0.121)	(0.144)	(0.130)	(0.086)	(0.083)	(0.118)	(0.101)
Capital / TA $_{(t-1)}$ * % Change in Price $_{(t-1)}$	-0.011	-0.008	0.016	0.019	-0.017	-0.021	-0.014	-0.009
	(0.015)	(0.022)	(0.021)	(0.022)	(0.013)	(0.014)	(0.013)	(0.016)
Observations	116,658	116,658	103,912	103,912	347,557	347,557	362,787	362,787
R-squared	0.256	0.359	0.278	0.400	0.345	0.460	0.277	0.410
Time FE	Y	><	Y	><	Y	><	Y	><
Security FE	Y	><	Y	><	Y	><	Y	><
Bank FE	Y	Y	Y	Y	Y	Y	Y	Y
Security * Time FE	N	Y	N	Y	N	Y	N	Y

PANEL B: BUYING PRE-CRISIS, QUARTER-BY-QUARTER

	2006Q2	2006Q3	2006Q4	2007Q1	2007Q2
Capital / TA $_{(t-1)}$ * % Change in Price $_{(t-1)}$	-0.000	-0.012	-0.021	-0.187***	-0.050
	(0.019)	(0.017)	(0.042)	(0.065)	(0.033)
Observations	19,408	19,887	20,523	19,713	20,228
R-squared	0.456	0.472	0.490	0.465	0.462
Security FE	Y	Y	Y	Y	Y
Bank FE	Y	Y	Y	Y	Y

PANEL C: BUYING POST-CRISIS, QUARTER-BY-QUARTER

	2010Q1	2010Q2	2010Q3	2010Q4	2011Q1	2011Q2	2011Q3	2011Q4	2012Q1	2012Q2	2012Q3	2012Q4
Capital / TA $_{(t-1)}$ * % Change in Price $_{(t-1)}$	0.026	0.001	-0.121***	0.039	-0.063*	0.037	-0.026	-0.048**	-0.082*	0.042*	-0.001	0.036*
	(0.019)	(0.059)	(0.039)	(0.033)	(0.036)	(0.045)	(0.022)	(0.021)	(0.045)	(0.023)	(0.031)	(0.019)
Observations	26,377	25,714	28,444	29,369	29,952	28,090	28,658	29,394	28,835	29,518	31,089	32,117
R-squared	0.455	0.469	0.446	0.470	0.446	0.472	0.463	0.472	0.453	0.483	0.497	0.480
Security FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Bank FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

The dependent variable is the logarithm of the amount bought / sold (in nominal value) of security *i* by bank *b* at time *t*, 0 otherwise. The table reports the estimated coefficients and robust standard errors (in parentheses) clustered at bank level estimated using least squares. The change in price is included in the regressions without Security * Time FE. All regressions include bank controls (Size, Interbank borrowing / TA, Deposits / TA, and Return on equity) and the interactions with the change in price. See Appendix for the exact definition. The change in price is normalized by its standard deviation. The within standard deviation of C/TA is 0.5 %. Fixed effects and other controls are included ("Y"), not included ("N"), or spanned by other fixed effects ("><"). ***: Significant at 1 percent level; **: Significant at 5 percent level; *: Significant at 10 percent level.

TABLE 8. CREDIT SUPPLY DURING THE CRISIS

	(1)	(2)	(3)	(4)	(5)	(6)
Capital / TA $_{(t-1)}$	-0.044**	-0.053***	-0.048**	-0.043**	-0.043**	-0.040***
	(0.020)	(0.020)	(0.020)	(0.019)	(0.019)	(0.014)
C/TA $_{(t-1)}$ * Average Price Change Securities $_{(t)}$		0.009**			0.009*	
		(0.004)			(0.005)	
C/TA $_{(t-1)}$ * Average Price Change Securities $_{(t-1)}$			0.006*			
			(0.004)			
Capital / TA $_{(t-1)}$ * Future Default				-0.015		
				(0.036)		
Observations	554,485	554,485	554,485	554,485	334,437	554,485
R-squared	0.626	0.626	0.626	0.626	0.731	0.048
Bank FE	Y	Y	Y	Y	Y	Y
Borrower * Time FE	Y	Y	Y	Y	Y	N

Dependent variable: logarithm of total debt from borrower *j* to bank *b* at time *t*. The table reports the estimated coefficients and robust standard errors (in parentheses) clustered at bank level estimated using least squares. All regressions include bank controls (Size, Interbank borrowing / TA, Deposits / TA, and Return on equity). See Appendix for the exact definition. The sample of specification (5) includes only banks with C/TA above average. The within standard deviation of C/TA is 0.5 %. Fixed effects are included ("Y"), not included ("N"), or spanned by other fixed effects ("><"). *** Significant at 1 percent level; ** Significant at 5 percent level; * Significant at 10 percent level.

TABLE 9. REAL EFFECTS DURING THE CRISIS: FIRM-LEVEL CREDIT

	(1)	(2)	(3)	(4)
Capital / TA $_{(t-1)}$	-0.048***	-0.014***	-0.020***	-0.016***
	(0.006)	(0.004)	(0.005)	(0.005)
Average Price Change Securities $_{(t)}$			-0.016***	
			(0.003)	
C/TA $_{(t-1)}$ *** Average Price Change Securities** $_{(t)}$			0.003***	0.003**
			(0.001)	(0.001)
Observations	226,051	226,051	226,051	226,051
R-squared	0.053	0.918	0.917	0.918
Time FE	Y	Y	N	Y
Firm FE	N	Y	Y	Y

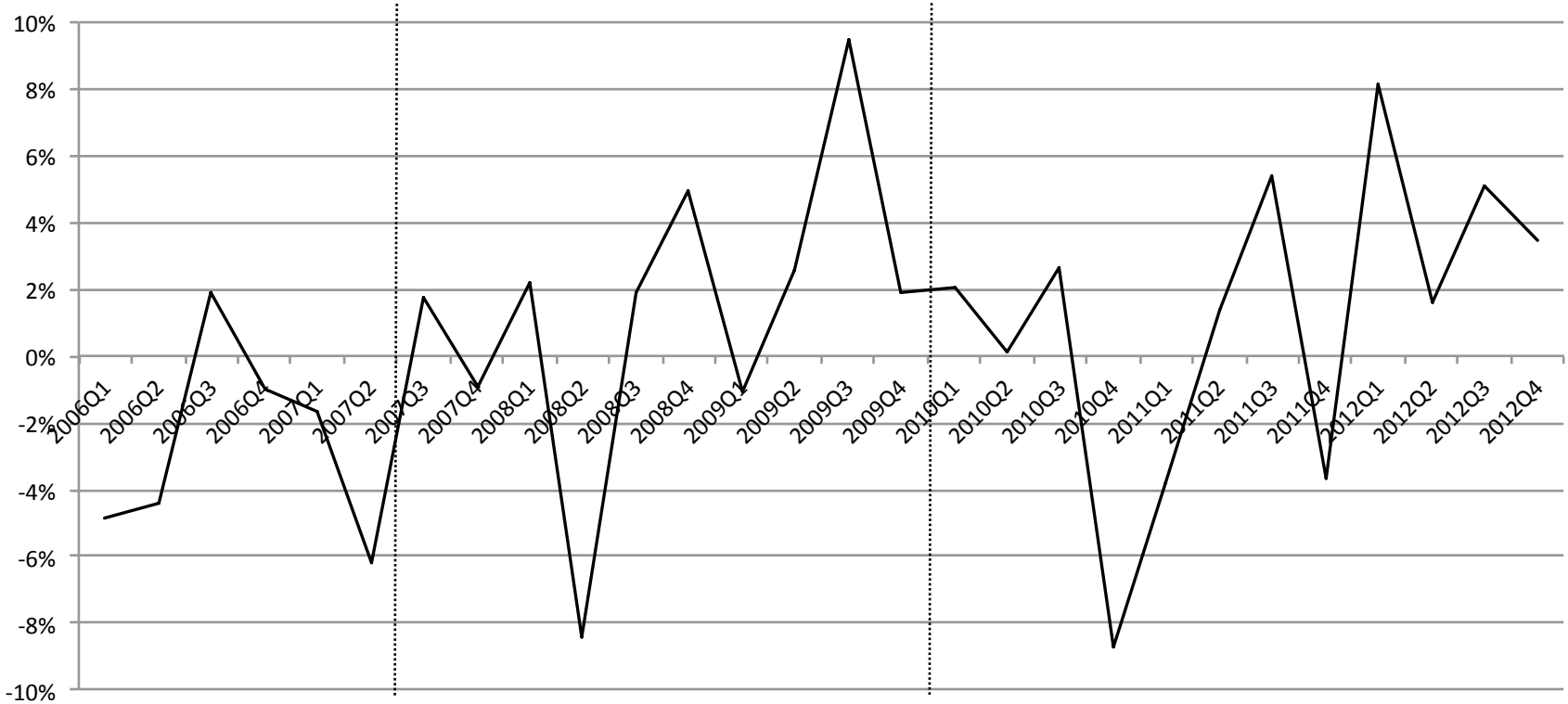
Dependent variable: logarithm of total debt of borrower *j* at time *t*. The table reports the estimated coefficients and robust standard errors (in parentheses) clustered at firm level estimated using least squares. All specifications include bank balance sheet controls (Size, Interbank borrowing / TA, Deposits / TA, and Return on equity) computed as a weighted average at firm level and the interaction with the average price change. See Appendix for the exact definition. Fixed effects are included ("Y") or not included ("N"). *** Significant at 1 percent level; ** Significant at 5 percent level; * Significant at 10 percent level.

TABLE 10. CREDIT SUPPLY AND REAL EFFECTS OUTSIDE THE CRISIS

	Pre-crisis				Post-crisis			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Capital / TA $_{(t-1)}$	0.015**	0.018**	0.016**	0.007	-0.013	-0.013	-0.012	0.008
	(0.007)	(0.009)	(0.007)	(0.008)	(0.033)	(0.033)	(0.033)	(0.007)
C/TA $_{(t-1)}$ * Average Price Change Securities $_{(t)}$		0.006				0.000		
		(0.008)				(0.002)		
Capital / TA $_{(t-1)}$ * Future Default			-0.060				-0.036	
			(0.058)				(0.065)	
Observations	263,606	263,606	263,606	109,019	784,377	784,377	784,377	300,475
R-squared	0.6197	0.6197	0.6197	0.042	0.6295	0.6295	0.6295	0.031
Time FE	><	><	><	Y	><	><	><	Y
Bank FE	Y	Y	Y	-	Y	Y	Y	-
Borrowe FE	><	><	><	N	><	><	><	N
Borrower * Time FE	Y	Y	Y	N	Y	Y	Y	N

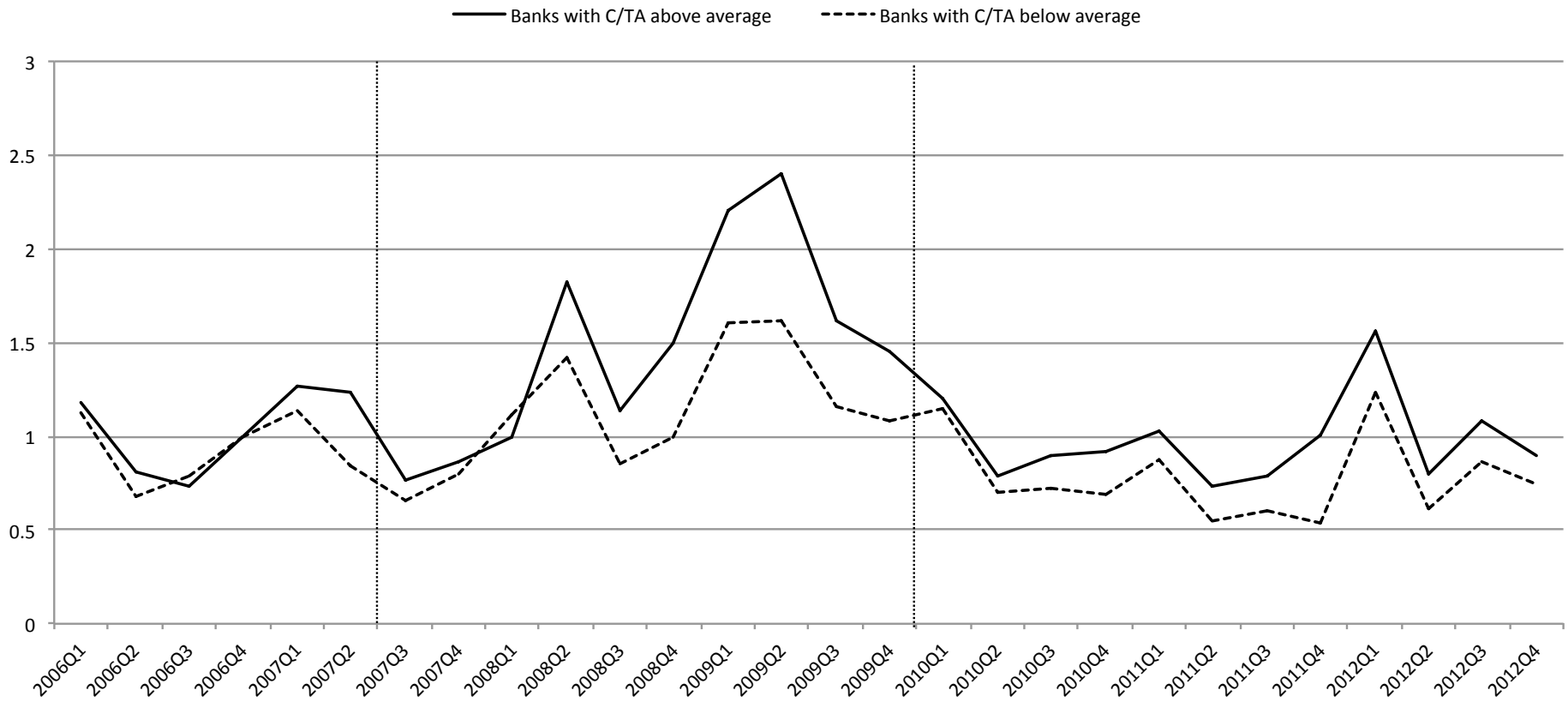
Dependent variable: logarithm of total debt from borrower *j* to bank *b* at time *t* (specifications 1-3 and 5-7); and logarithm of total debt of borrower *j* at time *t* (specifications 4 and 8). The table reports the estimated coefficients and robust standard errors (in parentheses) clustered at bank level estimated using least squares. All specifications include bank balance sheet controls (Size, Interbank borrowing / TA, Deposits / TA, and Return on equity). See Appendix for the exact definition. The within standard deviation of C/TA is 0.5 %. Fixed effects are included ("Y"), not included ("N"), or spanned by other fixed effects ("><"). *** Significant at 1 percent level; ** Significant at 5 percent level; * Significant at 10 percent level.

Figure 1. Weighted average price change in securities (%)



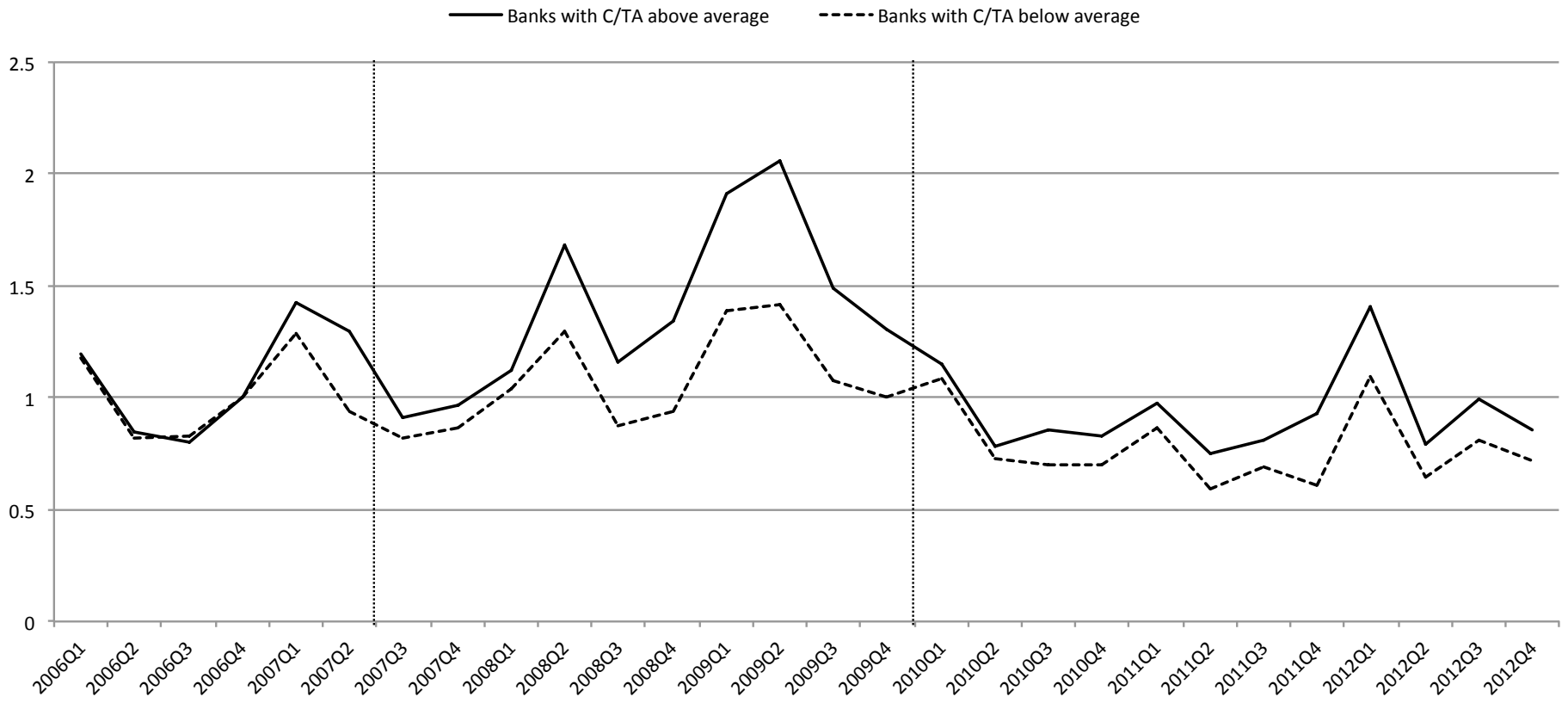
This figure plots the annualized quarterly average change in price, weighted by the total holdings of each security that banks hold.

Figure 2. Net securities investments as percentage of total assets (normalized at 2006Q4 level)



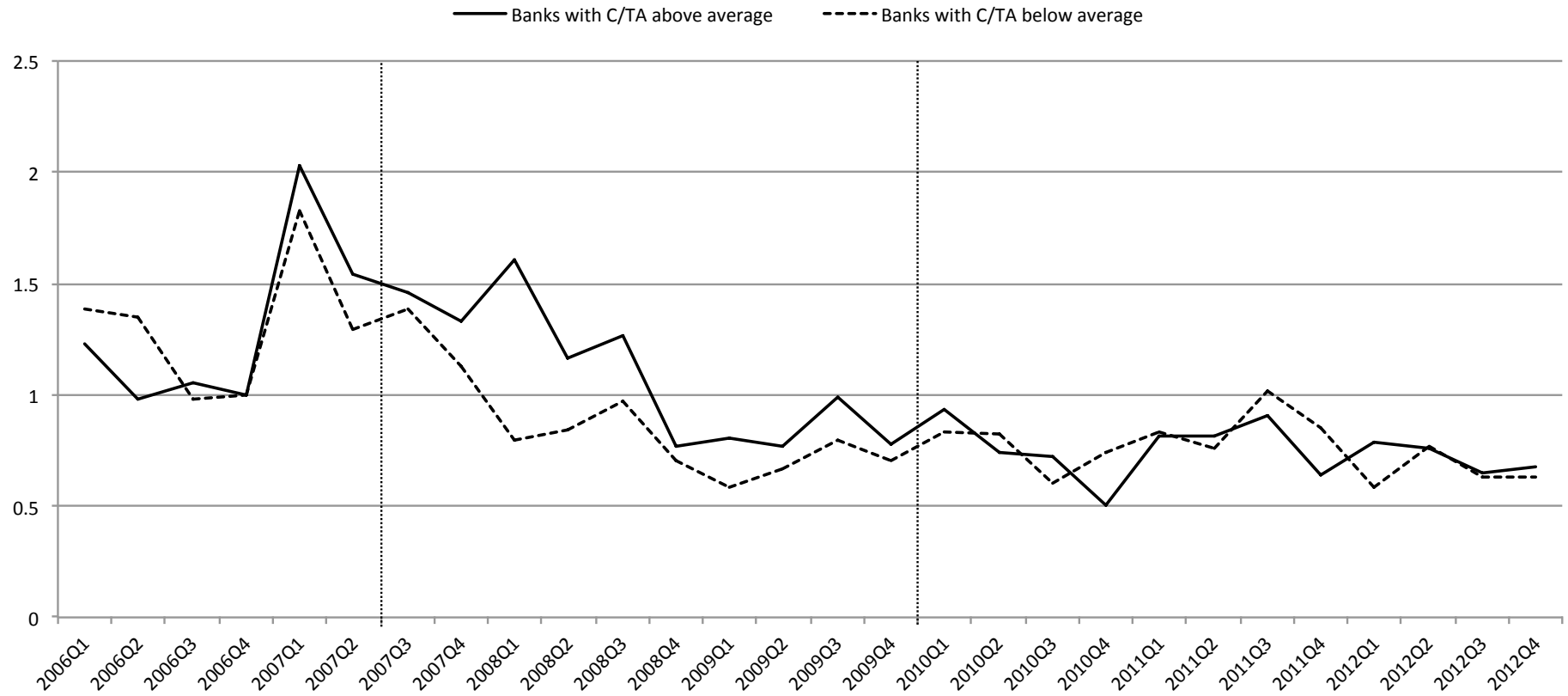
This figure plots the net investments in securities (buys minus sells) as percentage of total assets, depending on whether banks had C/TA above or below the average in 2007Q2. The value is normalized (for each bank) at 2006Q4 level.

Figure 3. Securities buys as percentage of total assets (normalized at 2006Q4 level)



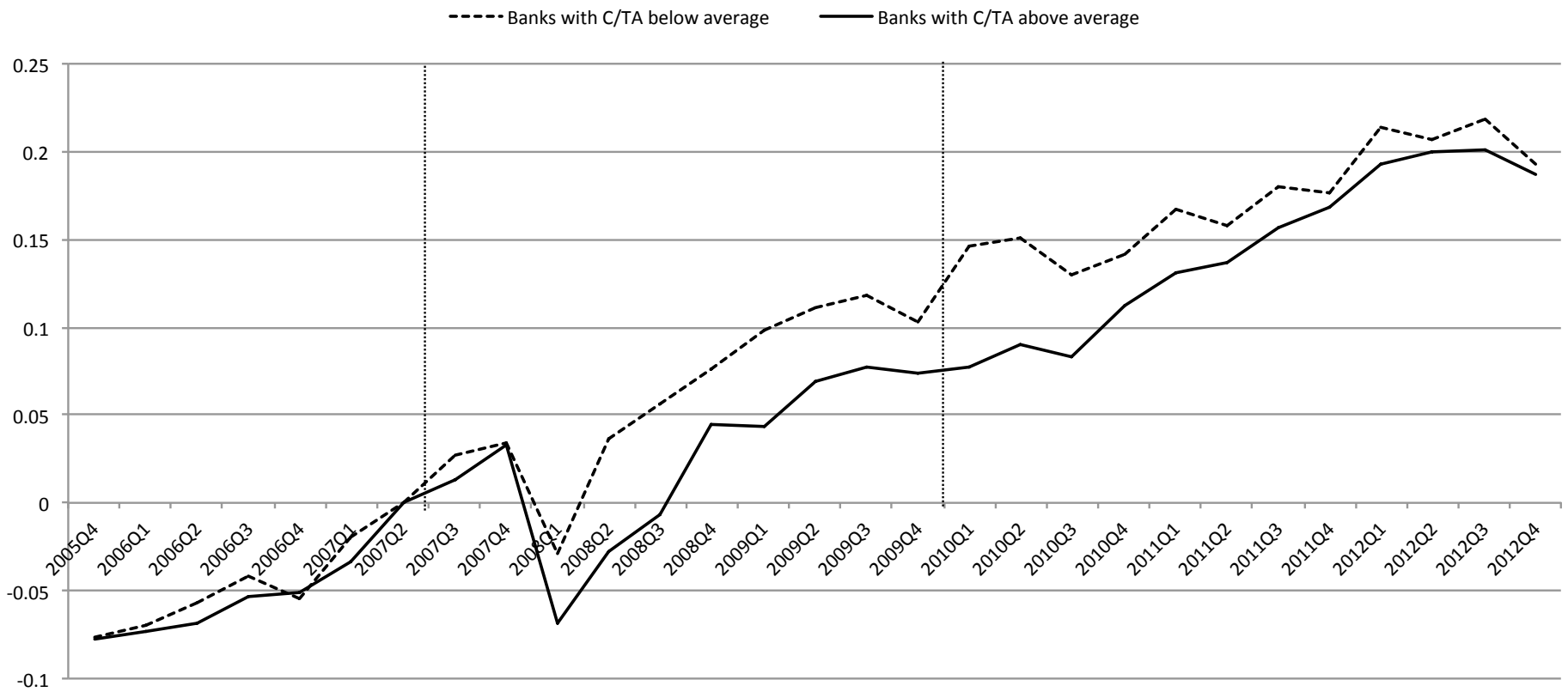
This figure plots the gross investments in securities (total amount bought) as percentage of total assets, depending on whether banks had C/TA above or below the average in 2007Q2. The value is normalized (for each bank) at 2006Q4 level.

Figure 4. Securities sells as percentage of total assets (normalized at 2006Q4 level)



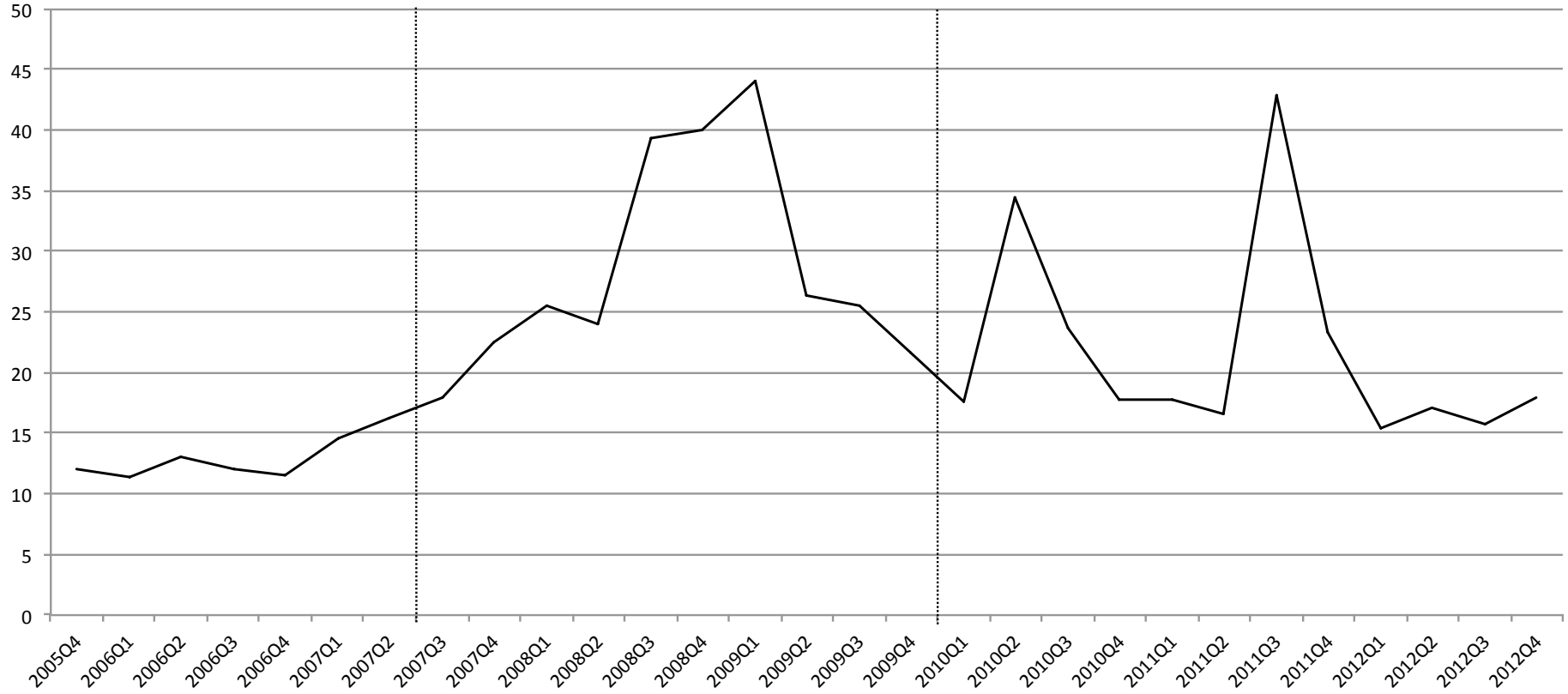
This figure plots the gross desinvestments in securities (total amount sold) as percentage of total assets, depending on whether banks had C/TA above or below the average in 2007Q2. The value is normalized (for each bank) at 2006Q4 level.

Figure 5. Evolution of credit



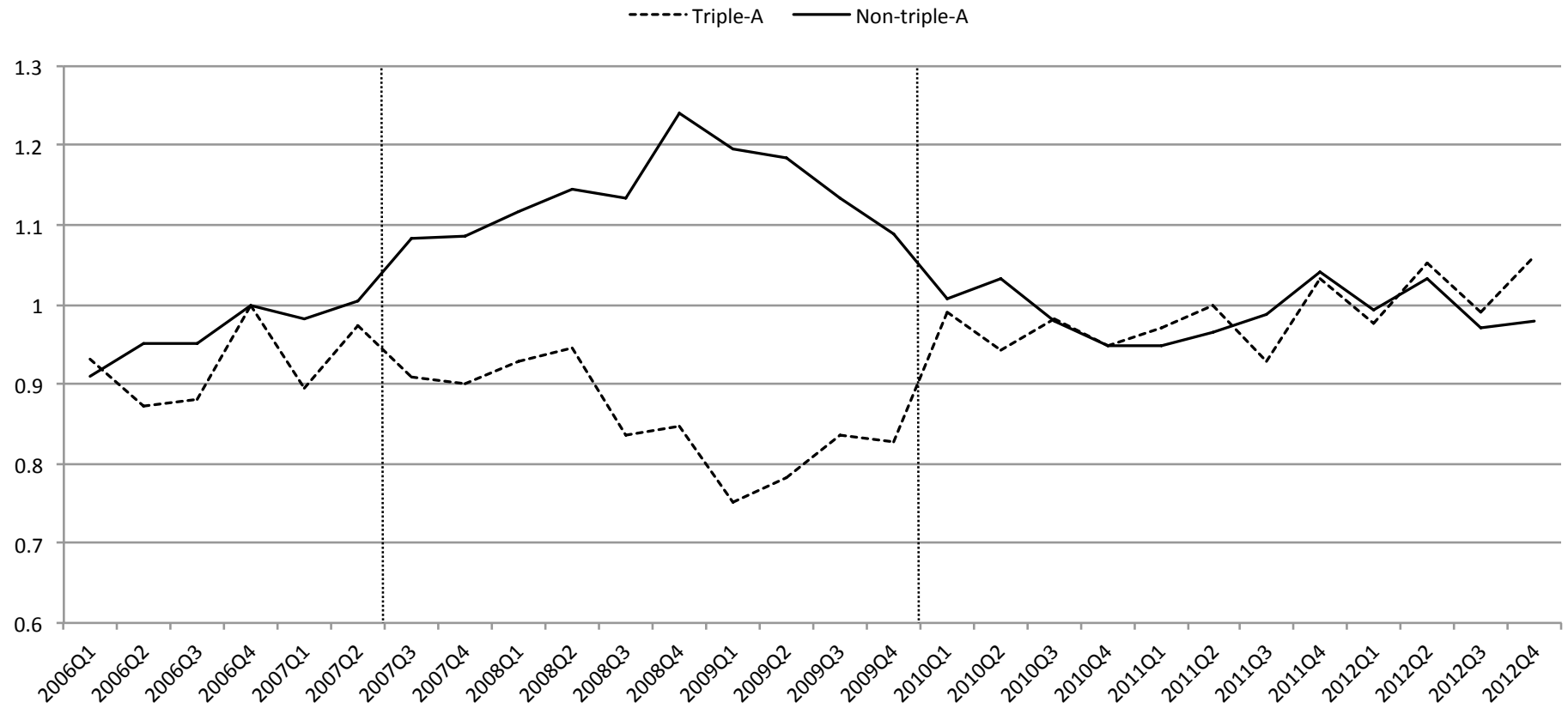
This figure plots the average evolution of total credit at bank-level, log-normalizing at the 2007Q2 level, depending on whether banks have C/TA above or below the average.

Figure 6. Evolution of the VSTOXX® (Euro Stoxx 50® Volatility)



This figure plots the evolution of the EURO STOXX 50® Volatility index, which is "an index based on EURO STOXX 50® realtime options prices designed to reflect the market expectations of near-term up to long-term volatility by measuring the square root of the implied variance across all options of a given time to expiration" (www.stoxx.com).

Figure A1. Total Holdings / Total Outstanding, normalized at 2006Q4



Evolution of the proportion of total bond issuance held by the banking sector, normalized to 2006Q4. We do not consider securities that move from Aaa to non-Aaa, or viceversa, during the period.

TABLE A1. VARIABLES DEFINITION

Variables	Units	Definition
Bank-level variables		
Capital / TA	%	Book equity over total assets
Size	Log (thousand €)	Logarithm of total assets
Interbank Borrowing / TA	%	Liabilities from banks over total assets
Savings Deposits / TA	%	Savings deposits over total assets
Return on Equity	%	Yearly pre-tax profits over total book equity
Security-level variables		
Coupon	%	Annualized coupon
Price	%	Market price
Maturity	Months	Residual maturity
Rating	Numerical scale	Moody's rating

TABLE A2. RATINGS EQUIVALENCE

Moody's Rating	Numerical value	S&P	Fitch
Aaa	28	AAA	AAA
Aa1	26	AA+	AA+
Aa2	25	AA	AA
Aa3	24	AA-	AA-
A1	23	A+	A+
A2	22	A	A
A3	21	A-	A-
Bbb1	20	BBB+	BBB+
Bbb2	19	BBB	BBB
Bbb3	18	BBB-	BBB-
Bb1	17	BB+	BB+
Bb2	16	BB	BB
Bb3	15	BB-	BB-
B1	14	B+	B+
B2	13	B	B
B3	12	B-	B-
Caa1	11	CCC+	CCC
Caa2	10	CCC	CCC
Caa3	9	CCC-	CCC
Ca	7	CC / C	CCC
C	4	D	DDD / DD / D

TABLE A3. STANDARD DEVIATION OF THE PRICE CHANGE OF SECURITIES

		SD
Periods		
	Pre-crisis	1.749%
	Crisis	5.769%
	Post-crisis	3.857%
Different ratings during the crisis		
	Aaa rated securities	2.961%
	Aa to A rated securities	4.466%
	Bbb and below rated securities	7.943%
Different maturities during the crisis		
	Up to 1 year securities	2.221%
	1 to 5 year securities	5.522%
	5 to 10 year securities	7.250%