On-balance sheet securitized assets and banking risks: Implications for liquid assets quality

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Abstract

We examine if securitized assets generated high correlation among banks, which further increased bank's aggregate risk exposure relative to its total risk in the pre-crisis period. We show how securitization processes increase bank's aggregate risk through assets side of bank's balance sheet. For this purpose, we examine the effects of four categories of securities holdings on banks' assets portfolios that differ in their risk weights: total securities holdings, government and agencies securities, residential mortgage-back securities (RMBS) and other mortgage-back securities (other MBS). The regulatory discontinuity analysis shows that the only statistically significant and positive effect on aggregate risk relative to the bank's total risk is captured by other MBS holdings. We further examine how the relationship varies for different percentiles of the ratio of the aggregate and total bank's risk with a quantile regression analysis. The results also show that only other MBS have statistically significant effect along the entire distribution with 1% significance levels for the higher quantiles (90%, 95% and 99%). These findings indicate that securities holdings characterized with controversial risk weights actually drove banks' aggregate risk exposure in the pre-crisis period.

1. Introduction

The recent financial crisis is pure evidence about how developments in the financial markets can affect banks' financial structure and how this can have huge consequences for the entire financial system. In particular, securitization is a financial innovation that heavily affected assets and liability sides of banks' balance sheets and had fundamental effects on banks' risk exposures in the pre-crisis period. Further, regarding liability side of banks' balance sheets, there is a consistency in homogeneity in a sense that banks were mainly financed with deposits. Regarding assets side, there is also consistency in holding assets, which could be either loans or securities. However, the developments in financial markets has influenced to a significant extent the structure of securities holdings.

Securities have the role of liquid assets in banks' assets portfolio and as such should represent liquid buffer stock against unexpected deposit outflows or unexpected loan failures. Therefore, we would expect that banks' assets portfolios should concentrate mainly investments in treasuries and agencies securities. Unfortunately, this is not the case with the assets' portfolios in the preceding period of the financial crisis. As we observe in plot A of Figure 1, there is no significant increase in the holdings of treasury and agency securities on banks' assets portfolios in the period of 2000 – 2008. Moreover, we observe that during the period of 2004 -2008 there is a decreasing trend in treasuries and agencies securities holdings. We observe that banks concentrate holdings in RMBS securities and other MBS securities (CMBS, CDOs, CMOs…etc). Especially, we observe the strong increasing trend of other MBS during the entire sample period.

If we look at the descriptive statistics of banks' balance sheet items for the period 1997-2008 (Appendix I) we observe significant transformation in the structure of the liquid assets. We observe that cash holdings decrease from 9.55% in 1997 to 3.67% in 2007. Looking over different categories of securities, treasuries and agencies holdings decrease from 7.38% (1997) to 6.38 % (2007). In contrast, we observe that holdings in RMBS securities have increased from 1.66% (1997) to 4.01% (2007). Finally, we observe the most significant increase in holdings of other MBS securities, from 1.18% (1997) to 7.49% (2007).

These observations indicate that banks were heavily investing in securities that have some degree of volatility and illiquidity and as such could deliver higher returns than liquid and low-risk treasuries and agencies securities. They allocated securities with a certain level of risk and liquidity attributes as liquid assets considering them equally safe and sound to treasuries and agencies securities.

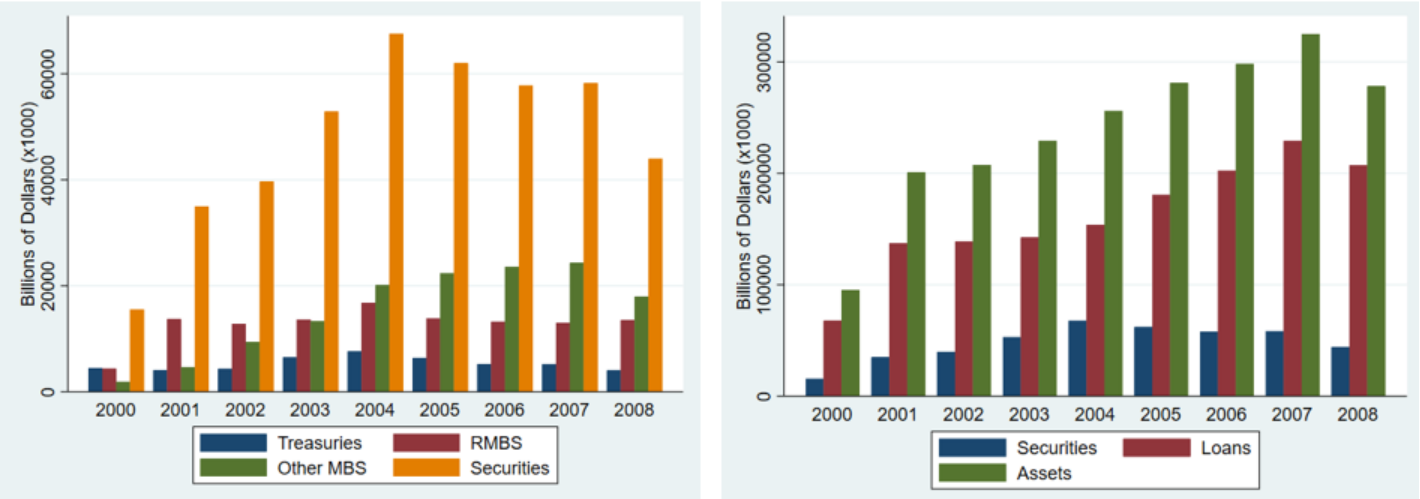

Figure 1: Assets structure of banks' balance sheets
Plot A: The four categories of securities (as a fraction of total securities)
Plot B: Loans and securities (as a fraction of total assets)

Figure 2 also supports described investment behavior. We observe that risk weighted assets had a rising trend in the pre-crisis period, characterized by a steep slope from 2004 and onwards.

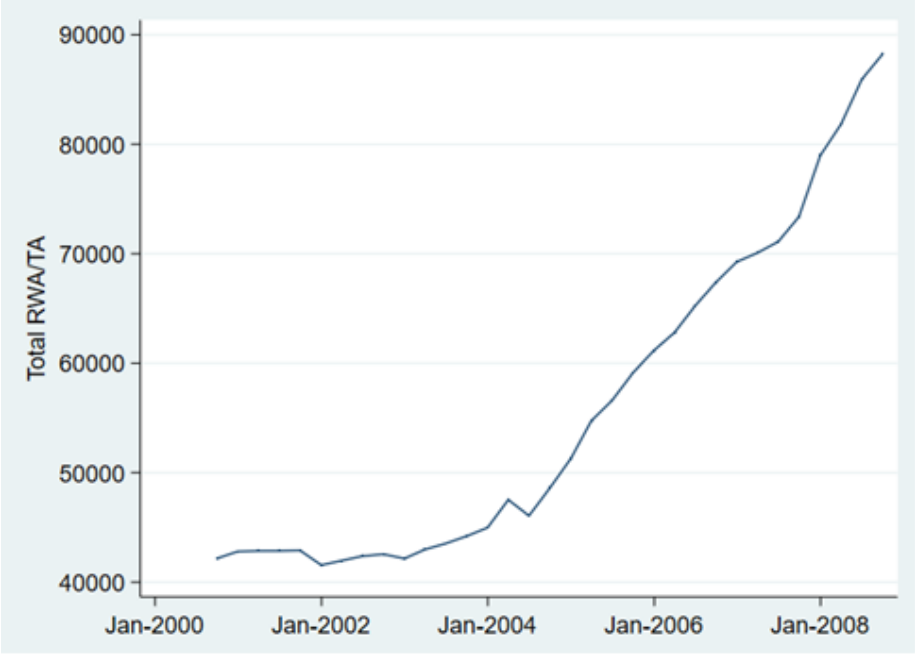

Figure 2: Total Risk weighted assets / Total Assets (In billion $ x 1000)

Consequently, such securitization process widely exposed banks to asset commonality on their balance sheets and to a vulnerability stemming from the imprecise evaluation of the underlying risks.

Allen et al. (2012) show that any mechanism leading to asset commonality matters for systemic risk. Gennaioli et al. (2013) show that holding securities allows for broad diversification of idiosyncratic default risk to the extent that losses become driven entirely by the systematic risk exposure. On the one side, securitization promotes expansion of banks' balance sheets and as such enables the diversification of idiosyncratic risk. As asset commonality mechanism on the other side, it generates high correlations among banks as their investments become similar.

We argue that the existence of the aggregate risk within the securitization process was completely ignored and as such represents the key determinant for the evolution of the financial crisis. Regarding the occurrence of the recent financial crisis the literature has widely accepted the arguments given by the "textbook" view, the regulatory arbitrage view and managers' excessive risk taking view[1]. The collapse of the housing bubble in the U.S. is also considered as a proximate cause of the crisis by some authors (Shleifer and Vishny, 2010). All of these arguments have definitely played important role in shaping the financial fragility in the period before the crisis, but we argue that the reason why markets have failed to anticipate the financial crisis is mainly due to the unrecognized aggregate risks in banks' assets portfolios. Due to the diversification features of securitization, the credit rating agencies certified most of the securities as "safe". However, the early literature on the financial crisis, Coval et al. (2009b) already shows that from asset pricing perspective they were not even closely to safe and carried high systematic risks.

Furthermore, this research aims to contribute to the ongoing debate regarding the regulation aspects for measuring banks' correlations as an indicator for exposure to the aggregate risk. Basel III (2010)[2] recognized certain material impact on banks' balance sheets due to advancements in securitization and as a result, restrictions through the leverage ratio and minimum liquidity ratio are introduced. The Basel III framework has also advanced by taking into consideration the counterparty risk exposure for each asset and aggregate loss correlation coefficient for each business unit in determining risk weights, but the drawback is that these parameters are still left to be estimated individually and internally by banks themselves[3]. The

[1] According "textbook view" the essential feature of securitization is to make all investors symmetrically informed about their payoffs, so that they can trade securitized assets without fear for default. Such informational symmetry is able to create a liquid market for safe debt (Gorton and Pennachhi, 1990;DeMarzo, 2005; Dang, Gorton and Holmstrom, 2015). According regulatory arbitrage view, by holding securitized assets banks were able to sustain higher leverage and still comply with risk-weighted capital requirements (Acharya, Schnabl, and Suarez, 2013). Managers' excessive risk taking view implies irrational and herding behavior of banks' managers in the pre-crisis period due to securitization profits (Rajan, 2006; Ruiz-Verdu, P., and Boyallian, 2017)

[2] Introduced upper limits for the Leverage ratio, Liquidity Ratio and measurement of the counterparty risk exposure for each assets (Credit Value Adjustment)

[3] " the bank may be permitted to use internally determined correlations in operational risk losses across individual operational risk estimates, provided it can demonstrate to a high degree of confidence and to the satisfaction of the

argument behind leaving banks on their own in estimating their correlation parameters is related to the complex methodologies for estimating correlations. Practitioners argue that if Basel III imposes mandatory methodology for estimating correlations, the difficulty in controlling and comparison of such estimations also arise.

We argue that as long as banks have freedom in their choice for estimation procedure and assumptions, the estimations of the correlation coefficients will be driven by different banks' incentives in different economic conditions. Begley et al. (2017) recently have shown that banks' self-reported risk measures become least informative especially when they matter the most. Their results indicate that underreporting is especially frequent during the critical periods of high systemic risk and for banks with larger trading operations. These findings suggest that without relevant regulatory requirements, the level of aggregate risk exposure of banks would be still non-tractable and ambiguous and as such could lead to unanticipated market shocks as we have seen with the recent financial crisis. Therefore, we empirically analyze what does the securitization implies for banking risks. More particular, we examine whether securitization generates high correlation among banks, increasing bank's aggregate risk relative to its total risk.

To test this hypothesis, we first construct variable for measuring the relation between the bank's aggregate risk and its total risk. The variable of interest is the ratio of covariance between each individual bank's returns with returns of the rest of banks in the sample over bank's individual variance for the corresponding quarter. If the ratio is increasing over time, it implies that an increase in securities holdings is followed by an increase in the aggregate risk of the bank relative to its total risk. For constructing the ratio, we use prices data of the CRSP database. We then construct four different securities' variables from the accounting data categorized by their risk weights. First, we consider the effect of total securities holdings for a particular bank on the correlation ratio and then we isolate the effect of government and agencies securities holdings, RMBS holdings and other MBS securities holdings. We have on disposal quarterly accounting data for 54 public commercial banks operating in the U.S. during the period from 2000:Q3 – 2008:Q3 from the Commercial Bank Database of the Federal Reserve Bank of Chicago (FRB Chicago).

For identification strategy, we use Enron market shock at the end of 2001 and regulatory intervention related to the off-balance sheet vehicles in July, 2004. We use this identification strategy to conduct regulatory discontinuity analysis. Off-balanced sheet vehicles played big role

national supervisor that its systems for determining correlations are sound, implemented with integrity, and take into account the uncertainty surrounding any such correlation estimates (particularly in periods of stress). The bank must validate its correlation assumptions" - https://www.bis.org/bcbs/publ/d424.htm

in hiding Enron's financial liabilities and altogether with the dot com bubble, contributed to less confidence in the securitization market. However, in July, 2004 US banks regulators promoted a new regulation allowing banks to leave the conduits off balance sheets and required banks to hold very low capital against some of the conduits, at only 10% (in comparison to the capital required for on-balance sheet assets). The response of the market was in an extreme growth in the issuance of new securities.

The regulatory discontinuity analysis shows that the only statistically significant effect on aggregate risk relative to the bank's total risk is captured by other MBS holdings. The finding indicates that securities holdings characterized with controversial risk weights actually drove banks' aggregate risk exposure in the pre-crisis period. We further examine how the relationship varies for different percentiles of the data with quantile regression. We also find only other MBS statistically significant along the entire distribution with 1% significance levels for the higher quantiles (90%, 95% and 99%).

The research contributes to the theoretical and empirical literature on the origins of the global financial crisis of 2008. By showing, that assets securitization drives high correlation among banks in the pre-crisis period, the paper provides evidence in support to the credit ratings literature that has the earliest suggested that securities carried systematic risk and as a result were not adequately priced (Coval 2009a, Coval 2009b, Brennan et al. (2009)[4]. Furthermore, it empirically contributes to the group of theoretical literature that suggests how the change in banks' characteristics can contribute in recognizing potential sources for aggregate risks (Gennaioli et al.2012, 2013, Allen et al. 2012, DeAngelo and Stulz 2015).

In contrast to the empirical evidence that risk accumulation on banks' balance sheets was due to extremely low interest rates in the pre-crisis period (Maddaloni and Peydro 2011, Calomiris, 2008), to the managers' risk taking incentives (Fahlenbrach and Stulz, 2011, Cheng et al. 2010, and Ruiz-Verdu and Boyallian, 2016) or to the regulatory arbitrage incentives (Ashcraft et al. 2010 and Suarez et al. 2013), this research suggests unregulated correlation parameters due to securitization as a key determinant in aggregate risk accumulation on banks' balance sheets. While the empirical papers mainly confirm the relationship between securitization and systemic risk using standard measures of systemic risk (SRISK and CoVar) and difference-in-difference approach[5] (Chen et al. 2017 and Brunnermeier et al. 2012), this research contributes to the existing

[4] Additional literature that provides evidence related to the demand for mortgage-based securities and corresponding misleading ratings of these securities by the rating agencies: Benmelech and Dlugosz, 2009; Keys, Mukherjee, Seru and Vig, 2010; Mian and Sufi, 2009;

[5] Where they rely on the bankruptcy filing of Lehman Brothers in September 2008 as a source of exogenous variation

empirical literature in providing two novel results with respect to the relationship between securitization and banks' risks. First, it measures the effect of securitization not only on the overall aggregate risk, but it provides a comparative analysis on the evolution of the aggregate risk relative to the total bank's risk at a bank level. Next, it measures the effect of different categories of securities on banks' correlations, where the securities differ by their risk weights. Hence, we examine whether on securitization mainly contributed to a large extent in building aggregate risk on banks' assets portfolios instead of only lowering bank's overall risk exposures.

The remainder of the study is organized as follows. Section 2 provides literature review with respect to the securitization and banking risks. Section 3 provides hypothesis development. Section 4 describes the datasets and the empirical strategy. Section 5 discusses the main results and section 6 concludes the findings of the research.

2. Literature Review

This study examines whether on securitization generates financial fragility across the banking system and how. Regulated banks played a key role in securitization processes and held large amounts of securitized assets. The evidence suggests that the financing of securitized assets in the pre-crisis period was mainly provided by the shadow banking (Hanson et al. 2015, Sunderam, 2015) and rose due to the secondary market activities of the government-sponsored enterprises, Fannie Mae and Freddie Mac[6] (Loutskina and Strahan, 2009). Banks expanded their balance sheets by trading these securitized assets, increased investments in risky projects, raised their leverage, and endogenously became interconnected by sharing each other's risks. For this purpose, we examine the literature review on securitization and its relations with banks' balance sheet composition, riskiness of banks' assets and banks' exposure to aggregate risk.

2. 1 The role of securitization in shaping financial fragility: theoretical evidence

In this section, we discuss theoretical literature evidence related to the increasing bank interdependence and the concentration of aggregate risk on banks' balance sheets as a consequence

[6] Fannie Mae is the Federal National Mortgage Association created by the U.S congress with passage of the National Housing Act of 1934 and became public corporation in 1968; Freddie Mac was chartered by Congress in 1970 to provide stability and liquidity to the market for residential mortgages, focusing mainly on mortgages originated by savings institutions. It was also privatized in 1986.

of the securitization. We examine theories that explain how the change in banks' characteristics can contribute in recognizing potential sources for aggregate risks in order to provide conceptual explanation for the occurrence of the financial crisis.

Gennaioli et al. (2012) provide a novel idea for modeling financial markets in which the neglect of low probability risks plays the central role in the relationship between the financial innovation and financial fragility. They connect financial innovation, surprise about risk, and corresponding financial fragility through a unified model of belief formation. Their model starts with the traditional foundations of financial innovation (Alen and Gale, 1994): innovation is driven by investor demand for particular cash flow patterns. The novel contribution of Gennaioli et al. (2012) to this traditional view is by considering the main essential assumption: both investors and financial intermediaries do not take into consideration certain improbable risks when trading new securities.

Following the standard model of Alen and Gale (1994), there is a room for financial innovation to offer investors safe cash flow streams that are not available from traditional securities in sufficient supply. However, the new dimension that Gennaioli et al. (2012) add is that when some risks are neglected, new securities are over-issued as financial innovative products relative to what would be possible under rational expectations. Precisely because new securities have been over-issued, they are vulnerable to a small piece of news that reveals unattended risks to investors' minds. Then additional problems occur with respect to the cash flow reserves. There are not enough cash flows in the neglected states of the world to make promised payments full. Investors realize that the new securities are false substitutes for the traditional ones, thus, they fly to safety by selling instantly these securities in the market and buying the truly safe ones.

Gennaioli et al. (2013) develop this argument further, in order to give explanation for the financial crisis 2007-2009. Their model emphasizes securitization as the main driver for the boom and bust in the fluctuation in risk premia. In good times, securitization is a device that simultaneously creates relatively safe and liquid form of collateral and diversifies assets portfolio. Thus, by holding securities on the assets side of the balance sheet, banks have two great benefits: diversification of their assets portfolio and provision of collateral. Consequently, securitization enables diversification of banks' assets portfolios, but it simultaneously makes banks' returns to be correlated due to similarities in their assets' portfolios. Then in bad times, securitization generates a strong correlation in the returns of intermediaries, inferring to the existence of aggregate risk. This further makes secondary markets illiquid after bad aggregate news.

Wagner (2010, 2011) model diversification and bank similarities and show that more diversification makes banks' risks more similar to each other. The reason behind is in the trade-off between diversification and diversity: holding diversified assets' portfolios, makes banks less diverse and disposed to more joint defaults as a result. This is because, actually, full diversification is equivalent to holding market portfolio. This further implies that all banks invest in the same portfolio which makes their assets risks to be perfectly correlated.

Following similar reasoning, Gennaioli et al. (2013) consider that the diversification of the idiosyncratic risk is the only way an intermediary can offer a risk-free payment, but they argue that it is the exposure to aggregate risk that allows intermediaries to earn rents while still providing an attractive returns to investors. On the other side, they argue that such aggregate risk generates negative externality when it is neglected by the agents in the economy, especially when the markets are driven by certain financial innovation (securitization). In particular, the neglect of aggregate risk potentially generates the following two essential issues:

- It induces over optimism about the average return of an individual intermediary;
- It induces market participants to neglect the fact that an intermediary might be unsuccessful precisely in a state – a recession, in which many other intermediaries could be also unsuccessful.

Thus, things change dramatically when investors and intermediaries neglect tail aggregate risks, because they do not think about truly bad outcomes during quiet times.

Similarly, Broer (2018) considers that diversification and tradability features of the structured financial products generate two opposite effects: the false perception of absolutely safety on the one side, and the high correlation of defaults on the other side. As a result, investors and intermediaries do not share the same attitude toward correlated risks due to structured financial products. There are investors that believe in low default correlations and other investors who believe high default correlations due to structured financial products. He finds that the average losses for investors are larger than their average expected losses in the presence of structured financial products in the market. He explains this anomaly by the existing disagreement about default correlations. This disagreement about default correlations is the one that raises prices. Then the scenario is the following: increasing prices increase banks' exposure to structured financial products which further increase banks' interdependence and exposure to aggregate risk.

Gennaioli et al. (2012, 2013) argue that while securitization enables financial institutions to diversify risk, it increases their exposure to the aggregate risk by increasing the overlaps in banks' assets portfolios. Allen et al. (2012) provide evidence about whether and how such asset

commonality among banks leads to systemic risk may depend on their funding maturity structure. They examine the interaction of banks' asset structures, information, and debt maturity in generating systemic risk. Their results indicate that asset structure matters for systemic risk and total welfare when banks use short-term debt for financing purposes, but not when they use long-term debt. The reasoning behind this argument is that with short-term finance, asset holders need not roll over the debt and banks are informationally linked. Upon observing the signal, investors update the probability that their bank will be solvent at the final date and make decision on whether to roll over the debt. Roll over always occurs after a good signal is realized but not after a bad signal arrives.

Other important evidence delivered by Allen et al. (2012) is that upon the arrival of bad news, roll over occurs less often in the unclustered than in the clustered asset structure. This further implies that investors infer that the conditional default probability related to the clustered assets is high and thus they decide not to roll over the debt upon the arrival of negative information. In this setting, Allen et al. (2012) main implication is that the failure to roll over the debt is the source of systemic risk in the presence of highly clustered asset structures among banks.

Recently, Eisenbach (2017) relates short-term debt, information and rollover risk in a similar sense as Allen et al. (2012). Calomiris and Kahn (1991) argue that maturity mismatch between assets and liabilities generates rollover risk which further serves as a disciplining device in the market against banks' excessive risk taking. Eisenbach (2017) document that in the presence of aggregate risk due to correlation in banks' assets, there is inconsistency between what is ex post efficient and what is achievable when choosing a debt-maturity structure ex-ante. The interaction between the short term financing as market discipline, asset liquidating values and news impact generates amplifying feedback loops that lead to excessive risk taking in good states and fire sales in bad states as illustrated in Figure 3:

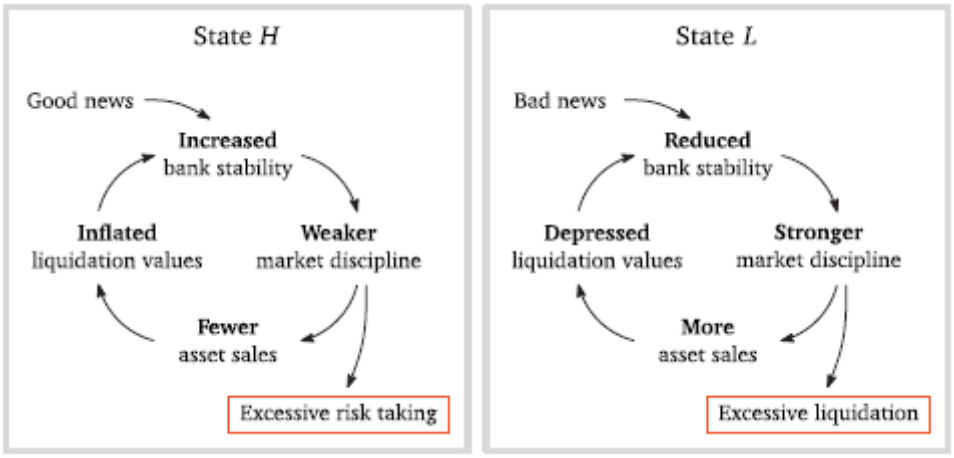

Figure 3: Eisenbach: Rollover risk - A two sided inefficiency

Eisenbach (2017) concludes that the short-term debt is not able to deal with two sources of risk. It suffers from a lack of state contingency in banks' exposure to rollover risk ex-post. Finally, the correlation among banks' assets is the main driver of such inefficiency. Thus, paper provides strong argument for a policy regulation that would diminish correlation among banks' assets.

Suarez et al. (2013) examine the contribution of securitization to financial fragility from the regulatory arbitrage perspective, theoretically and empirically. Their results show that commercial banks used conduits to invest in long-term assets without holding capital against these assets. This further suggests that banks' investment decisions are at least partly motivated by activity aimed at circumventing regulatory constraints. Since these investments reflect significant maturity mismatch and default only in a severe economic downturn, banks are taking on rollover risk that is highly correlated within the financial sector. Thus, their results show that regulatory arbitrage activity, if successful, can create significant concentrations of systemic risk in the financial sector. The main implication is that a significant part of the conduit activity is a way for banks to concentrate aggregate risks instead of dispersing them, and do so without necessarily holding much capital against these risks.

DeAngelo and Stulz (2015) elaborate the relationship between bank leverage, regulatory requirements and systemic risk when risk-management costs restrict banks to produce perfectly safe claims. Their results suggest that when banks have access to perfect/complete markets, they can construct perfect asset-side hedges to support safe debt that captures a liquidity premium. With perfect hedging there are no defaults, runs, or systemic risks, thus high leverage is optimal for banks. Things become complicated when only imperfect hedging is possible. Real-world banks are not able to produce liquid claims that provide 100% assured access to capital with no information

sensitivity. In the real world, the relevant risks for liquid-claim production include unknown unknowns that govern left-tail outcomes and that are not clearly integrated into traditional finance models. However, banks still have an incentives to control the risk of their asset structures to foster liquid – claim production and in this case capital regulation can generate social benefits. The issue that arises is how efficiently banks control the risk of their asset structure when liquidity demand applies to relatively (not perfectly) safe debt due to reaching-for-yield behavior. Stein (2012) argues that as banks compete to service the demand for liquidity the outcome is socially excessive production of risky liquid claims and high leverage. Further, such excessive production of risky liquid claims comes with an externality: generating aggregate risk that is not fully priced in the market.

Brennan et al. (2009) examine the limitations of a bond rating system which relies only on assessments either of default probabilities as in the case of Standard & Poor's or of expected default losses as in the case of Moody's. For both rating systems, they find that CDOs tranches are overpriced due to the neglect of the aggregate risk. They argue that credit rating agencies fail to recognize the distinction between the total and systemic risk in pricing structured finance products. Therefore, the over issuance of CDOs during 2006 and 2007 can be explained by the mispricing further caused by ratings-based pricing.

Looking back to the traditional literature, Diamond and Dybvig (1983) does not admit a rationale for banks to hold marketable securities, but the evidence suggest that financial innovation in markets provides incentives for traditional banks to engage heavily in securitization. In Diamond's (1984) delegated-monitoring model asset diversification enables banks to issue more debt. In this setting, banks diversify idiosyncratic risks, which further allows them to offer risk-free deposits to their investors, thus eliminating the need to monitor the monitor. Gorton and Pennacchi (1990) also discuss the role of asset diversification in fostering the production of safe debt. Nevertheless, recent literature evidence shows that things change dramatically when the diversification is not perfect. Gennaioli et al. (2012, 2013) also recognize the incentive to diversify in order to enhance safe debt issuance, but their model strongly emphasizes that when asset diversification is imperfect it makes banks exposed to correlated tail risk from loan and security holdings. Furthermore, over-production of structured finance products transforms the correlated tail risk into systemic.

2.2 Securitization and its contagion effects: empirical evidence

In this section, we provide empirical literature review on securitization and its contagion effects. We analyze empirical evidence on securitization and its impact on banks' asset commonality, assets' diversification and assets' credit ratings. Moreover, we focus on empirical evidence on processes that lead to systemic risk, where the systemic risk is considered as an externality a bank imposes on the financial system through securitization.

Studies on systemic risk such as Bartram et al. (2007) and Yorulmazer and Goldsmith – Pinkham (2010), provide evidence in favor of asset commonality as an important determinant of systemic risk. In particular, Yorulmazer and Goldsmith –Pinkham (2010) find significant contagion effects within UK banks after the bank run at Northern Rock and positive wealth effects after its bailout. Their results indicate that contagion effects are mainly due to a high correlation of assets between banks, a similar customer base or jointly syndicated loans.

Calmes and Theoret (2014) examine the relationship between clustering behavior of banks and systemic risk in U.S and Canada. They measure the sensitivity of lending and market-based income activities[7] to macroeconomic external shocks. They document that market-based banking has progressively become a major determinant of bank systemic risk both in Canada and the U.S. Common patterns seem to be more prevalent for the non-interest income generating activities while bank common patterns in lending activities have vanished, especially in the U.S. Their findings show that rising share of non-interest income activities in bank total operations is associated with an increase in the overall volatility of bank performance.

For instance, Loutskina (2005) provides some summary statistics for the significant growth of loan securitization in the pre-crisis period. Importantly, loan securitization has been the most dramatically driven in the mortgage market. For illustration, in 1976, the amount of securitized home mortgages was $28 billion and by the end of 2003, the total amount of securitized home mortgages had grown almost 150 times, reaching $4.2 trillion. Over the same period, the amount of home mortgages outstanding grew from $489 billion to $7.3 trillion. By comparison, there was no securitization of commercial mortgages, business loans, or consumer loans in 1976. By the end of 2003, $294 billion of commercial mortgages, $104 billion worth of C&I loans, and $658 billion worth of consumer loans were securitized.

Trading these giant amounts of securitized loans has affected the assets side of banks' balance sheets by providing large volumes of similar liquid assets. On the other side, securitization

[7] Market-based income activities include non-interest income activities such as securitization and investment banking

enables assets' diversification since it implies holding a fraction of each other's assets. In this sense, Loutskina and Strahan (2009) provide evidence that loan securitization fosters financial integration and investor diversification. Their results suggest that loan securitization mitigate the consequences of shocks to local banks and other lenders. Such generated integration allows capital to flow between markets while diversification facilitates risk sharing and risk management among banks.

However, a large fraction of the empirical evidence suggests the existence of contagion effects of diversification and its relationship with systemic risk. Cai et al. (2018) document that institution-level risk reduction through diversification ignores the negative externalities of an interconnected financial system. They measure commonality in banks' syndicated loan portfolio and for this purpose they develop a novel measure of interconnectedness for which the key component is the similarity between two banks' syndicated loan portfolios. They find that while banks seem to diversify by syndicating loans to other banks, it increases systemic risk of the financial system, because banks become more similar to one another. Thus, loan syndication increases the overlap of bank loan portfolio and makes them more vulnerable to contagious effects. Finally, they conclude that interconnectedness is driven mainly by bank diversification, less by bank size or overall loan market size.

Other source of fragility that is heavily argued in the empirical literature are estimations and evaluations of the credit ratings of securitized assets in the period before the financial crisis. Coval et al. (2009a) argue that credit ratings agencies didn't own full estimation capabilities to be confident in estimating the underlying securities' default risks, and how likely defaults were to be correlated[8]. This lead to relying on subjective assessments and imprecision in evaluating underlying risks of the structured finance products. Griffin and Tang (2012) use large sample of CDOs from 1997 to 2007 and conclude that rating agencies used their subjective assessment to increase the size of AAA-rated tranches beyond the model-implied objective level.

Remarkably, Coval et al. (2009b) provide empirical evidence that systemic risk was not fully priced in the case of structured finance instruments. They argue that investors and regulators considered structural finance products equivalent to corporate bonds, but they show that their underlying economic risks were highly dissimilar. They demonstrate that senior CDO tranches have significantly different systematic risk exposures from their credit rating matched

[8]However, the industry argues that regulators are those that didn't approved more adequate estimations. A managing director at Moody's has stated: " we did go out and ask the community whether they wanted a different category of rating (for structured products) because this idea was floated by regulators but the strong response was please don't change anything" Financial Times, 11 June 2008 (Brennan et al. 2009)

counterparts, and as a result should provide different risk premia. This implies that the information credit rating agencies provide to their customers is inadequate for pricing. Their pricing estimates suggest that investors in senior CDO tranches are highly undercompensated for the highly systemic nature of the risks they bear.

Wagner and Nijskens (2011) study the systemic risk of banks before the crisis considering credit default swaps (CDS) trading and collaterilized loan obligations (CLOs) issuance. They provide evidence that once banks expose themselves to either of the two risk transfer approaches, their beta increases significantly. They show that the increase in beta is solely due to an increase in banks' correlations. This implies that while banks may have decreased their individual credit risk, they actually exposed themselves to greater systemic risk.

Brunnermeier et al. (2012) and Chen et al. (2017) measure the effects of structured financial products on the banks' exposure to systemic risk using systemic risk measures such as CoVar (Adrian and Brunnermeier, 2008), Systemic Expected Shortfall (Acharya et al. 2010), and SRISK (Engle and Brownlees, 2016) and using Lehman brothers bankruptcy as identification strategy for the difference-in-difference approach. Brunnermeier et al. (2012) measure the contribution to systemic risk considering two sub-samples of banks: banks with high non-interest income (like investment banking, venture capital and trading activities) and banks with high interest income (traditional banks). They find that banks with a higher non- interest income have a higher contribution to systemic risk. Their results suggest that activities that are not traditionally associated with banks, such as trading and securitization, investment banking, gains on non-hedging derivatives etc. are associated with a larger systemic risk.

Chen et al. (2017) examine how securitization in particular affects systemic risk in the banking system. They find that securities holdings increase substantially banks' systemic risk. In addition, they show that the systemic risk increase is interconnectedness driven. They explore cross-variations in the securitization ratio[9] and other bank characteristics and find that larger, more complex and diversified securitizers contribute more significantly to the systemic risk in the banking system. The paper suggest securitization as key determinant of bank systemic risk, due to an interconnectedness driven mechanism.

Loutskina (2011) analyzes how the role of securitization affects banks' riskiness from the liability side of the balance sheet. The paper documents that securitization led to a material changes on banks' balance sheets and in banks' risk exposure. It provides evidence that securitization acts as a substitute for bank's on-balance sheet liquidity as it provides deposit

[9] Securitization ratio represents the ratio of securitized assets over total assets

institutions with an effective channel to convert illiquid loans into liquid securities. By providing a new source of funds in the form of existing loans, securitization reduces the sensitivity of bank lending to the availability of the external sources of funds such as traditional liquid funds and deposits. As such, securitization weakens the ability of the monetary authority to affect banks' lending activity. This further makes banks more vulnerable to various economic shocks when the market for securitized loans is disrupted, increasing exposure to systematic risk.

Existing empirical papers in the literature investigate the effect of total securitization on systemic risk, where systemic risk is considered as an externality that drives the overall financial system. This research differs in two main aspects in comparison to the existing empirical literature:

- It provides different approach in measuring contagion effects of securitization in comparison to the standardly used measures for systemic risk[10].
- It investigates the impact of different categories of securities on banks' correlations, where the securities differ by their risk weights.

Our main measure is the correlation ratio and it is defined as a ratio of aggregate risk over bank's total risk. Using such ratio, we aim to measure not only the aggregate risk but also bank's total risk. We discussed that securitization enables diversification of banks' assets idiosyncratic risk on one side, but expands banks' balance sheets on the other side, thus increasing financial links among banks. We have a situation in which through securitization the idiosyncratic risk interacts with the tail aggregate risks creating extreme financial fragility (Gennaioli et al. 2013) Accordingly, we want to capture simultaneously the two effects that securitization has on banks' overall risk, as suggested by both theoretical and empirical evidence.

Using this measure for banks correlations, we examine the effect of four categories of securities on the aggregate risk relative to the idiosyncratic risk. Consequently, securities that carry relatively low risk identical to riskless assets (treasuries and agencies securities) should not have significant effect on aggregate risk relative to the idiosyncratic risk[11]. Since the RMBS consists of a large number of small mortgage home loans which are backed by the houses as collateral, the default risk associated with them is also quite low[12]. One of the trivial reasoning is that chances of large number of borrowers defaulting on their repayments at the same time is very low. Thus, we

[10] CoVar (Adrian and Brunnermeier, 2008), Systemic Expected Shortfall (Acharya et al. 2010), and SRISK (Engle and Brownlees, 2016)

[11] Hanson et al. (2015) consider government and agency securities as low risk assets and provide numerical example; however they do not provide evidence for this issue

[12] Begley and Purnanandam, 2017 consider RMBS as relatively safe assets, but they do not provide evidence

would also expect that RMBS shouldn't have significant effect on aggregate risk relative to the idiosyncratic risk.

On the other side, other MBS is the category of securities backed by real estate loans other than home mortgages. In our dataset, this category also includes structured finance products such as passthroughs MBS, collateralized mortgage obligations (CMOs) and collateral debt obligations (CDOs). Due to the strong diversification capabilities of these securities, they were considered as pretty much safe assets on banks' balance sheets. However, there is literature evidence which shows that these securities were actually characterized with much higher risk weights (Coval et al., 2009a,b; Brennan et al., 2009; Griffin and Tang, 2012). Therefore, we consider this category of securities as highly controversial regarding its risk exposure. Consequently, we could expect that they carry certain idiosyncratic and aggregate risks simultaneously and thus should have significant effect on the correlation ratio. This research aims to enrich empirical literature on securitization and financial fragility by providing evidence about the effect of these different categories of securities on aggregate risk relative to bank's total risk.

3. Hypothesis development

In order to explain given aspects of the global financial crisis of 2008, this research undertakes empirical tests following theoretical results of Gennaioli et al. (2013). According to their findings, securitization enables intermediaries to boost leverage by pooling risky projects to eliminate idiosyncratic risk. Combined with liquidity guarantees from the portion of safe projects, the diversified pool of projects is safe, and thus serves as collateral for the riskless debt. On the one side, securitization promotes the expansion of bank balance sheets by enabling the diversification of the idiosyncratic risk. On the other side, this further increases financial links among banks. Therefore, the insurance against idiosyncratic risk interacts with the neglect of tail aggregate risks in creating extreme financial fragility. Thus, securitization spreads unexpected aggregate shocks across all intermediaries, leading all of them to default.

In particular, we are interested in studying how securitization shapes financial fragility in the pre-crisis period and its contribution to banks' aggregate risk exposure. In this matter, the purpose of the study is to examine whether a high fraction of securitization in the banking industry generates high correlation among banks, increasing banks' aggregate risk relative to the bank's total risk.

Gennaioli et al. (2012, 2013) explain that in the presence of increasing securitization trend among banks, the neglect of aggregate risk represents the main source of fragility. The agents neglect the possibility that an adverse idiosyncratic shock, against which the intermediary is insured, occurs precisely in a recession state when many other intermediaries are experiencing the same shock. Under the neglect of risk many of the successful intermediaries also may be not able to repay their debt. In other words, this neglected risk could be interpreted in terms of counterparty risk. By holding securitized assets in their portfolios, banks are exposed to the risk of the sellers of securitized assets. Moreover, by holding securitized assets from many different sellers, banks' assets become correlated and exposed to common aggregate risk.

Phelan (2017) in his model argues that high correlation should provide greater informational advantage to intermediaries, however, according risk management theory high correlation also implies aggregate risk. Increasing the correlation in the portfolio increases the value of the portfolio, but for the same portfolio size, correlation increases the variance of the portfolio. Gennaioli et al. (2012,2013) show that securitization enables diversification of the idiosyncratic risk, but Allen et al. (2012) show that securitization exposes intermediaries to the common assets structure (marketable securities), thus increasing their correlation with the rest of banks in the industry. Therefore, securitization leads to changes in the composition of risk in banks' asset portfolios: it diversifies idiosyncratic risk at the expense of higher aggregate risk.

Consequently, Phelan (2017) proposes that empirical research should find that banks take on different degrees of correlated risk as portfolios grow. We argue that exactly exposure to the security holdings causes changes in correlation risk among banks in the onset of financial crisis. We consider four categories of securities holdings that differ by their risk weight: total securities holdings, government and treasuries securities, residential mortgage back securities (RMBS) and other mortgage back securities (other MBS). Increased holdings of each category should increase correlation among banks, but should not necessarily increase the aggregate risk. Treasury and agencies securities and RMBS holdings are relatively low risk assets by their own nature, thus high portion of holdings would increase correlation but they should not affect significantly the aggregate risk. On the other side, increased holdings of structured finance products belonging to the group of other MBS, should increase banks' correlation, but also should affect the aggregate risk more than they would affect the idiosyncratic risk. The reasoning for this assumption lies in ignoring the extent to which their defaults are correlated (Gennaioli et al. 2012, 2013; Broer, 2018; Coval et al. 2009a, 2009b; Brennan et al. 2009)). In this sense, the main hypothesis that we test is the following:

H: Securitization generates high correlation among banks with mortgage back securities - other than residential mortgage back securities, as the key determinant in increasing banks' aggregate risk relative to bank's total risk in the pre-crisis period.

4. Data, variables and methodology

4.1 Data

In order to estimate the correlation among banks we collect daily market prices from the Center for Research in Security Prices (CRSP). We collect quarterly accounting data from the Commercial Bank Database of the Federal Reserve Bank of Chicago (FRB Chicago). This database accounts all banks filing the Report of Condition and Income (named "Call Report") that are regulated by the Federal Reserve System, Federal Deposit Insurance Corporation (FDIC), and the Controller of the Currency. It does not have data from savings institutions that file the Thrift Financial Report (TFR) with the Office of Thrift Supervision (OTS).

We merge prices data with the accounting data using CRSP-FRB links dataset provided by Federal Reserve Bank of New York[13]. This dataset links bank's regulatory identification number (RSSD ID) from the National Information Center (NIC) to the permanent company number (PERMCO) used in the Center for Research in Security Prices (CRSP) from January 1, 1990 to March 31, 2011. The RSSD ID is a unique identifier assigned to commercial banks or bank holding companies by the Federal Reserve and is the primary identifier of entities in regulatory reports such as the Call Report (FFIEC031) and Y9-C. The PERMCO is a unique and permanent company identification number assigned to publicly-traded institutions in the CRSP database. While a company may change its name, ticker, exchange, the PERMCO will remain the same.

The sample covers the period from 2000:Q3 – 2008:Q3. For this period, the CRSP-FRB links dataset provides RSSD ID - PERMCO links for 132 commercial banks[14] which biggest business unit is the commercial banking and which are listed on one of the largest U.S. stock markets (the NYSE, AMEX or Nasdaq stock market). However, when merging this list of 132 commercial banks with market prices data from CRSP allowed our samples include 54 U.S. commercial banks in total over this time period.

[13] https://www.newyorkfed.org/research/banking_research/datasets.html
[14] Publicly Traded National Commercial Banks Companies with SIC Codes: 6020,6021 and 6022

Thus, restricted to only commercial banks that are listed on the largest US public stock markets (we do not consider commercial banks that trade OTC), our final sample is an unbalanced panel including 54 banks and accounting for total observations of 982.

We also construct two separate samples of banks considering the extreme values of total securities. We construct one sample of top 15 banks with highest values for the total securities and one sample of bottom 15 banks with lowest values for the total securities. Since we have unbalanced panel data, if we construct the sub-samples by their aggregate values of total securities over the years the sub-samples would be biased. The reasoning behind the bias is that some banks will have higher aggregate values of the total securities just because they keep it in their assets portfolios over longer period, but not because they concentrate high amounts of total securities. Therefore, we construct the sub-samples by determining individual bank's total aggregate value of total securities for the time period 2000:Q3 – 2008:Q8 and by dividing their aggregate value by individual bank's total number of observations (quarters). Finally, we rank banks according this ratio and we extract top 15 and bottom 15 banks.

4.2 Variables

The leading independent variable is securitization which is defined as the ratio of total outstanding securitized assets over total assets. Total outstanding securitized assets include all categories of securitized assets with all different maturities that exist on bank's balance sheet. We also define three additional independent variables that measure the effect of different categories of securities. We measure the effect of treasuries and agencies securities, defined as the ratio of total outstanding treasuries and agencies securities over total assets. We measure the effect of residential mortgage-back securities (RMBS) defined as the ratio of total outstanding RMBS securities over total assets and separately the effect of other MBS securities defined as the ratio of total outstanding other MBS securities over total assets. All securitization independent variables are used with natural logarithm transformation in the regression analyses.

Following the instruction book for preparation of consolidated reports of condition and income (FFIEC 031 and 041) by Federal Reserve Bank of U.S. there is a structural difference between RMBS and other MBS. RMBS include only mortgage back securities which are backed by home mortgages, while other MBS include mortgage back securities which are backed by real estate other than home mortgages. Broadly, this category includes commercial mortgage back

securities (CMBS), structured finance products such as passthroughs MBS, CDOs, CMOs and other securities which are backed by some real estate.

Independent Variable Description[15]

Tot_Sec = Ln [(securities_less_3m + securities_3m_1y + securities_1y_3y + securities_3y_5y + securities_5y_15y + securities_over_15y + securities_mat_less_1y) / TA]

Tot_Tres_Agen_Sec = Ln [(securitiestreasury_less_3m + securitiestreasury_3m_1y + securitiestreasury_1y_3y + securitiestreasury_3y_5y + securitiestreasury_5y_15y + securitiestreasury_over_15y) / TA]

T**ot_RMBS** = Ln [(securitiesrmbs_less_3m + securitiesrmbs_3m_1y + securitiesrmbs_1y_3y + securitiesrmbs_3y_5y + securitiesrmbs_5y_15y + securitiesrmbs_over_15y)/ TA]

O**ther_MBS** = Ln [(securitiesothermbs_less_3y + securitiesothermbs_over_3y) / TA]

For the purpose of measuring correlation among banks we construct the dependent variable - correlation ratio. As the main objective of the empirical analysis is to examine if securitization increases banks' aggregate risk relative to the bank's total risk, we consider the ratio of covariance between individual bank's returns with returns of the rest of banks in the sample over bank's variance for the corresponding quarter. According to our hypothesis, if this ratio is increasing over time it implies that an increase in securities holdings on bank's asset portfolio is associated with higher aggregate risk relative to the bank's total risk.

The idea for this measure comes from the CAPM[16] , more precisely, beta. We know that beta is computed as $\beta = \frac{Cov(R_A, R_m)}{Var(R_m)}$ and as such represents the asset's contribution to market variance. Further, assets that have $\beta > 1$ are highly correlated with the market and assets that have $\beta < 1$ are less correlated with the market. Analogically, in order to measure the covariance (or the correlation) of each bank with the rest of the banks in the sample, I consider all banks representing a market. I compute the return of this market as weighted sum of the returns of all banks (except the returns of the bank for which I estimate the covariance) at time t: $R_{banks} = \sum_{i=1}^{N} x_i R_i$. In this sense, our measure for the correlation ratio distinguishes from the CAPM approach such that in computing beta, the return of the market is computed as weighted sum of returns of all stocks,

[15] The accounting definition for each security item is provided in Appendix II
TA = Total Assets

[16] Introduced by Sharpe (1964) and Lintner (1965a,b)

including the one for which we determine its covariance with the market. Hence, I compute the correlation ratio for an individual bank in each quarter as[17]:

$$CorrRat = \frac{Cov(\ R_{b1,t,}R_{banks,t})}{Var_{b1,t}}$$

We control for a set of bank-specific variables that the literature has suggested could have a potential effect on the aggregate or total bank's risk in the regression analysis: leverage ratio, bank size, capital adequacy ratio, return on assets (ROA), other borrowed money and deposits levels. Hovakimian et al. (2012) investigate driving factors of systemic risk and find leverage and bank size as significant determinants of systemic risk. One of the results of Phelan (2017) is that bank size and profitability should be related to the amount of correlated risk in banks' assets, thus we also control for capital ratio and bank performance through ROA.

We define leverage ratio as a natural logarithm of the book value of total assets divided by book value of total equity. We define bank size as the natural logarithm of individual bank's total assets. We define capital ratio as the ratio of the sum of Tier 1 capital and Tier 2 capital over total risk weighted assets. We control for the effect of bank performance using return on assets ratio (ROA).

Other borrowed money and deposits levels are control variables for which we haven't found arguments in the literature, but for which we consider that could bias the estimation in our analysis. Moreover, as the aim of the empirical analysis is to measure if securitization increases correlation among banks in the pre-crisis period as an indicator for aggregate risk, other borrowed money represent mostly of any other bank's obligation for the purpose of borrowing money not reported elsewhere[18]. Consequently, the increasing correlation among banks could be affected by the interbank borrowing. In order to prevent this bias, we control for other borrowed money for each individual bank.

Finally, in order to prevent increasing correlation among banks due to regulatory arbitrage incentives we control for a variable that we have constructed for this purpose, deposits levels. Deposits levels is a ratio of weighted average of bank's deposits over total deposits in the economy for the particular quarter. As such, the ratio captures the time variation of deposits levels through total deposits in the economy and deposits' level variations across institutions through total

[17] I compute the covariance and variance using daily data of banks' stock prices

[18] Line item instructions for the Consolidated Report of Condition for a bank with domestic offices only (FFIEC 032, 033, or 034)

outstanding deposits of individual banks[19]. The argument for controlling banks' deposits levels is related to the fact that higher deposit levels induce banks' risk taking incentives. Higher deposit growth is related with increased lending, which further implies higher exposure to idiosyncratic risk.

$$DepositsLevels = \frac{Transaction\ Deposits + Brokered\ Deposits + Time\ Deposits + Savings\ Deposits}{Aggregate\ Deposits}$$

Finally, many empirical papers also use liquidity ratio as control variable in determining the relationship between banks' risks and balance sheet composition. In contrast, we avoid using liquidity ratio in order to prevent collinearity in the regression analyses. Since the liquidity ratio is a ratio of liquid assets divided by total assets, potentially creates collinearity with the bank size (total assets) and each of the four securities holdings (since securities belong to liquid assets).

4.3 Methodology: Regulatory discontinuity design and quantile regression

The aim of the empirical analysis is to examine whether on securitization generates high correlation among banks, increasing bank's aggregate risk relative to its total risk. For this purpose, we first estimate this relationship by OLS unbalanced panel data regressions. The OLS estimator confirms only if the relationship exists, but it does not give insights regarding the causality. Nevertheless, it is possible that banks which are aware that are already highly correlated with the banks in the industry, have tendency to engage in securitization in an attempt to decrease their risk exposure. There is also possibility for existence of potentially unobservable factors, which might affect simultaneously securitization and aggregate and total risk. In order to prevent endogeneity issues, we conduct regulatory discontinuity analysis in addition to the OLS regressions following Loutskina (2011). For identification strategy, we use one macroeconomic and one regulatory shock that affected significantly market reaction on securitization activities.

We evaluate whether securitization activities of banks affected their aggregate and total risk exposures differently around the two exogenous shocks. The first shock is related to the Enron collapse at the end of 2001. Off-balance sheet vehicles were key device for hiding Enron's

[19] We exclude the demand deposits in the computation of Deposits Levels

financial liabilities and this resulted in fear and swings in the confidence for securities markets[20]. Since there is a decline in the securities activities of banks after the Enron collapse at the end of 2001, we would expect decreasing effect of securitization on aggregate risk relative to the bank's total risk. In particular, we expect negative relationship between securitization and the ratio of aggregate and bank's total risk.

The other shock represents regulatory change related to securitization activities. Moreover, in July 2004, US bank regulators relaxed regulatory requirements by allowing banks to leave conduits off balance sheets and by lowering capital requirements for such conduits. The regulatory change required holding capital for some conduit liquidity enhancements at only a 10% conversion factor, which is much lower than the capital required for the on-balance sheet assets. Consequently, market responded in sharply increase with issuance and trading the securities. We expect that an increase in securitization activities after this regulatory change will be positively associated with the aggregate risk exposure relative to bank's total risk exposure. That is, we expect positive relationship between securitization and correlation ratio.

The empirical strategy contains baseline panel regressions with the following functional form:

$$Cov/Var_{j,t} = \beta_0 + \beta_1 * Ln\,(TotSec_{j,t-1}) + \beta_{2002} * Ln\,(TotSec_{j,t-1}) * D_{2002} + \beta_{2004} * Ln\,(TotSec_{j,t-1}) * D_{2004} + \beta_2 * Controls_{j,t-1} + \varepsilon_{t,i} \quad \textbf{(1)}$$

$$Cov/Var_{j,t} = \beta_0 + \beta_1 * Ln\,(Treas\_Agen\_Sec_{j,t-1}) + \beta_{2002} * Ln\,(Treas\_Agen\_Sec_{j,t-1}) * D_{2002} + \beta_{2004} * Ln\,(Treas\_Agen\_Sec_{j,t-1}) * D_{2004} + \beta_2 * Controls_{j,t-1} + \varepsilon_{t,i} \quad \textbf{(2)}$$

$$Cov/Var_{j,t} = \beta_0 + \beta_1 * Ln\,(RMBS\_Sec_{j,t-1}) + \beta_{2002} * Ln\,(RMBS\_Sec_{j,t-1}) * D_{2002} + \beta_{2004} * Ln\,(RMBS\_Sec_{j,t-1}) * D_{2004} + \beta_2 * Controls_{j,t-1} + \varepsilon_{t,i} \quad \textbf{(3)}$$

$$Cov/Var_{j,t} = \beta_0 + \beta_1 * Ln\left(Other\_MBS\_Sec_{j,t-1}\right) + \beta_{2002} * Ln\left(Other\_MBS\_Sec_{j,t-1}\right) * D_{2002} + \beta_{2004} * Ln(Other\_MBS\_Sec_{j,t-1}) * D_{2004} + \beta_2 * Controls_{j,t-1} + \varepsilon_{t,i} \quad \textbf{(4)}$$

We consider four different specifications. In the first one, we examine the effect of total securities holdings on the correlation ratio, in the second we isolate the effect of only treasuries and agencies securities on the correlation ratio, in the third one we isolate the effect of only residential mortgage back securities (RMBS) and with the fourth one we isolate the effect of other MBS. The idea is to provide evidence if some of the securities' category have superior effect on the correlation ratio.

[20] Acharya and Schnabl, 2010 provide evidence about the stagnation of the asset-backed commercial paper market during this period

We capture the different impact of securitization on the correlation ratio around the two exogenous shocks by interacting securitization independent variables with following dummy variables in the regression specifications:

- D_{2002} is a dummy variable equal to one for every quarter after and including 2002:Q3 and zero otherwise
- D_{2004} is a dummy variable equal to one for every quarter after and including 2004:Q3 and zero otherwise

The coefficients of the interaction terms dβ_{2002}#c.sec and dβ_{2004} #c.sec are the main coefficients of interest. They capture the marginal effect of securitization to the increase of the correlation ratio in the presence of the macroeconomic and regulatory shock, respectively. As after the Enron collapse at the end of 2001 the interest in securitization activities declined significantly, we expect that the correlation ratio will be associated with a decline, too. Thus, we expect the sign of dβ_{2002}#c.sec to be negative. In contrast, the regulatory event in July, 2004 restored the confidence in securities markets resulting in sharply growth in securitization activities. As a result, we would expect that securitization will have positive effect on correlation ratio after 2004. This further implies that the sign of dβ_{2004}#c.sec to be positive.

We generalize the examination to the entire distribution of the banks' correlated returns by employing quantile regression (Koenkar and Bassett, 1978). Unlike classical regression, which relates the mean of dependent variable to the explanatory variables, we would like to show how the relationship between different categories of securities and bank's correlation ratio varies for different percentiles of the data. More particular, we would like to examine how correlation ratio is affected by the banks' securitization levels in the extreme deciles of the distribution.

All independent variables are lagged with one quarter and we control for bank fixed effects and time fixed effects including both the quarter fixed effects and the year fixed effects. We include bank fixed effects to control for time-invariant heterogeneity across banks, while the quarter and year fixed effects should capture any direct impact of other macroeconomic factors.

We test for heteroscedasticity in all regression approaches, and especially for the unbalanced panel data we use modified Wald test for groupwise heteroscedasticity in fixed effect regression model. For all the regression prob>chi2 is very close to 0, which indicates heteroskedasticity. Therefore, in order to prevent heteroscedasticity and serial correlation in the same time we use robust standard errors for all specifications and regression approaches.

4.4 Descriptive Statistics

Table 1, 2 and 3 present descriptive statistics of the dependent, explanatory and control variables in the regression analyses. Tables 1 and 2 report the mean, median and standard deviation for the four periods separately: 2000:Q3 – 2002:Q2, 2002:Q3 – 2004:Q2, 2004:Q3 – 2006:Q2, 2006: Q3 – 2008:Q3. Table 3 reports Student's t–test on differences of the means between the subsequent periods. First column presents the t-test values and the second column presents p-values. We indicate a statistical significance of the differences in means at 1%, 5% and 10% level with one, two and three stars, respectively.

From Table 1 and 2 we observe that the correlation ratio took drastic changes in its mean values through the different periods. Its mean doubles between 2000/2002 and 2002/2004 periods. It is followed by a large decline between 2002/2004 and 2004/2006, to be followed with a significant increase from 7.54 to 10.03 for 2004/2006 and 2006/2008, respectively. From the securitization explanatory variables, we observe that both government and treasury securities and RMBS decrease in their means over the four periods. In contrast, we observe that the mean value of the securities that belong to other MBS relatively increases through the four periods.

Remarkably, the summary statistics of most of the variables is characterized with extreme values in standard deviations in comparison to the corresponding mean values. We observe that the standard deviations of the correlation ratio and the securitization variables are much higher than corresponding mean values. Bank size and other borrowed money also have extremely high standard deviations, while control variables such as leverage, CAR and ROA have very low standard deviations in comparison to their mean values.

Finally, we find that the differences in means of the correlation ratio between 2000/2002 and 2002/2004 and between 2002/2004 and 2004/2006 are significant at 1% and 5 % significance level, respectively. Regarding the securitization variables, the differences in means between 2004/2006 and 2006/2008 are significant at 1% and 5% significance level for total securities, government and treasury securities and RMBS securities.

Table 1: Descriptive Statistics for the period 2000:Q3 – 2002:Q2 and period 2002:Q3 – 2004:Q2

	2000:Q3 - 2002:Q2				2002:Q3 - 2004:Q2			
Variables	mean	median	SD	obs.	mean	median	SD	obs.
Dependent variable								
Correlation ratio	6.09	6.81	13.25	197	12.21	8.04	29.23	216
Regressors								
(Tot_sec/Tot_Assets) %	18.34	15.72	14.07	197	17.84	15.83	12.73	217
(Tot_tres_agen_sec/Tot_Assets)%	10.81	9.40	8.57	197	10.69	9.23	9.19	217
(Tot_RMBS/Tot_Assets)%	5.86	3.23	8.07	197	5.79	3.61	6.61	217
(Other_MBS/Tot_Assets)%	2.24	0.25	3.94	197	2.89	5.66	0.15	217
Control variables								
Leverage	12.32	12.56	3.27	197	11.51	11.14	3.40	217
Bank size (in mill.)	2,016,586.00	470,644.00	6,862,031.00	197	2,133,451.00	500,309.00	7,820,254.00	217
CAR	0.13	0.12	0.03	197	0.14	0.13	0.04	217
ROA	0.01	0.01	0.01	197	0.01	0.01	0.01	217
OtherBorrowedMoney	64,363.99	8,800.00	141,853.90	197	58,208.23	18,600.00	108,498.90	217
Deposits Level	0.00039	0.00010	0.00127	197	0.00038	0.00008	0.00136	217

Table 2: Descriptive Statistics for the period 2004:Q3 – 2006:Q2 and period 2006:Q3 – 2008:Q3

	2004:Q3- 2006:Q2				2006:Q3 - 2008:Q3			
Variables	mean	median	SD	obs.	mean	median	SD	obs.
Dependent variable								
Correlation ratio	7.54	6.16	18.68	263	10.03	5.81	20.03	305
Regressors								
(Tot_sec/Tot_Assets) %	15.46	14.18	10.73	263	12.60	11.87	8.62	305
(Tot_tres_agen_sec/Tot_Assets)%	8.97	8.35	7.40	263	7.21	6.16	5.50	305
(Tot_RMBS/Tot_Assets)%	5.13	2.94	6.05	263	4.16	2.67	4.60	305
(Other_MBS/Tot_Assets)%	3.89	8.22	0.06	263	3.24	0.01	6.80	305
Control variables								
Leverage	10.20	10.54	2.82	263	10.31	10.19	2.24	305
Bank size (in mill.)	2,105,150.00	414,234.00	8,327,634.00	263	2,482,448.00	490,452.00	9,327,396.00	305
CAR	0.15	0.13	0.06	263	0.14	0.12	0.03	305
ROA	0.01	0.00	0.01	263	0.00	0.00	0.01	305
OtherBorrowedMoney	48,266.27	20,700.00	63,114.42	263	145,331.70	30,450.00	673,977.40	305
Deposits Level	0.00032	0.00007	0.00125	263	0.00030	0.00008	0.00107	305

Table 3: t-statistics for the differences in means

Variables	t-test: differences in means					
	means_2002/2004	p-values	means_2004/2006	p-values	means_2006/2008	p-values
Dependent variable						
Correlation ratio	-2.6972***	0.0073	2.118**	0.0347	-1.5238	0.1281
Regressors						
(Tot_sec/Tot_Assets) %	0.382	0.7026	2.22**	0.0269	3.5152***	0.0005
(Tot_tres_agen_sec/Tot_Assets)%	0.1301	0.8966	2.2745**	0.0234	3.2351***	0.0013
(Tot_RMBS/Tot_Assets)%	0.0984	0.9216	1.1376	0.2558	2.1815**	0.0296
(Other_MBS/Tot_Assets)%	-1.3382	0.1816	-1.5115	0.1313	1.0258	0.3054
Control variables						
Leverage	2.444**	0.0149	4.6153***	0.0000	-0.5098	0.6104
Bank size (in mill.)	-0.1609	0.8722	0.0381	0.9696	-0.505	0.6138
CAR	-3.6734***	0.0003	-3.157***	0.0017	4.9187***	0.0000
ROA	1.2182	0.2239	0.381	0.7034	1.9629	0.0502
OtherBorrowedMoney	0.4985	0.6184	1.2515	0.2114	-2.3265**	0.0203
Deposits Level	0.0602	0.9520	0.4932	0.6221	0.2091	0.8345

In figure 4 we provide plot of the dependent variable – correlation ratio over the sample time period. We graph how the correlation ratio evolves over time for top 5 securitized banks (bold lines) and bottom 5 securitized banks (dash lines). We could say that the correlation ratio does not behave differently for the two sets of banks.

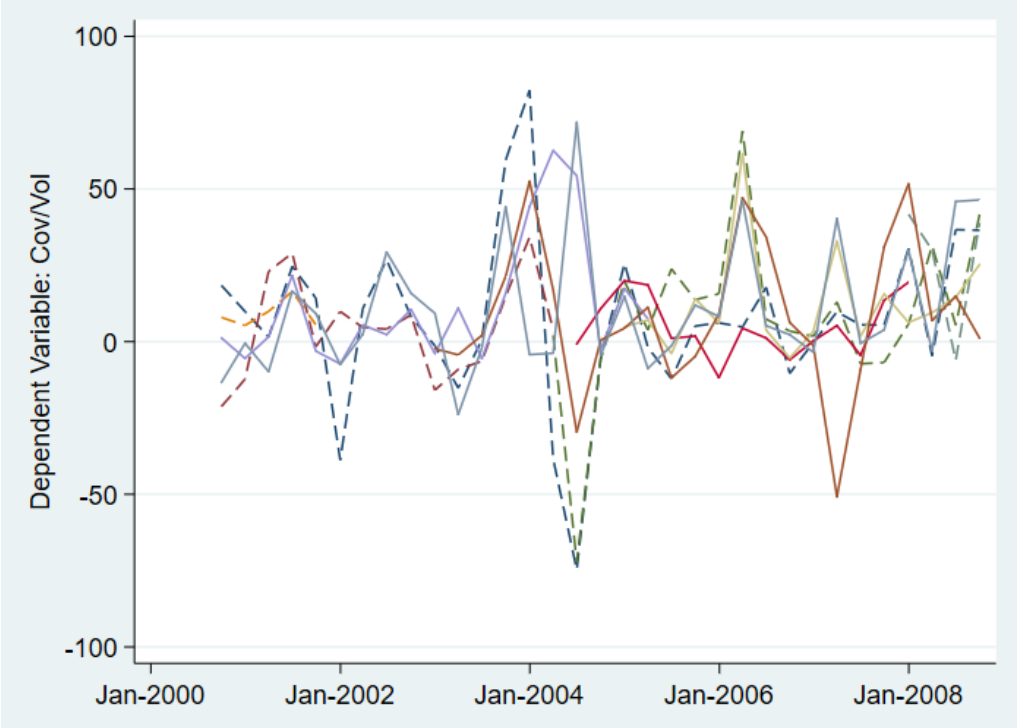

Figure 4: Correlation ratio movements over time for top 5 securitized banks (bold lines) and bottom 5 securitized banks (dash lines)

5. Discussion of the results

The results of the empirical analysis overall support our hypothesis. Regulatory discontinuity analysis emphasizes other MBS as the category that makes significance difference in its effect on the correlation ratio before and after 2002/2004 events. We provide baseline results on the entire set of banks and on the two subsets of high-securitized and low-securitized banks. Table 4 and Table 5 report the baseline results of the ordinary OLS regression specifications and the regulatory discontinuity analysis for the entire sample, respectively. Table 6 and Table 7 report baseline results of the ordinary OLS regression specifications and regulatory discontinuity analysis for the two sub-samples of banks, respectively. Finally, we discuss graphical representations of the quantile regression results, while the corresponding tables are provided in Appendix IV.

5.1 Empirical analysis of the entire sample of banks

The results from the ordinary OLS regression analysis suggest significant relationship between securitization and correlation ratio. Moreover, the relationship is negative for the total securities and for the treasuries and agencies securities. This result is expected since treasuries and agencies securities are the minimum risk securities and banks hold them initially to diversify the idiosyncratic risk. Consequently, it is expected that higher amount of treasuries and agencies securities in bank's assets portfolio will be negatively associated with the correlation ratio. Further, since securities and treasuries holdings represents the highest fraction of total securities holdings it is naturally that total securities holdings will be also negatively associated with the correlation ratio. On the other side, residential mortgage back securities are securities weighted with higher risk[21] and consequently, the results suggest positive relationship between RMBS and correlation ratio. Surprisingly, the relationship between other MBS and correlation ratio is not statistically significant in the ordinary OLS regression analysis.

As the relationships identified by the ordinary OLS regression analysis could suffer from endogenous issues we further conduct regulatory discontinuity analysis. The regulatory discontinuity analysis provides more specific evidence for our relationship of interest. It emphasizes the effect of other MBS on the correlation ratio as superior. In addition, the effect of other MBS on the correlation ratio is different for the two exogenous shocks. Given the

[21] Basel I requirements assign at least 50% risk weight to uninsured residential mortgages

endogeneity issues, the direct coefficient on securitization (β_1) is not identified. Only the coefficients on the interaction term with the exogenous event dummies (d2002#c.sec and d2004#c.sec) are identified.

We provide two sets of estimated coefficients of the exogenous events dummies. d_{2002} and d_{2004} provide evidence if the macroeconomic and the regulatory event have any effect on the correlation ratio. We observe that coefficients for both dummy variables are statistically significant at 1% and 10% significance level for the macroeconomic and regulatory event, respectively and for almost all types of securities[22]. Such results suggest that after the events happened, the correlation ratio of individual banks certainly beard change in contrast to the case if the events didn't happen at all.

d2002#c.sec and d2004#c.sec provide evidence if the securitization in particular, had effect on the correlation ratio of each individual bank after the events have taken place. Furthermore, the regulatory discontinuity analysis provides evidence for other MBS as securities with superior effect on the aggregate risk relative to the idiosyncratic risk and further, as the only category of securities for which there is a difference in its effect before and after 2002/2004 events. This result is in consistency with the descriptive statistics of banks' balance sheet items. In addition, the coefficient related to the Enron collapse event has expected negative sign. That is, we expect that after the Enron collapse the securitization activities of banks would be followed by a decline as a result of the lost market confidence in securities. Consequently, the aggregate risk of individual banks should be followed by a decline, too. Therefore, negative sign of the coefficient of the dummy d2002#c.sec for other MBS implies that especially other MBS had decreasing effect on correlation ratio, moreover, on the aggregate risk exposure, in the period after the Enron collapse. Hence, the results suggest that other MBS had driven the aggregate risk exposure corresponding to the period before the Enron collapse much more than the rest of the securities' types.

In contrast, the coefficient of the dummy d2004#c.sec, corresponding to the regulatory change in July, 2004 and associated with fast growth in securitization, is positive and statistically significant only for other MBS. This result is also in consistency with the descriptive statistics of banks' balance sheets. Since the regulatory change in July, 2004 enabled relaxing accounting tracking for the conduits securities and relaxing capital requirements, it was expected that the market increase securitization activities. According our hypothesis, this should result in increasing correlation among banks and thus, increasing aggregate risk. Therefore, our results indicate that

[22] d2004 is not statistically significant for total securities and for other MBS

other MBS in particular, had also driven explicitly the increasing aggregate risk exposure of individual banks in the period after the regulatory change in July, 2004 has taken place.

Overall, the results delivered by the regulatory discontinuity analysis emphasize the other MBS as the key driver in aggregate risk exposure in the overall pre-crisis period. The Enron collapse induced fear and skepticism toward the securities holdings within the banking industry and the outcome was a decreasing effect on correlations. In contrast, 2004 regulation enhanced the confidence in securities markets and the outcome was increasing effect on correlations among banks. Remarkably, the effects on correlations are driven mainly by other MBS holdings.

Regarding the set of control variables, we observe that bank size and other borrowed money have positive and statistically significant effect on the correlation ratio in both regression approaches.

As a robustness check we test the relationship between securitization and correlation ratio for the “before” and “after” exogenous changes subsets. For this purpose, we run regression analysis in which we interact the dummy variables of interest (#d2002 and #d2004) with all control variables. This approach allows us to split the dataset for "before" and "after" exogenous shocks subsets and then run simple regression without any dummies on each subset of observations separately. The results are consistent with the results from the regression discontinuity analysis[23]. The only statistically significant effect on correlation ratio is captured by the category of other MBS. The coefficient of other MBS is positive and statistically significant at 5% significance level.

[23] The table of results is given in Appendix III

Table 4: OLS Regression analysis on the entire sample

VARIABLES	Model (1) Tot_Sec	Model (2) Gov_Ag_Sec	Model (3) RMBS_Sec	Model (4) Other_MBS
sec	-2.563**	-1.896*	1.072*	-0.134
	(1.178)	(1.089)	(0.602)	(0.482)
Log (leverage)	-8.063	-8.364	-8.779	-10.58
	(7.952)	(7.873)	(7.761)	(7.695)
Log (banksize)	6.614	6.548	8.253*	7.800*
	(4.136)	(4.091)	(4.177)	(4.186)
CAR	-22.75	-23.29	-30.18	-32.39
	(42.77)	(41.85)	(40.84)	(40.01)
ROA	141.8	120.4	114.3	114.0
	(225.9)	(222.4)	(217.5)	(223.5)
OtherBorrowedMoney	4.23e-06**	4.23e-06**	3.86e-06**	4.36e-06**
	(1.59e-06)	(1.69e-06)	(1.52e-06)	(1.71e-06)
DepositsLevel	-3,771	-3,360	-5,424	-4,534
	(4,321)	(4,556)	(3,934)	(4,279)
Constant	-65.98	-63.93	-75.60	-68.29
	(59.83)	(58.16)	(57.58)	(56.84)
Observations	920	903	928	928
R-squared	0.086	0.088	0.085	0.082
Number of rssdid	54	53	54	54
Bank FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Quarter FE	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5: Regulatory discontinuity analysis on the entire sample

VARIABLES	Model (1) Tot_Sec	Model (2) Gov_Ag_Sec	Model (3) RMBS_Sec	Model (4) Other_MBS
sec	-0.929	-0.227	-0.302	0.432
	(1.269)	(1.262)	(0.793)	(0.557)
d2002	-20.52***	-21.89***	-12.49***	-21.58***
	(4.338)	(4.409)	(3.351)	(3.740)
d2002#c.sec	-1.387	-1.254	2.439**	-1.513*
	(1.422)	(1.314)	(0.986)	(0.864)
d2004	-9.177	-12.80**	-9.553*	-4.341
	(6.186)	(6.364)	(5.468)	(5.106)
d2004#c.sec	-0.756	-1.408	-0.788	1.382*
	(2.028)	(1.620)	(1.027)	(0.782)
Log (leverage)	-8.052	-8.433	-8.150	-11.13
	(7.920)	(7.873)	(7.588)	(7.594)
Log (banksize)	8.109*	8.140*	9.647**	7.732
	(4.270)	(4.289)	(4.342)	(4.632)
CAR	-15.02	-14.99	-18.38	-23.39
	(41.99)	(40.87)	(38.85)	(37.48)
ROA	135.0	101.1	128.0	103.4
	(233.4)	(231.9)	(220.9)	(225.9)
OtherBorrowedMoney	4.15e-06**	4.02e-06**	3.84e-06**	4.10e-06**
	(1.71e-06)	(1.78e-06)	(1.56e-06)	(1.78e-06)
DepositsLevel	-3,352	-3,061	-4,272	-4,079
	(4,381)	(4,528)	(3,884)	(4,396)
Constant	-85.03	-83.68	-102.2*	-68.63
	(60.31)	(59.22)	(58.78)	(62.61)
Observations	920	903	928	928
R-squared	0.103	0.109	0.105	0.104
Number of rssdid	54	53	54	54
Bank FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Quarter FE	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

5.2. Empirical analysis of the subsamples

Analyses so far suggest that other MBS have superior effect on generating aggregate risk among banks in the pre-crisis period. The main argument of this research is that the impact of securitization on correlations is through the tendency for asset commonality on banks' balance sheets. Accordingly, we should expect that the impact of securitization on correlations would be stronger for banks with higher levels of total securities on their assets portfolios.

Therefore, we further provide empirical measurements to examine whether on the impact of securitization on correlations is different for banks with different levels of total securities. For this purpose, we construct two sub samples of top 15 and bottom 15 banks according to the total securities holdings and we run ordinary OLS and regression discontinuity regressions. The results are presented in Tables 3 and 4, respectively.

We capture the effect of securitization on correlations of top banks in comparison to bottom banks through the interaction term of the dummy variable *highsec* and corresponding securitization variable (Total_Sec, Gov_Ag_Sec, RMBS_Sec and other_MBS)[24].

We observe that coefficients of the interaction term *highsec#c.sec* are positive for total securities and government and agencies securities holdings and negative for RMBS and other MBS holdings in both empirical approaches. These results suggest that top banks affect stronger the increase in correlations among banks in comparison to bottom banks, through total securities holdings and government and agencies securities holdings. If we consider RMBS and other MBS holdings, the results suggest that top banks affect stronger the decrease in correlations among banks in comparison to the bottom banks. However, we do not find the different impact on correlations for top banks in comparison to bottom banks statistically significant.

[24] **#**highsec is a dummy variable equal to 1 if the bank belongs to the sample of top 15 securitized banks, and 0 otherwise.

Table 6: OLS Regression analysis on the two subsamples

VARIABLES	Model (1) Tot_Sec	Model (2) Gov_Ag_Sec	Model (3) RMBS_Sec	Model (4) Other_MBS
sec	-3.012***	-2.418**	1.261*	0.519
	(1.004)	(1.024)	(0.678)	(0.516)
highsec#c.sec	3.348	3.352	-1.064	-1.287
	(3.263)	(3.060)	(1.391)	(0.954)
Log (leverage)	-7.456	-8.485	-8.236	-8.612
	(7.263)	(7.656)	(7.563)	(7.033)
Log (banksize)	6.651	6.592	7.965*	8.384**
	(4.126)	(4.056)	(4.324)	(4.031)
CAR	-19.69	-22.50	-27.54	-23.57
	(40.55)	(40.88)	(39.63)	(36.70)
ROA	135.9	117.9	121.7	120.2
	(224.4)	(222.8)	(218.3)	(226.0)
OtherBorrowedMoney	4.27e-06**	4.35e-06**	3.77e-06**	4.33e-06**
	(1.69e-06)	(1.80e-06)	(1.51e-06)	(1.68e-06)
DepositsLevel	-4,871	-4,739	-5,488	-4,146
	(4,904)	(4,958)	(3,894)	(4,316)
Constant	-67.26	-63.29	-74.50	-81.78
	(58.84)	(57.58)	(58.39)	(54.47)
Observations	920	903	928	928
R-squared	0.087	0.089	0.085	0.084
Number of rssdid	54	53	54	54
Bank FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Quarter FE	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 7: Regulatory discontinuity analysis on the two subsamples

VARIABLES	Model (1) Tot_Sec	Model (2) Gov_Ag_Sec	Model (3) RMBS_Sec	Model (4) Other_MBS
sec	-1.369	-0.732	-0.0783	1.275
	(1.131)	(1.121)	(0.883)	(0.851)
d2002	-20.09***	-21.31***	-12.73***	-22.08***
	(4.411)	(4.400)	(3.378)	(3.786)
d2002#c.sec	-1.230	-1.094	2.347**	-1.643*
	(1.487)	(1.280)	(0.996)	(0.926)
d2004	-9.155	-13.02**	-9.626*	-4.798
	(6.165)	(6.393)	(5.493)	(5.114)
d2004#c.sec	-0.727	-1.489	-0.827	1.147
	(2.021)	(1.609)	(1.029)	(0.780)
highsec#c.sec	2.539	2.758	-0.803	-1.278
	(3.334)	(3.215)	(1.457)	(1.018)
Log (leverage)	-7.622	-8.572	-7.772	-9.061
	(7.349)	(7.719)	(7.551)	(7.242)
Log (banksize)	8.054*	8.117*	9.324**	7.754*
	(4.268)	(4.265)	(4.567)	(4.612)
CAR	-12.90	-14.57	-16.60	-16.34
	(40.31)	(40.18)	(38.24)	(35.90)
ROA	131.5	98.91	133.2	108.0
	(232.0)	(231.8)	(221.4)	(227.3)
OtherBorrowedMoney	4.16e-06**	4.11e-06**	3.75e-06**	3.99e-06**
	(1.78e-06)	(1.87e-06)	(1.56e-06)	(1.76e-06)
DepositsLevel	-4,235	-4,214	-4,363	-3,839
	(4,919)	(4,903)	(3,853)	(4,410)
Constant	-85.09	-82.43	-99.78	-74.47
	(60.00)	(59.26)	(60.45)	(62.21)
Observations	920	903	928	928
R-squared	0.104	0.110	0.105	0.106
Number of rssdid	54	53	54	54
Bank FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Quarter FE	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

5.3 Quantile regression analysis

We employ a quantile regression analysis in order to examine how the relationship varies for different percentiles of the data[25]. To preserve space, the tables of quantile regression estimates for different percentiles have been included in the appendix IV. Results of the quantile regression analysis are consistent for the different percentiles and confirm the findings from the regression discontinuity design. With quantile regression approach we also find only other MBS statistically significant along the entire distribution with 1% significance levels for the higher quantiles (90%, 95% and 99%).

Figure 5 and 6 plot the estimated coefficients and associated 95% confidence intervals for the four different explanatory variables from a quantile regression. We compare the effects of the four categories of securities for different percentiles of the correlation ratio. Figure 5 shows the effects for different quantiles of the four categories of securities in the period after the Enron event in 2002 and figure 6 shows the effects for different quantiles in the period after the regulatory event in 2004. Figure 7 shows separately the effect of other MBS for different percentiles of the correlation ratio in the periods after the Enron event (2002) and after the regulatory event in 2004, respectively.

First of all, looking at both figures 5 and 6, the results demonstrate that the effect of the four categories of securities is not monotonic along the entire distribution. Second important remark would be that at the median all four categories of securities have almost the same effect on the aggregate risk relative to the idiosyncratic risk. For the period after the Enron event in 2002, we observe that coefficients of all four categories of securities are just below zero at the median, indicating negative effect around the median. For the period after the regulatory event in 2004, we observe that coefficients of all four categories of securities are just above the zero indicating positive effect around the median.

For the period after the Enron event (2002), we could argue that there is increasing trend in the effect of treasury and agencies securities and decreasing trend in the other MBS. Moreover, in the period after the Enron event in 2002, the effect of total securities, treasury and agencies securities and RMBS securities is increasing for the upper quantiles, in contrast to the decreasing effect of the other RMBS for the same quantiles.

For the period after the regulatory event in 2004, we observe that for the quantiles below the median the effects of all four categories of securities change in similar manner, but they

[25] We use robust standard errors to control for heteroscedasticity and serial correlation of the standard errors

significantly differ in their magnitude. For the quantiles above the median the effects of all four categories of securities behave very differently. An important remark is that in the period after the regulatory event in 2004, the effect of other MBS dominates along the entire distribution of the correlation ratio. In contrast to the previous period (2002-2004), other MBS now show increasing effect in the upper quantiles. In addition, the difference in the effects between other MBS and the other three categories is much larger for the higher quantiles.

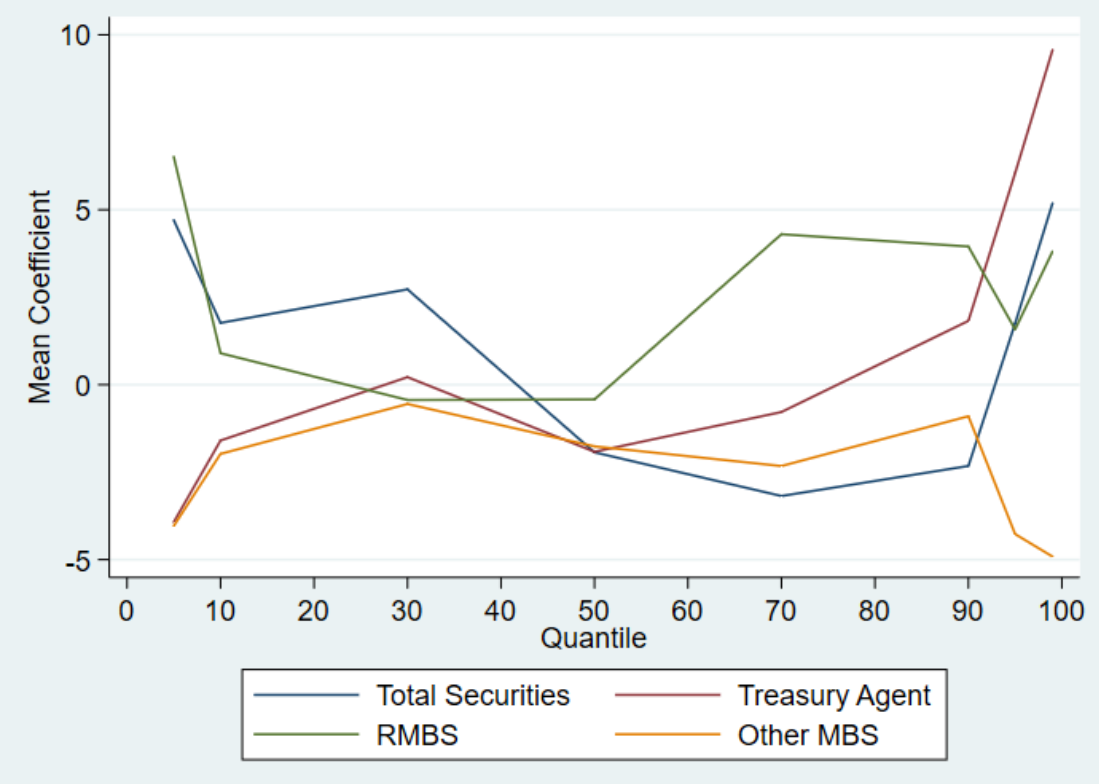

Figure 5: Coefficients from quantile regressions - The effect of securitization after the exogenous shock in 2002

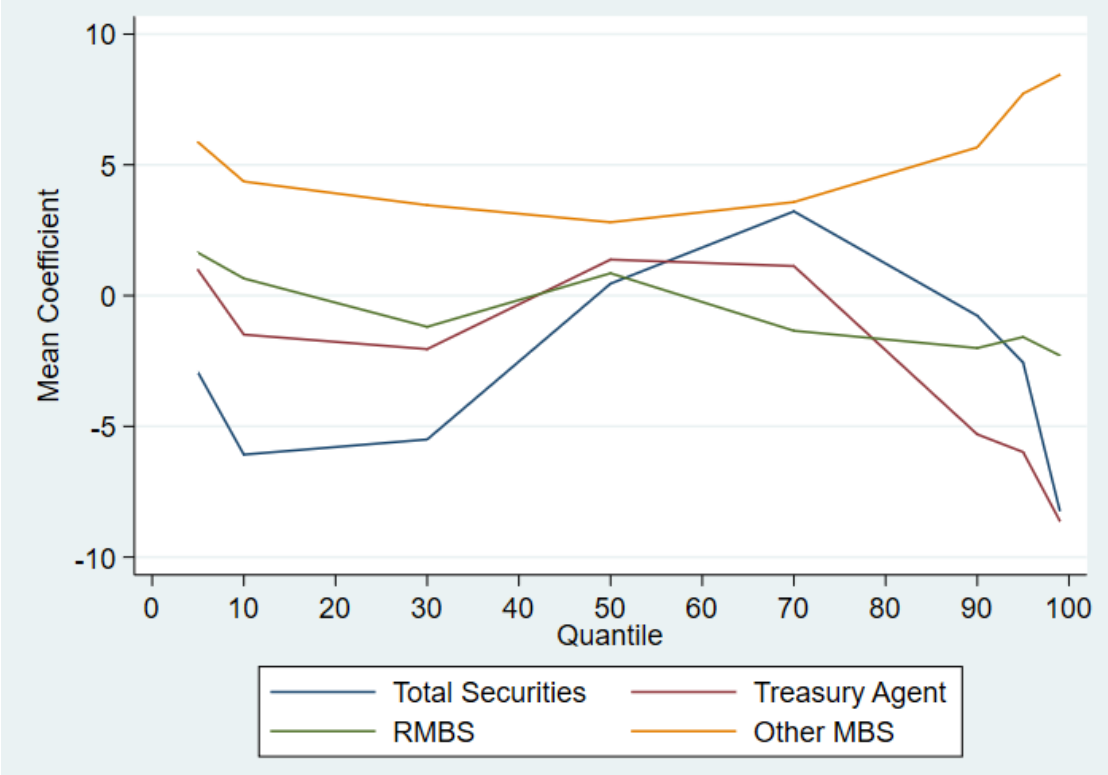

Figure 6: Coefficients from quantile regressions – The effect of securitization after the regulatory event in 2004

Figure 7 compares the effect of other MBS in the subsequent periods (2002-2004 and 2004-2008). We observe that actually, other MBS have completely opposite effect on the aggregate risk relative to the idiosyncratic risk in the corresponding periods. In the period after the Enron event in 2002, the coefficients from the quantile regression are mainly negative, indicating negative effect of other MBS on the aggregate risk relatively to the idiosyncratic risk. In addition, the effect of other MBS changes in concave pattern along the entire distribution. In the period after the regulatory event in 2004, the coefficients of other MBS from the quantile regression are positive and the effect of other MBS changes in convex pattern.

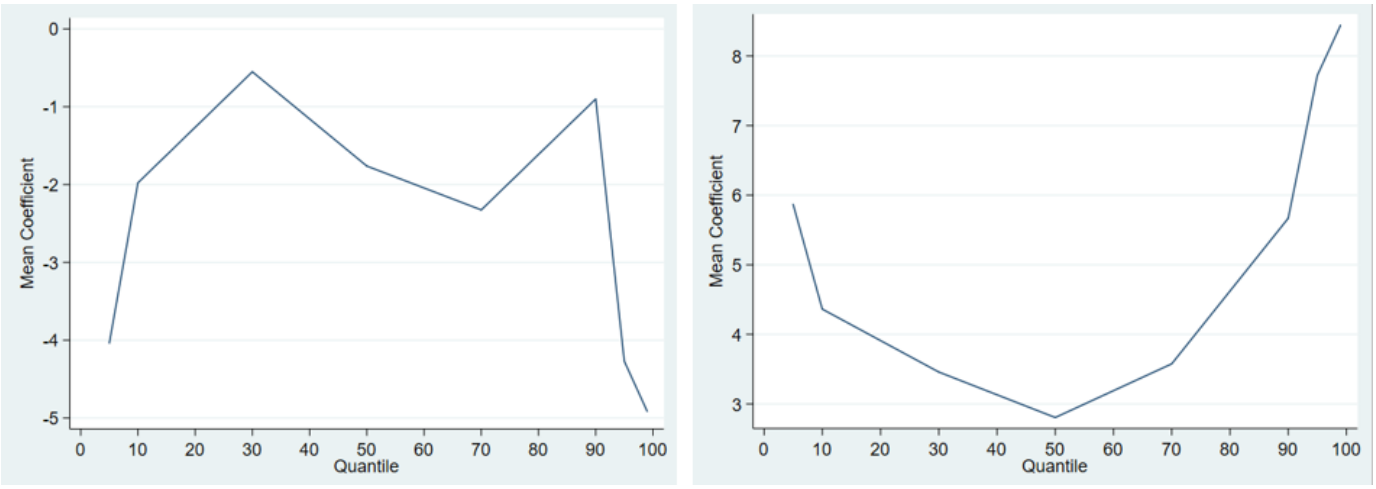

Figure 7: Coefficients from quantile regression for other MBS: left plot depicts other MBS after 2002, right plot depicts other MBS after 2004

6. Conclusion

This research examines the contribution of securitization to bank's aggregate risk relative to the bank's total risk in the pre-crisis period. We argue that investing in securitized assets generates asset commonality on banks' assets portfolios. Such asset commonality allows an efficient risk sharing in the financial system on the one side, but it creates financial links among banks on the other side. We argue that while the purpose of banks' investments in securities was primarily for diversification of the idiosyncratic risk and lowering the total bank's risk exposure by that, in essence, securities exposed banks heavily to the aggregate risk.

For this purpose, we construct a measure for determining correlation among banks correspondingly to the beta measure of the CAPM. The measure represents a ratio of covariance between each individual bank's returns with returns of the rest of banks in the sample over bank's variance for the corresponding quarter. In this ratio, the covariance measures joint movements of banks and the variance measures their idiosyncratic risk exposure. If the ratio is associated with an increasing trend over time, it implies that an increase in securities holdings is followed by an increase in the aggregate risk of the bank relative to the idiosyncratic risk.

We perform ordinary OLS regression analysis in order to determine if any relationship between securitization and banks' correlations exists. We prevent endogeneity issues by performing regulatory discontinuity analysis. We take advantage of the Enron collapse at the end of 2001 and the regulatory change in July, 2004 and use them as exogenous variations for the regulatory discontinuity analysis. We examine the relationship securitization and correlation ratio for different percentiles of the data by employing quantile regression analysis. We provide empirical evidence about the effect of securitization on banks' correlations for the entire sample of banks and for two subsamples: top 15 and bottom 15 banks according the levels of securities holdings on their assets portfolios. We examine the effect of four categories of securities holdings that differ in their risk weights: overall securities holdings, government and agencies securities, residential mortgage-back securities (RMBS) and other mortgage-back securities holdings (other MBS).

Within the regulatory discontinuity analysis, the only statistically significant effect on aggregate risk relative to the total bank's risk is captured by other MBS holdings. This finding indicates that securities holdings characterized with controversial risk weights actually drove banks' aggregate risk exposure in the pre-crisis period. The quantile regression analysis shows that the effects of the other MBS are positive and statistically significant at 1% significance level along

the high quantiles of the risk ratio distribution (90%, 95% and 99%).This result classifies the other MBS as bank's interconnectedness generators. They develop bank's interconnectedness with the system exposing banks to a new source of risk rather than only affecting bank's total risk in any way.

We conclude that securitization generated aggregate risk exposure in the pre-crisis period through the banks' assets side of the balance sheet. We consider this finding very important since indicates that in the presence of financial innovation the assets portfolios are not constant, but rather dynamic. That is, an increasing exposure of banks to a particular sector, accompanied by a financial innovation in the markets leads to high aggregate risk exposure. This is exactly the case with the real estate sector and mortgage back securities in the pre-crisis period. Overall, our findings indicate how the change in banks' characteristics can contribute in recognizing potential sources for aggregate risks. The study highlights the importance of banks' balance sheet adjustments in order to provide conceptual explanation for the occurrence of the financial crisis.

Finally, considering findings in this research, we argue that measuring correlations of banks' assets portfolios should be very precisely determined and regulated. Many practitioners are against mandatory regulatory requirements for reporting the correlations of banks assets due to the complex and time-consuming nature of determining correlations. In an attempt to find compromise, Basel III framework requires estimation of parameter such as aggregate loss correlation coefficient for each business unit, however, its estimation is determined individually and internally by the bank. We strongly recommend that the measurement of the aggregate loss correlation should be defined with precise procedures and should be a subject to a formal regulatory requirements and controls. We support this recommendation with the evidence provided in this research: measuring correlations is a tool for managing the impact of financial innovations in markets.

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8. Appendix

8.1 Appendix I: Descriptive statistics of Balance Sheet Items

Descriptive Statistics: Balance Sheet items in percentages of total assets

Items	Total over 1997	Total over 2002	Total over 2007
Loans			
Real estate loans	31.05	37.12	47.7
Personal loans	6.1	3.26	1.16
Agricultural Loans	63.96	54.85	0.32
Commercial and Industrial Loans	25.13	21.6	19.45
Net loans	67.12	65.3	69.77
Liquid Assets			
Cash	9.55	5.82	3.67
Reverese repos	2.32	2.16	2.18
Securities	1.19	15.84	11.26
Treasury and agency securities	7.38	8.39	6.38
RMBS securities	1.66	6.18	4.01
Other MBS securities	1.18	4.53	7.49
Trading assets	1.38	65.21	68.05
Total assets	1.82E+08	2.08E+08	3.25E+08
Deposits			
Demand deposits	24.4	14.69	6.99
Transaction deposits	27.71	17.81	8.74
Brokerage deposits	1.89	1.14	2.56
Time deposits	30.17	21.11	24.97
Savings deposist	22.51	46.9	50.64
Foreign deposits	9.2	7	4.58
Repos	3.88	0.93	3.1
Subordinated debt	0.95	0.25	1.1
Other borrowed money	1.3	3.87	4.88
Trading Liabilities	21.41	28.43	0.33
Total liabilities	1.67E+08	1.88E+08	2.97E+08
Total equity	15636369	19684352	28428571

8.2. Appendix II: Accounting description of securities items

Total securities	
Securities with repricing maturity of less than three months	securities_less_3m
Securities with repricing maturity of more than three months and less than a year	securities_3m_1y
Securities with repricing maturity of more than one year and less than three years	securities_1y_3y
Securities with repricing maturity of more than three years and less than five years	securities_3y_5y
Securities with repricing maturity of more than five years and less than fifteen years	securities_5y_15y
Securities with repricing maturity of more than fifteen years	securities_over_15y
Securities with remaining maturity of less than one year	securities_mat_less_1y
Total treasury and agency securities	
Non-mortgage-related securities with repricing maturity less than 3 months	securitiestreasury_less_3m
Non-mortgage-related securities with repricing maturity of more than 3 months and less than a year	securitiestreasury_3m_1y
Non-mortgage-related securities with repricing maturity of more than one year and less than three years	securitiestreasury_1y_3y
Non-mortgage-related securities with repricing maturity of more than three years and less than five years	securitiestreasury_3y_5y
Non-mortgage-related securities with repricing maturity of more than five years and less than fifteen years	securitiestreasury_5y_15y
Non-mortgage-related securities with repricing maturity of more than fifteen years	securitiestreasury_over_15y
Total Residential RMBS securities	
Residential RMBS with repricing maturity of less than three months	securitiesrmbs_less_3m
Residential RMBS with repricing maturity of more than three months and less than a year	securitiesrmbs_3m_1y
Residential RMBS with repricing maturity of more than one year and less than three years	securitiesrmbs_1y_3y
Residential RMBS with repricing maturity of more than three years and less than five years	securitiesrmbs_3y_5y
Residential RMBS with repricing maturity of more than five years and less than fifteen years	securitiesrmbs_5y_15y

Residential RMBS with repricing maturity of more than fifteen years	securitiesrmbs_over_15y
Total Other MBS securities	
Other MBS with repricing maturity of less than three years	securitiesothermbs_less_3y
Other MBS with repricing maturity of more than three years	securitiesothermbs_over_3y

8.3 Appendix III: Regression analysis of the "before" and "after" regulation change subsets

Specification (1):

$$Cov/Var_{j,t} = \beta_0 + \beta_1 * Ln\,(TotSec_{j,t-1}) + \beta_{2002} * Ln\,(TotSec_{j,t-1}) * D_{2002} + \beta_{2004} * Ln\,(TotSec_{j,t-1}) * D_{2004} + \beta_{2002} * Controls_{j,t-1} * D_{2002} + \beta_{2004} * Controls_{j,t-1} * D_{2004} + \varepsilon_{t,i}$$

Specification (2):

$$Cov/Var_{j,t} = \beta_0 + \beta_1 * Ln\,(Treas_{Agen Sec_{j,t-1}}) + \beta_{2002} * Ln\,(Treas_{Agen Sec_{j,t-1}}) * D_{2002} + \beta_{2004} * Ln\,(Treas_{Agen Sec_{j,t-1}}) * D_{2004} + \beta_{2002} * Controls_{j,t-1} * D_{2002} + \beta_{2004} * Controls_{j,t-1} * D_{2004} + \varepsilon_{t,i}$$

Specification (3):

$$Cov/Var_{j,t} = \beta_0 + \beta_1 * Ln\,(RMBS_{Sec_{j,t-1}}) + \beta_{2002} * Ln\,(RMBS_{Sec_{j,t-1}}) * D_{2002} + \beta_{2004} * Ln\,(RMBS_{Sec_{j,t-1}}) * D_{2004} + \beta_{2002} * Controls_{j,t-1} * D_{2002} + \beta_{2004} * Controls_{j,t-1} * D_{2004} + \varepsilon_{t,i}$$

Specification (4):

$$Cov/Var_{j,t} = \beta_0 + \beta_1 * Ln\left(Other_{MBS Sec_{j,t-1}}\right) + \beta_{2002} * Ln\left(Other_{MBS Sec_{j,t-1}}\right) * D_{2002} + \beta_{2004} * Ln\left(Other_{MBS Sec_{j,t-1}}\right) * D_{2004} + \beta_{2002} * Controls_{j,t-1} * D_{2002} + \beta_{2004} * Controls_{j,t-1} * D_{2004} + \varepsilon_{t,i} \quad \textbf{(4)}$$

Regression analysis in which we add interaction terms of the event dummies with all control variables

VARIABLES	Model (1) Tot_Sec	Model (2) Gov_Ag_Sec	Model (3) RMBS_Sec	Model (4) Other_MBS
sec	-0.148	0.607	-1.298	0.0249
	(1.498)	(1.467)	(2.552)	(1.721)
d2002	59.69	57.56	-2.431	-50.50
	(71.17)	(64.90)	(125.6)	(108.9)
d2002#c.sec	-0.460	-0.776	3.567	-2.044
	(1.784)	(1.191)	(2.759)	(1.792)
d2004	-101.0	-118.8*	-89.09	-69.06
	(71.91)	(69.37)	(69.83)	(108.0)
d2004#c.sec	-2.174	-2.850	1.386	3.192**
	(2.786)	(1.984)	(1.449)	(1.261)
Log (leverage)	-25.51**	-27.05**	-12.26	-32.68**
	(12.39)	(12.80)	(13.31)	(14.41)
d2002#c.Log (leverage)	3.227	6.437	10.35	28.39*
	(15.34)	(13.99)	(17.48)	(16.65)
Log (banksize)	11.60**	10.99*	10.68	6.633
	(5.588)	(5.644)	(11.25)	(9.585)
d2002#c.Log(banksize)	-6.457**	-7.439**	-3.435	-6.232
	(3.135)	(2.845)	(6.323)	(5.139)
CAR	-107.1	-121.0	-131.0	-297.8
	(133.3)	(138.0)	(169.8)	(188.2)
d2002#c.CAR	-84.95	-48.87	-0.136	105.1
	(165.8)	(159.2)	(189.8)	(242.5)
ROA	-929.7**	-961.1***	-1,458***	-1,448*
	(372.8)	(357.1)	(504.2)	(782.5)
d2002#c.ROA	1,229***	1,269***	1,958***	1,749**
	(451.8)	(455.8)	(574.0)	(687.9)
OtherBorrowedMoney	9.58e-06	1.04e-05	-7.09e-07	-6.28e-06
	(7.58e-06)	(7.99e-06)	(7.05e-06)	(8.45e-06)

d2002#c.OtherBorrowedMoney_1	1.10e-05	1.42e-05	-1.09e-05	0.000134**
	(2.26e-05)	(2.24e-05)	(2.89e-05)	(5.61e-05)
DepositsLevel	-6,315	-6,033	-6,114	-746.0
	(4,688)	(4,688)	(5,700)	(5,099)
d2002#c.DepositsLevel	2,770	3,349*	1,295	-958.6
	(1,758)	(1,685)	(3,234)	(3,096)
d2004#c.Log(leverage)	20.57	19.13	9.831	-22.33**
	(16.68)	(13.92)	(12.71)	(10.83)
d2004#c.Log(banksize)	0.588	2.238	2.614	8.815
	(4.182)	(3.602)	(4.958)	(7.110)
d2004#c.CAR	222.2	197.0	210.4**	157.9
	(133.7)	(122.4)	(95.87)	(116.8)
d2004#c.ROA	19.62	-35.38	305.5	142.0
	(496.0)	(508.6)	(442.3)	(782.9)
d2004#c.OtherBorrowedMoney	-1.71e-05	-2.16e-05	1.45e-05	-0.000125**
	(2.36e-05)	(2.30e-05)	(2.86e-05)	(5.30e-05)
d2004#c.DepositsLevels	2,244	1,319	-673.9	-971.1
	(2,588)	(2,170)	(3,345)	(4,082)
Constant	-63.67	-48.88	-77.99	44.28
	(67.82)	(67.14)	(169.3)	(124.9)
Observations	920	903	752	518
R-squared	0.123	0.129	0.145	0.172
Number of rssdid	54	53	49	34
Bank FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Quarter FE	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

8.4 Appendix IV: Quantile regressions

Table 1: 5% percentile regression

VARIABLES	Model (1) Tot_Sec	Model (2) Gov_Ag_Sec	Model (3) RMBS	Model (4) Other MBS
sec	-0.238	2.909	-6.053	-3.522***
	(2.262)	(2.347)	(5.068)	(1.127)
d2002	154.8	-51.59	210.4	-29.52
	(130.1)	(82.16)	(271.3)	(269.6)
d2002#c.sec	4.703	-3.926	6.510	-4.038
	(5.058)	(2.836)	(7.318)	(3.034)
d2004	-114.5	0.162	-19.93	11.34
	(115.5)	(54.20)	(105.0)	(291.9)
d2004#c.sec	-2.936	0.979	1.640	5.868*
	(5.291)	(3.059)	(5.787)	(3.183)
Log(leverage)	-4.994	-32.85**	2.939	-24.57***
	(15.92)	(14.96)	(42.35)	(9.150)
d2002#c.Log(leverage)	-34.42	21.17	-29.96	-4.090
	(35.59)	(17.97)	(45.73)	(45.24)
Log(banksize)	-0.0776	2.169	7.151	3.585***
	(2.647)	(3.051)	(10.12)	(1.300)
d2002#c.Log(banksize)	-2.391	-3.772	-7.268	2.987
	(6.245)	(4.636)	(11.89)	(12.05)
CAR	43.57	-122.4	152.4	57.39
	(134.5)	(121.7)	(358.2)	(95.05)
d2002#c.CAR	-561.8**	-74.00	-582.9	-478.0
	(251.0)	(146.7)	(386.8)	(365.9)
ROA	-103.7	-765.0	-1,827*	-2,517***
	(387.5)	(786.7)	(947.3)	(799.9)
d2002#c.ROA	672.8	976.4	2,201	1,665
	(647.4)	(805.5)	(1,406)	(1,561)
OtherBorrowedMoney	-1.19e-05	1.65e-05	-6.01e-06	-7.29e-05*
	(0.000136)	(0.000151)	(0.000192)	(3.88e-05)

d2002#c.OtherBorrowedMoney	2.87e-05	6.37e-06	1.70e-05	0.000104
	(0.000137)	(0.000155)	(0.000199)	(0.000221)
DepositsLevel	-2,695	-7,262	-6,128	1,115
	(16,999)	(25,486)	(22,416)	(3,964)
d2002#c.DepoditsLevel	-2,120	2,413	422.5	-8,208
	(17,467)	(25,503)	(22,813)	(12,095)
d2004#c.Log(leverage)	30.64	5.931	15.00	-2.452
	(33.46)	(13.92)	(22.20)	(47.40)
d2004#c.Log(banksize)	-0.686	-1.313	-2.953	-0.980
	(6.312)	(4.245)	(6.752)	(13.19)
d2004#c.CAR	457.4**	153.8	354.2**	408.0
	(218.5)	(97.39)	(148.9)	(360.1)
d2004#c.ROA	-168.6	128.7	-125.1	727.3
	(677.5)	(400.6)	(1,242)	(1,708)
d2004#c.OtherBorrowedMoney	-7.08e-06	-1.33e-05	-3.04e-06	-2.79e-05
	(2.65e-05)	(3.14e-05)	(5.31e-05)	(0.000229)
d2004#c.DepositsLevel	7,180*	6,719**	8,221*	5,080
	(4,191)	(2,992)	(4,319)	(11,807)
Constant	-12.81	64.22	-158.5	4.874
	(75.92)	(74.30)	(261.6)	(33.57)
Observations	920	903	752	518
Year FE	YES	YES	YES	YES
Quarter FE	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 2: 10% percentile regression

VARIABLES	Model (1) Tot_Sec	Model (2) Gov_Ag_Sec	Model (3) RMBS	Model (4) Other MBS
sec	3.017	2.861***	-1.760	-2.978*
	(2.665)	(1.031)	(2.539)	(1.557)
d2002	-20.96	-14.95	14.92	-74.43
	(118.1)	(99.71)	(102.9)	(158.1)
d2002#c.sec	1.766	-1.597	0.900	-1.978
	(4.060)	(3.020)	(2.915)	(3.230)
d2004	-53.43	-36.32	-30.95	98.99
	(90.81)	(82.00)	(49.15)	(155.9)
d2004#c.sec	-6.078*	-1.491	0.657	4.363
	(3.314)	(2.953)	(1.748)	(2.964)
Log(leverage)	-23.17	-21.18	-10.03	-23.82
	(16.19)	(15.21)	(14.60)	(16.96)
d2002#c.Log(leverage)	-11.38	-1.844	-12.10	6.317
	(24.33)	(22.62)	(17.55)	(27.89)
Log(banksize)	0.807	0.573	1.886	3.832
	(2.929)	(2.370)	(4.262)	(3.220)
d2002#c.Log(banksize)	2.662	-1.153	-1.186	1.984
	(4.837)	(5.688)	(5.228)	(9.388)
CAR	-152.0	-139.0	-75.97	49.86
	(124.8)	(114.8)	(166.4)	(107.8)
d2002#c.CAR	-138.5	-81.68	-115.3	-208.3
	(228.8)	(196.9)	(173.4)	(318.8)
ROA	-41.06	-33.30	-2,265**	-2,262**
	(435.2)	(483.7)	(894.5)	(1,105)
d2002#c.ROA	77.22	277.9	2,846***	1,992
	(658.4)	(570.9)	(958.3)	(1,270)
OtherBorrowedMoney	1.88e-05	2.16e-05	1.78e-05	-7.92e-05
	(2.28e-05)	(2.74e-05)	(2.61e-05)	(9.38e-05)
d2002#c.OtherBorrowedMoney	-3.23e-05	-2.02e-05	-2.00e-05	0.000111
	(2.60e-05)	(3.14e-05)	(0.000110)	(0.000131)

DepositsLevel	-6,903**	-6,865**	-5,889*	623.4
	(2,808)	(2,819)	(3,092)	(8,560)
d2002#c.DepositsLevel	-1,050	1,432	524.0	-8,597
	(7,047)	(4,381)	(5,403)	(10,006)
d2004#c.Log(leverage)	34.84*	20.14	24.63**	-1.190
	(19.11)	(17.96)	(12.06)	(26.28)
d2004#c.Log(banksize)	-5.010	-1.951	-2.371	-5.252
	(4.200)	(5.378)	(3.389)	(9.419)
d2004#c.CAR	279.0	181.9	180.5***	97.14
	(193.7)	(161.4)	(63.01)	(303.8)
d2004#c.ROA	318.9	114.1	-37.82	180.3
	(526.9)	(386.1)	(535.5)	(950.1)
d2004#c.OtherBorrowedMoney	1.70e-05	2.53e-06	5.43e-06	-2.99e-05
	(3.27e-05)	(1.54e-05)	(0.000107)	(9.31e-05)
d2004#c.DepositsLevel	9,366	7,352*	6,633	8,428
	(6,516)	(3,827)	(4,568)	(5,531)
Constant	62.81	58.51	2.538	4.576
	(80.70)	(60.55)	(99.91)	(62.18)
Observations	920	903	752	518
Year FE	YES	YES	YES	YES
Quarter FE	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3: 30% percentile regression

VARIABLES	Model (1) Tot_Sec	Model (2) Gov_Ag_Sec	Model (3) RMBS	Model (4) Other MBS
sec	1.736	1.774	1.487	-2.187
	(1.514)	(1.408)	(1.562)	(1.434)
d2002	75.53	6.460	76.27	-16.80
	(59.27)	(65.44)	(104.3)	(2,431)
d2002#c.sec	2.725	0.216	-0.437	-0.552
	(2.077)	(2.663)	(2.354)	(2.106)
d2004	-116.9**	-54.82	-149.6**	33.49
	(47.18)	(59.36)	(71.65)	(183.2)
d2004#c.sec	-5.500***	-2.045	-1.194	3.459**
	(1.830)	(2.428)	(1.882)	(1.645)
Log(leverage)	-9.317	-13.65	-15.06	-17.46
	(11.09)	(9.737)	(14.09)	(103.7)
d2002#c.Log(leverage)	-7.717	6.581	8.132	15.76
	(13.61)	(14.29)	(16.93)	(104.6)
Log(banksize)	0.904	1.162	0.930	3.555
	(1.949)	(2.139)	(3.742)	(236.3)
d2002#c.Log(banksize)	-3.812	-2.601	-7.993	-2.566
	(2.900)	(4.015)	(5.039)	(234.4)
CAR	-15.24	-36.08	-55.26	-34.44
	(83.49)	(55.41)	(119.9)	(208.8)
d2002#c.CAR	-206.6*	-94.64	-194.3	-176.5
	(123.7)	(115.6)	(169.8)	(362.2)
ROA	-480.0	-515.0	-933.0**	-2,081*
	(337.4)	(331.3)	(439.7)	(1,084)
d2002#c.ROA	1,353***	1,100**	1,335**	2,192
	(444.1)	(440.6)	(674.5)	(1,661)
OtherBorrowedMoney	-1.15e-06	7.92e-07	-1.16e-06	2.79e-06
	(9.84e-06)	(8.28e-06)	(2.29e-05)	(0.000157)
d2002#c.OtherBorrowedMoney	-7.79e-06	-1.20e-05	1.96e-06	3.74e-05
	(1.36e-05)	(2.67e-05)	(3.07e-05)	(0.000187)

DepositsLevel	107.6	124.4	391.5	-75.53
	(1,793)	(1,634)	(2,182)	(2.935e+06)
d2002#c.DepositsLevel	-2,692	-2,961	93.40	-4,527
	(2,653)	(3,180)	(3,001)	(2.934e+06)
d2004#c.Log(leverage)	20.35**	10.42	17.26	-15.74
	(9.977)	(12.13)	(11.88)	(21.45)
d2004#c.Log(banksize)	2.753	0.998	5.940	1.469
	(2.475)	(3.662)	(3.632)	(12.33)
d2004#c.CAR	219.3**	118.5	280.6**	159.2
	(97.07)	(106.2)	(124.6)	(285.7)
d2004#c.ROA	-688.8*	-348.6	191.8	-196.5
	(357.4)	(359.1)	(572.5)	(996.7)
d2004#c.OtherBorrowedMoney	1.27e-05	1.43e-05	4.34e-06	-3.47e-05
	(1.15e-05)	(2.55e-05)	(2.14e-05)	(0.000104)
d2004#c.DepositsLevel	2,114	2,733	-619.2	2,256
	(2,130)	(2,873)	(2,243)	(7,080)
Constant	17.98	27.43	43.69	11.01
	(41.54)	(34.02)	(78.80)	(2,454)
Observations	920	903	752	518
Year FE	YES	YES	YES	YES
Quarter FE	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4: 50% percentile regression

VARIABLES	Model (1) Tot_sec	Model (2) Gov_Ag_sec	Model (3) RMBS	Model (4) Other MBS
sec	0.273	0.310	-0.406	-0.142
	(1.023)	(1.000)	(1.672)	(0.698)
d2002	-17.84	6.349	-2.343	141.2
	(85.50)	(85.00)	(112.5)	(175.5)
d2002#c.sec	-1.934	-1.918	-0.422	-1.763
	(3.429)	(3.353)	(2.534)	(1.415)
d2004	11.96	-4.414	-51.02	-114.5
	(80.42)	(80.29)	(99.90)	(173.8)
d2004#c.sec	0.458	1.378	0.856	2.805**
	(3.335)	(3.259)	(2.050)	(1.272)
Log(leverage)	-6.756	-5.879	-8.542	-2.693
	(8.386)	(8.286)	(11.11)	(9.186)
d2002#c.Log(leverage)	24.48	22.55	18.19	1.988
	(17.47)	(16.79)	(17.16)	(16.55)
Log(banksize)	3.724**	3.480**	2.045	3.611**
	(1.488)	(1.535)	(2.506)	(1.781)
d2002#c.Log(banksize)	-5.540	-7.141	-4.766	-11.98
	(4.404)	(4.725)	(5.595)	(10.25)
CAR	15.21	13.54	-23.21	85.99
	(70.15)	(70.87)	(89.50)	(67.66)
d2002#c.CAR	45.26	44.46	-62.99	-255.0
	(146.5)	(145.6)	(173.2)	(367.5)
ROA	-778.4***	-715.2***	-1,231***	-701.7*
	(180.2)	(217.5)	(432.0)	(369.9)
d2002#c.ROA	1,010**	1,089**	1,383**	1,431
	(468.8)	(458.0)	(676.1)	(1,276)
OtherBorrowedMoney	-1.05e-05	-1.07e-05	-8.91e-06	-2.76e-06
	(1.50e-05)	(1.52e-05)	(1.23e-05)	(1.92e-05)

d2002#c.OtherBorrowedMoney	4.09e-06	1.09e-05	7.28e-06	0.000139
	(2.93e-05)	(2.74e-05)	(4.46e-05)	(0.000155)
DepositsLevel	-967.3	-916.5	314.7	-756.4
	(1,737)	(1,829)	(1,923)	(2,283)
d2002#c.DepositsLevel	739.9	1,673	-683.3	1,312
	(3,137)	(3,106)	(4,040)	(7,465)
d2004#c.Log(leverage)	-13.91	-14.05	-1.809	0.593
	(16.20)	(15.41)	(14.88)	(15.14)
d2004#c.Log(banksize)	2.129	3.683	3.378	8.657
	(4.301)	(4.625)	(5.258)	(10.22)
d2004#c.CAR	-65.14	-73.15	104.2	153.4
	(131.4)	(129.5)	(152.2)	(362.0)
d2004#c.ROA	-171.0	-289.0	-36.55	-693.7
	(450.8)	(427.7)	(578.6)	(1,250)
d2004#c.OtherBorrowedMoney	1.08e-05	4.10e-06	6.26e-06	-0.000132
	(2.80e-05)	(2.64e-05)	(4.41e-05)	(0.000154)
d2004#c.DepositsLevel	-1,065	-1,639	-1,200	-1,891
	(2,866)	(2,757)	(3,741)	(7,202)
Constant	-25.71	-24.82	8.587	-45.02
	(34.76)	(35.15)	(57.79)	(35.99)
Observations	920	903	752	518
Year FE	YES	YES	YES	YES
Quarter FE	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5: 70% percentile regression

VARIABLES	Model (1) Tot_sec	Model (2) Gov_Ag_sec	Model (3) RMBS	Model (4) Other MBS
sec	-0.136	0.0237	-2.540*	-0.267
	(0.500)	(0.796)	(1.312)	(0.835)
d2002	-58.17	-3.926	-103.8	-109.0
	(85.58)	(57.46)	(124.9)	(112.5)
d2002#c.sec	-3.182	-0.782	4.300	-2.326
	(1.975)	(1.774)	(2.820)	(1.605)
d2004	4.148	-46.33	53.65	148.8
	(83.35)	(49.52)	(117.0)	(111.0)
d2004#c.sec	3.221	1.129	-1.344	3.577**
	(2.491)	(1.801)	(2.683)	(1.467)
Log(leverage)	-10.03*	-9.853	-7.492	-8.878
	(5.760)	(8.198)	(9.048)	(8.980)
d2002#c.Log(leverage)	29.86*	24.75	22.92	24.60
	(17.36)	(15.77)	(18.87)	(18.48)
Log(banksize)	3.396***	3.397**	2.839	5.092***
	(0.954)	(1.592)	(1.964)	(1.794)
d2002#c.Log(banksize)	-5.074	-7.936**	2.163	-1.796
	(4.949)	(3.964)	(7.600)	(6.873)
CAR	-19.49	-19.10	-10.33	-40.33
	(43.18)	(68.65)	(72.86)	(73.91)
d2002#c.CAR	173.2	168.7	88.99	379.3*
	(168.7)	(164.3)	(177.7)	(208.6)
ROA	-929.5***	-888.8***	-1,478***	-1,035**
	(147.9)	(198.1)	(373.1)	(469.1)
d2002#c.ROA	1,746***	1,738***	1,140	511.6
	(499.5)	(533.3)	(710.9)	(1,004)
OtherBorrowedMoney	1.69e-07	-5.56e-07	-2.67e-06	-2.39e-06
	(1.08e-05)	(1.21e-05)	(1.20e-05)	(1.22e-05)

d2002#c.OtherBorrowedMoney	1.08e-05	1.67e-05	-3.83e-05	0.000202***
	(2.43e-05)	(1.93e-05)	(3.57e-05)	(5.39e-05)
DepositsLevel	-1,340*	-1,335	-814.8	-2,366
	(801.7)	(1,288)	(1,677)	(1,620)
d2002#c.DepositsLevel	2,860	4,296	1,214	-6,309
	(6,903)	(6,762)	(6,472)	(6,237)
d2004#c.Log(leverage)	-21.27	-16.68	-14.31	-30.57
	(17.28)	(14.53)	(17.84)	(18.67)
d2004#c.Log(banksize)	4.825	7.161*	-2.492	-0.826
	(5.099)	(3.939)	(7.551)	(6.997)
d2004#c.CAR	-163.4	-152.7	-74.66	-375.6*
	(165.9)	(151.5)	(164.9)	(196.4)
d2004#c.ROA	-741.9	-640.8	672.7	522.4
	(538.7)	(560.5)	(667.1)	(992.9)
d2004#c.OtherBorrowedMoney	-8.76e-06	-1.44e-05	4.37e-05	-0.000198***
	(2.53e-05)	(1.97e-05)	(3.52e-05)	(5.33e-05)
d2004#c.DepositsLevel	-4,078	-5,305	-2,752	6,729
	(6,956)	(6,747)	(6,350)	(6,172)
Constant	-4.009	-4.560	-6.566	-27.01
	(26.30)	(35.12)	(44.92)	(38.88)
Observations	920	903	752	518
Year FE	YES	YES	YES	YES
Quarter FE	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 6: 90 % percentile regression

VARIABLES	Model (1) Tot_sec	Model (2) Gov_Ag_sec	Model (3) RMBS	Model (4) Other MBS
sec	1.792	1.751	-2.314	-3.103
	(1.782)	(1.462)	(2.235)	(2.378)
d2002	-36.78	13.09	61.17	-110.5
	(92.15)	(68.79)	(168.8)	(202.4)
d2002#c.sec	-2.323	1.825	3.949	-0.902
	(2.772)	(2.104)	(3.737)	(3.017)
d2004	-84.37	-156.5**	-147.1	71.59
	(78.95)	(61.69)	(131.2)	(185.6)
d2004#c.sec	-0.769	-5.304***	-2.005	5.668***
	(2.488)	(1.697)	(3.080)	(2.021)
Log(leverage)	-11.66	-15.14	1.062	-10.51
	(12.27)	(11.24)	(20.97)	(26.33)
d2002#c.Log(leverage)	19.72	12.62	-9.126	23.42
	(17.47)	(16.23)	(28.36)	(32.54)
Log(banksize)	3.458	2.858	1.177	2.283
	(2.965)	(2.500)	(6.036)	(5.629)
d2002#c.Log(banksize)	-5.428	-5.872	-3.291	0.605
	(5.193)	(4.643)	(9.978)	(12.90)
CAR	-27.96	-47.69	2.496	17.33
	(145.8)	(120.1)	(212.3)	(223.3)
d2002#c.CAR	267.7	138.4	-53.18	205.8
	(208.4)	(156.3)	(282.8)	(421.8)
ROA	-831.0**	-897.0	-1,264	-1,748
	(355.7)	(584.0)	(1,016)	(1,236)
d2002#c.ROA	1,261**	1,625**	1,760	527.3
	(532.7)	(691.7)	(1,413)	(1,375)
otherborrowedmoney_1	-5.13e-07	-1.20e-06	-4.33e-06	-1.24e-05
	(2.30e-05)	(1.92e-05)	(3.52e-05)	(8.91e-05)
d2002#c.OtherBorrowedMoney	-5.64e-06	-8.22e-06	-1.15e-05	0.000110
	(3.59e-05)	(3.19e-05)	(4.37e-05)	(0.000115)

DepositsLevel	-1,964	-1,512	294.2	-67.46
	(3,019)	(2,728)	(5,088)	(6,212)
d2002#c.DepositsLevel	6,295	5,623	3,538	18.71
	(4,964)	(4,918)	(6,521)	(9,509)
d2004#c.Log(leverage)	-8.184	0.0268	6.791	-25.97
	(14.15)	(12.96)	(20.15)	(21.75)
d2004#c.Log(banksize)	7.695*	9.345**	6.659	0.503
	(4.467)	(4.126)	(8.007)	(11.92)
d2004#c.CAR	-243.2	-97.85	70.74	-244.4
	(153.4)	(103.7)	(187.7)	(359.8)
d2004#c.ROA	-419.1	-682.9*	-52.19	1,626
	(429.3)	(387.8)	(1,055)	(1,243)
d2004#c.OtherBorrowedMoney	5.09e-06	8.24e-06	1.46e-05	-9.79e-05
	(3.37e-05)	(3.40e-05)	(2.64e-05)	(7.19e-05)
d2004#c.DepositsLevel	-8,246*	-8,428*	-6,707	-3,085
	(4,557)	(4,823)	(4,562)	(7,455)
Constant	4.354	23.46	-9.106	-8.055
	(51.54)	(42.65)	(108.0)	(94.23)
Observations	920	903	752	518
Year FE	YES	YES	YES	YES
Quarter FE	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 7: 95 % percentile regression

VARIABLES	Model (1) Tot_sec	Model (2) Gov_Ag_sec	Model (3) RMBS	Model (4) Other MBS
sec	-0.418	-2.041	-0.705	-2.330
	(2.625)	(3.119)	(3.885)	(1.862)
d2002	-53.63	68.17	192.6	-224.6
	(154.9)	(138.0)	(130.1)	(259.2)
d2002#c.sec	1.751	6.047	1.580	-4.270
	(5.233)	(6.184)	(4.836)	(4.533)
d2004	-61.94	-152.0	-235.0***	164.3
	(117.8)	(118.6)	(81.38)	(247.8)
d2004#c.sec	-2.559	-5.983	-1.583	7.722*
	(4.735)	(5.403)	(3.032)	(4.178)
Log(leverage)	-2.028	10.27	2.623	-18.33
	(17.86)	(14.76)	(28.49)	(18.55)
d2002#c.Log(leverage)	12.35	-19.85	4.085	23.95
	(29.35)	(28.69)	(33.31)	(30.57)
Log(banksize)	3.684	3.700	6.160	6.632
	(5.041)	(2.366)	(7.068)	(6.331)
d2002#c.Log(banksize)	-1.944	-2.188	-17.34**	5.574
	(7.566)	(6.999)	(8.329)	(16.37)
CAR	30.95	108.5	83.48	-18.77
	(157.7)	(112.0)	(236.3)	(165.4)
d2002#c.CAR	179.6	-49.45	-60.84	491.4
	(245.7)	(264.3)	(267.0)	(320.3)
ROA	-887.5	-817.8**	-1,589	-3,051**
	(662.5)	(385.2)	(1,060)	(1,540)
d2002#c.ROA	1,235	1,381	3,123**	-840.3
	(1,113)	(998.1)	(1,247)	(3,045)
OtherBorrowedMoney	-6.02e-06	1.29e-06	-1.93e-05	-2.46e-05
	(3.94e-05)	(1.96e-05)	(6.11e-05)	(0.000110)
d2002#c.OtherBorrowedMoney	-2.53e-05	-2.50e-05	2.10e-05	0.000124
	(4.84e-05)	(6.51e-05)	(6.54e-05)	(0.000161)

DepositsLevel	-2,109	-2,029	-2,036	-2,931
	(4,542)	(3,773)	(6,364)	(8,770)
d2002#c.DepositsLevel	3,544	3,066	8,341	-1,880
	(6,779)	(5,810)	(7,008)	(16,378)
d2004#c.Log(leverage)	0.218	21.50	1.604	-17.95
	(24.31)	(25.31)	(18.22)	(26.29)
d2004#c.Log(banksize)	2.280	3.270	15.09***	-7.692
	(5.811)	(6.786)	(4.493)	(15.28)
d2004#c.CAR	-178.1	-32.72	14.32	-472.0*
	(190.2)	(246.6)	(125.7)	(275.0)
d2004#c.ROA	165.7	-338.6	-892.4	4,613
	(916.3)	(951.3)	(737.9)	(2,841)
d2004#c.OtherBorrowedMoney	2.95e-05	2.15e-05	-1.80e-06	-9.66e-05
	(3.21e-05)	(6.41e-05)	(2.31e-05)	(0.000120)
d2004#c.DepositsLevel	-4,810	-4,542	-9,768***	545.3
	(5,151)	(4,551)	(2,887)	(13,819)
Constant	-34.95	-78.26	-79.58	-13.68
	(99.25)	(71.34)	(104.9)	(62.04)
Observations	920	903	752	518
Year FE	YES	YES	YES	YES
Quarter FE	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 8: 99% percentile regression

VARIABLES	Model (1) Tot_sec	Model (2) Gov_Ag_sec	Model (3) RMBS	Model (4) Other MBS
sec	1.396	-1.165	-1.248***	-2.873***
	(11.43)	(3.079)	(0.396)	(0.787)
d2002	80.21	159.0	231.3***	-258.8***
	(678.3)	(140.2)	(53.24)	(70.43)
d2002#c.sec	5.184	9.565	3.805**	-4.914*
	(25.72)	(9.469)	(1.852)	(2.798)
d2004	-248.0	-199.2*	-340.5***	90.01
	(639.0)	(110.6)	(51.24)	(67.62)
d2004#c.sec	-8.211	-8.609	-2.288	8.444***
	(22.80)	(8.961)	(2.291)	(2.648)
Log(leverage)	10.98	20.63*	-31.18***	-27.88***
	(65.61)	(11.48)	(4.146)	(7.114)
d2002#c.Log(leverage)	-42.00	-57.87***	3.890	33.77*
	(71.47)	(21.33)	(12.95)	(17.62)
Log(banksize)	1.219	4.163	13.22***	2.590
	(13.05)	(4.166)	(0.858)	(2.586)
d2002#c.Log(banksize)	2.557	1.640	-18.88***	5.049
	(37.28)	(5.929)	(5.591)	(6.842)
CAR	22.78	116.7	-27.56	-196.9*
	(588.2)	(238.6)	(24.74)	(110.4)
d2002#c.CAR	-202.0	-276.3	-235.0***	609.4***
	(1,184)	(256.4)	(85.64)	(130.3)
ROA	-94.35	-337.9	-3,152***	-1,094*
	(1,555)	(928.5)	(353.6)	(630.6)
d2002#c.ROA	-471.9	-265.8	2,937***	-2,311
	(6,938)	(1,260)	(464.4)	(1,532)
OtherBorrowedMoney	-2.71e-05	-3.68e-05	-4.68e-05***	-9.00e-06
	(0.000111)	(6.14e-05)	(3.96e-06)	(5.95e-05)
d2002#c.OtherBorrowedMoney	-1.26e-05	-9.08e-06	3.82e-05**	0.000119
	(0.000458)	(6.66e-05)	(1.82e-05)	(0.000172)

DepositsLevel	1,229	495.7	-7,237***	-1,626
	(11,459)	(7,577)	(907.2)	(6,097)
d2002#c.DepositsLevel	-3,447	-3,677	9,384***	-1,104
	(31,970)	(8,273)	(3,461)	(9,007)
d2004#c.Log(leverage)	37.65	35.33	30.56**	-14.12
	(29.45)	(22.57)	(14.24)	(16.78)
d2004#c.Log(banksize)	3.025	0.765	12.91**	-2.974
	(34.40)	(4.828)	(5.473)	(6.411)
d2004#c.CAR	232.3	140.7	298.8***	-414.7***
	(1,021)	(117.9)	(94.65)	(64.21)
d2004#c.ROA	746.6	569.0	777.9	4,600***
	(6,722)	(735.6)	(535.8)	(1,537)
d2004#c.OtherBorrowedMoney	3.44e-05	4.05e-05	4.15e-06	-0.000104
	(0.000444)	(3.76e-05)	(2.84e-05)	(0.000161)
d2004#c.DepositsLevel	-3,332	-1,835	-8,759	-2,553
	(29,863)	(4,299)	(7,079)	(6,711)
Constant	-47.65	-115.7	-62.93***	49.99*
	(368.8)	(90.16)	(14.90)	(30.28)
Observations	920	903	752	518
Year FE	YES	YES	YES	YES
Quarter FE	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1