Why Did Holdings of Highly Rated Securitization Tranches Differ So Much across Banks?

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We provide estimates of holdings of highly rated securitization tranches of U.S. bank holding companies before the credit crisis and evaluate hypotheses that have been advanced to explain them. Whereas holdings exceeded Tier 1 capital for some large banks, they were economically trivial for the typical bank. Banks with high holdings were not riskier before the crisis using conventional measures, but they performed poorly during the crisis. We find that holdings of highly rated tranches were correlated with a bank's securitization activity. Theories unrelated to the securitization activity, such as "bad incentives" or "bad risk management," are not supported in the data. (*JEL* G01, G21)

Holdings of highly rated tranches of securitizations held by U.S. banks were at the heart of the financial crisis of 2007–2008. At least in the early phases of the crisis, the bulk of the assets that were considered to have become toxic by many observers were these securities with subprime and alt-A mortgage collateral. Losses in value led banks to have low capital and forced them to raise more capital, cut back on new loans, and engage in fire sales (see Brunnermeier 2009). The most visible and controversial policy initiative of the U.S. Treasury to deal with the crisis, the Troubled Asset Relief Program (TARP), started as an attempt to fund the purchase of these assets from banks.

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Many observers thought that banks used securitization to move assets from their balance sheets and were surprised that some banks held large amounts of highly rated tranches.[1] Though a vigorous debate has been taking place on why banks held these assets, to our knowledge, there are no rigorous estimates of the holdings of these assets across banks before the crisis, and there is no systematic investigation of the various theories that have been advanced to explain these holdings. In this paper, we estimate holdings of highly rated tranches of securitizations by U.S. bank holding companies and investigate which of the various theories proposed to explain these holdings are consistent with the empirical evidence. We find that there was substantial cross-sectional variation in such holdings across banks and that this variation is explained by the securitization activities of banks.

Highly rated securities include AAA, AA, and A tranches of mortgage-backed securities (MBSs), collateralized debt obligations (CDOs), and other asset-backed securities (ABSs). During the financial crisis, banks made various types of losses; for example, they made losses on nonprime mortgages and highly levered loans held on their books. However, early on, the largest bank writedowns came from mark-to-market losses on highly rated securitization tranches. For instance, in Q4 2007, Citibank had writedowns of $18 billion. Bloomberg reports that all but $1 billion of these writedowns came directly or indirectly from highly rated tranches of securitizations. Because banks, such as Citibank, also made losses on their off-balance-sheet vehicles that held such tranches, our broadest measure includes holdings in the structured investment vehicles sponsored by banks.

We are able to provide estimates of holdings of highly rated tranches from 2002 to 2008 for U.S. bank holding companies.[2] The median holdings of highly rated tranches normalized by total assets were less than 0.2%. Obviously, for the typical bank, these holdings were not material. The mean across banks was about 1.3% in 2006. But banks with large trading portfolios (more than $1 billion of trading assets and trading assets representing more than 10% of total assets) had higher holdings. The average on-balance-sheet holdings represented about 5% of assets as of 2006 for these banks. Adding off-balance-sheet holdings increases the holdings of banks with large trading portfolios to 6.6% of their total assets. However, holdings varied substantially across large banks. Citigroup recorded the largest amount of writedowns among bank holding companies and its holdings of highly rated tranches, including off-balance-sheet

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[1] In particular, the chairman of the Federal Reserve Board, Alan Greenspan (2004), delivered a widely noticed speech in which he stated that "The new instruments of risk dispersion have enabled the largest and most sophisticated banks in their credit-granting role to divest themselves of much credit risk by passing it to institutions with far less leverage."

[2] Though investment banks eventually reported information on their holdings of highly rated tranches, they did not have reporting requirements that make consistently identifying such holdings possible before the crisis. Consequently, investment banks are not included in the analyses of the paper.

holdings, amounted to 10.7% of assets, or roughly $201 billion, at the end of 2006.

We explore whether investments in highly rated tranches were correlated with risk taking by banks before the crisis. Using common risk measures, such as leverage and distance-to-default, we investigate whether banks that had high holdings of highly rated tranches were riskier ahead of the crisis than were other banks. We find no evidence that holdings were correlated with bank risk before the crisis when we control for bank characteristics. However, banks with larger holdings of highly rated tranches performed worse during the crisis, so that banks in the top quintile of highly rated tranches holdings had about 14% lower buy-and-hold excess returns, on average.

To understand why holdings of highly rated tranches varied so much across banks, we identify a number of possible determinants of the holdings of highly rated tranches from the ongoing debate as to why banks held these tranches. These determinants are not mutually exclusive. The first theory we investigate is the securitization by-product explanation. There are several reasons why banks that engaged in securitization would hold highly rated tranches. First, though most of the literature focuses on the benefits to issuers from having skin in the game by holding the riskiest tranche of a securitization (DeMarzo 2005; Shleifer and Vishny 2010; Gennaioli, Shleifer, and Vishny 2012), we argue that such benefits can also arise from holding highly rated tranches. Furthermore, banks engaged in securitization would have inventories of these securities from the process of creating, marketing, and making a market for them. Banks with securitization activities would also be better placed to assess the expected return and risk of highly rated tranches and therefore would be more comfortable with holding them for investment. Finally, commentators have argued that some banks were stuck with securities they could not sell in 2007. We find strong evidence that banks engaged in securitizations held more highly rated tranches before the crisis and that their holdings of these tranches increased with their securitization activities in the years before the crisis.

The second theory of holdings of securitization tranches we consider is the regulatory arbitrage theory. Everything else equal, banks faced lower capital requirements for holding these highest-rated tranches than they would have faced for holding the loans that backed these tranches directly (see Acharya and Richardson (2009), among others). They could also hold these tranches in off-balance sheet conduits and structured investment vehicles (SIVs), where the capital requirements were even lower (Acharya, Schnabl, and Suarez 2013). Finally, highly rated tranches had high yields compared with other securities with similar capital requirements (Coval, Jurek, and Stafford 2009). In its most naïve form, the regulatory-arbitrage hypothesis predicts that if holding regulatory capital is costly, banks would systematically hold highly rated tranches of securitizations instead of corporate bonds (which had higher capital requirements but lower yields for similar ratings) and instead of loans that

could be securitized. Further, large banks for which regulatory capital was costly would all have sponsored SIVs because these vehicles enabled them to hold assets with low capital requirements. This naïve regulatory arbitrage hypothesis does not hold in the data because there is too much variation across banks in the holdings of highly rated tranches. However, if the banks that engaged in securitizations were the ones for which regulatory arbitrage was most valuable, then our findings on the positive relation between holdings and securitization activity are consistent with a more sophisticated view of regulatory arbitrage.

The third possible explanation for holdings of highly rated tranches is that banks which were too-big-to-fail had incentives to hold them because they could invest in them at a low cost and not bear the full consequences of the risks associated with them (Carbo-Valverde, Kane, and Rodriguez-Fernandez 2010). Because of how they are engineered, these highly rated tranches pay off fully in most states of the world but pay poorly in states of the world in which public support of financial institutions is most likely, namely, in systemic crises. Bank size could explain holdings of highly rated securities for other reasons, however. For instance, one would expect that there are economies of scale in investing in these securities or in setting up asset-backed commercial paper (ABCP) programs and SIVs. We find that large banks invested more in highly rated tranches than small banks did. Yet, holdings of these tranches did not increase with bank size for large banks but did increase with securitization activity. Finally, there is wide variation in holdings of highly rated tranches among the largest banks, which is inconsistent with a simple view that too-big-to-fail led large banks to accumulate holdings of highly rated tranches uniformly.

Lastly, we explore other possible explanations for variation in securitization tranche holdings. Many observers have argued that inappropriate incentive systems made taking excessive risks, such as investing in assets that subsequently performed poorly, advantageous for managers and/or traders (e.g., Rajan 2010; UBS 2008). Blinder sums up this argument as follows: "Give smart people go-for-broke incentives and they will go for broke. Duh."[3] Compensation data are not available for traders who are not top executives of banks, so that the incentives of these traders cannot be examined directly. However, using data for top executives, we find no evidence that banks with larger holdings of highly rated tranches had executives with poorer incentives to maximize shareholder wealth or greater incentives to take risks. Another related motive is summarized by the Financial Crisis Inquiry Commission's conclusion that "dramatic failures of corporate governance and risk management at many

[3] See Alan S. Blinder, "Crazy compensation and the crisis," *Wall Street Journal*, May 28, 2009. Fahlenbrach and Stulz (2011) show, however, that banks whose CEOs had incentives better aligned with those of the other shareholders did not perform better during the crisis.

systematically important financial institutions were a key cause of this crisis."[4] Based on this reasoning, had banks properly understood their risk, banks would not have held highly rated tranches in the amounts they did.[5] But ex post adverse outcomes are not evidence of risk management failures (Stulz 2008), so that one cannot logically conclude that poor performance of the highly rated tranches was the result of risk management failure. Consequently, measuring the quality of risk management is a notoriously difficult task because one needed proprietary information on the risk management process at the time the decisions to hold these securities were made. However, using an index constructed by Ellul and Yerramilli (2013), we find no relation between holdings of highly rated tranches and the centrality and independence of risk management.

The paper is organized as follows. In the next section we develop possible explanations for banks' holdings of highly rated tranches and present the testable implications of each theory. In Section 2, we explain how we construct our estimates of holdings of highly rated tranches for depository banks and summarize these estimates. In Section 3, we investigate whether the banks with greater investments in highly rated tranches were riskier before the crisis and whether their performance differed during the crisis. We test the implications of the various theories in Section 4 and conclude in Section 5.

1. Theories of Holdings of Highly Rated Tranches

In Fama (1985), banks' cost of funding is a market cost of funding, but they face a cost of doing business, the cost of the reserves they have to maintain. So, to remain in business, banks have to charge an above-market rate to their lenders. This well-known result poses a paradox when considering banks' holdings of highly rated tranches. If banks pay a market rate of return on their sources of finance and earn a market rate of return on their investments in securities, how can holding securities be a positive NPV project for banks? Furthermore, as a bank's portfolio of securities grows large enough, holdings cannot be explained by the need to have a buffer to address unexpected liquidity demands from depositors and borrowers or to have inventory when acting as a market maker. Intuitively, a bank might monitor borrowers and this monitoring could create value. But it is not intuitive that these highly-rated securities are more efficiently held by banks.

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[4] Financial Crisis Inquiry Commission (2011, xvii). See also Bernanke (2010).

[5] For instance, Krishnamurthy states that "There are risk control checks and balances in any firm, starting with a senior risk management committee and going down to the head trader in a particular asset class. In every one of these steps there was an under-pricing and under-appreciation of the risk." (See Kellogg Insight, "Debt markets during the crisis," April 2011.)

We now consider the determinants of holdings of highly rated tranches discussed previously and derive testable hypotheses. For ease of presentation, we classify these determinants into four groups.

1.1 Securitization by-product

Before the financial crisis, securitization markets were very active in the United States.[6] The theoretical literature on securitization has shown that if there is information asymmetry between the issuer (or underwriter) and investors, the issuer has incentives to signal the quality of the collateral through retention of the riskiest tranche, the equity tranche, of the securitization.[7] Even in that literature, however, the issuer can retain higher-rated tranches in addition to the equity tranche to the extent that the demand curve for these tranches is downward-sloping and the issuer maximizes the proceeds from the sale of securities (DeMarzo and Duffie 1999). The securitization literature dealing with moral hazard issues also provides theoretical arguments for retention by the issuer. However, this literature is more ambiguous about which tranches the issuer will retain. Fender and Mitchell (2009) show that if, for example, a downturn is likely, the issuer may screen the underlying collateral more carefully if it retains a mezzanine tranche or a vertical slice of the securitization than if it retains the equity tranche.

The theoretical literature has not paid attention to three important considerations that are likely to affect a bank's holdings of highly rated tranches and make it more likely that banks would have viewed it as beneficial to hold highly-rated tranches for skin-in-the-game reasons. First, as we will discuss in detail later, the regulatory capital required to hold a dollar of equity tranche can be more than fifty times the regulatory capital required to hold a highly rated tranche. Even if holding a highly rated tranche is a less efficient signaling mechanism than is holding a lower-rated tranche, an issuer might choose to signal through holding more senior tranches than equity tranches to save regulatory capital. This benefit might have been magnified before the crisis by the fact that a bank could use highly rated tranches as collateral for secured lending, while it could not do so with equity tranches. The second important consideration is that typically the value of the equity tranche of a securitization increases in value as the correlation among the assets securitized increases, whereas the value of the highly rated tranches falls (e.g., Gibson 2004). Consequently, retention of the equity tranche is not suitable to communicate confidence to the market that the highly rated tranches have low risk because

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[6] See Gorton and Metrick (2013) for a review essay on securitization. See Greenbaum and Thakor (1987) for an early study of a bank's choice between retaining loans and securitizing them. In that model, banks offer insurance to borrowers whose loans are securitized, which is equivalent to retaining a stake in the securitization. See Duffie and Garleanu (2001) for a description of CDOs and Gorton and Souleles (2006) for special purpose vehicles (SPVs). See also Pennacchi (1988) and Gorton and Pennacchi (1989, 1995) as early examples of a related literature on loan sales.

[7] See Gorton and Metrick (2013) for a survey of the literature.

the equity tranche would be more valuable if the correlation is higher than the investors believe it to be. Finally, investors in highly rated tranches viewed them as extremely low risk. They wanted comfort that the tranches would remain unaffected even if the equity tranche were to be wiped out. Having banks invest alongside the outside investors in the highly rated tranches could give investors such comfort in a way that holding the equity tranche could not. Of course, this certification required investors to believe that the banks would keep holding highly rated tranches. The issue of continued retention is not, however, specific to this argument for holding highly rated tranches as it applies more generally to models that show that retaining some of the securitization is optimal for the issuer (Duffie 2008).

Though the literature focuses on a deal-level skin-in-the-game hypothesis, it is important to note that banks engaged in securitization could benefit from holding highly rated tranches even if they were not issued by them. These banks benefited from the success of securitization in general and therefore derived benefits from signaling that highly rated tranches in general had low risk and were liquid.

Securitization activity could be associated with higher holdings for several other important reasons. First, a securitization-active bank would be in a better position to assess these tranches as potential investments for itself as it has personnel familiar with these tranches and could better evaluate their risk and expected return. Consequently, we would expect these banks to invest more in these tranches as they would be more familiar with them (see, for instance, Huberman (2001) for evidence of the role of familiarity on investment). Second, a bank that is active in the securitization market as an issuer has a pipeline of deals. If it produces CDOs, it will have an inventory of ABSs. As it issues CDOs and other ABSs, it may take time to make a market for some tranches. Consequently, we would expect holdings of highly rated tranches to increase over time as the securitization activity increases. However, banks were possibly stuck with highly rated tranches that they could not sell as the market turned in 2007. We call this hypothesis the "hung deals" hypothesis, in that the banks failed to stop their production quickly enough and could not sell these securities without making a loss, leading them to hold on to the securities.

In summary, this subsection presents the following predictions for the relation between securitization and holdings of highly rated tranches:

Securitization H1: Activity. Holdings of highly rated tranches as a fraction of a bank's assets were higher for banks engaged in securitization activity.

Securitization H2: Cumulative activity. Holdings of highly rated tranches for banks active in securitization increased over time as each securitization would require skin in the game.

Securitization H3: Hung deals. To the extent that securitization activity did not slow down fast enough and banks were stuck with highly rated tranches that they intended to sell, holdings of highly rated tranches for firms active in securitization increased in 2007.

1.2 Regulatory arbitrage

Banks that view holding regulatory capital to be costly will, everything else equal, choose activities that consume the least amount of regulatory capital. With an amendment to risk-based capital requirements in November 2001, the Federal Reserve allowed bank holding companies (BHCs) to incorporate credit ratings in calculating regulatory capital for holdings of securities issued through securitizations.[8] Prior to the rule change, capital charges on such securities were dictated by asset type rather than credit quality. For example, mortgage-backed securities issued or guaranteed by Fannie Mae carried a 20% risk weight (so that the required capital for holding these securities was 20% of 8%, or 1.6%, in comparison with 8% for corporate loans), but non-agency mortgage-backed securities that were viewed as having similar risk carried a 50% or larger regulatory risk weight.[9] Following the rule change, the regulatory capital charge became a function of the securities' credit rating rather than of asset class. AAA-rated and AA-rated securitizations received a 20% risk weighting; A-rated securitizations received a 50% risk weighting; BBB-rated securitizations received a 100% risk weighting; BB-rated securitizations received a 150% risk weighting, and a dollar-for-dollar charge on residual interests or equity tranches, amounting to a risk weight of 1,250%.

After the regulatory changes of November 2001, a bank that made subprime loans was better off holding them on its books as securities backed by these loans than holding the loans directly.[10] Further, a bank was better off holding an AAA-rated securitization tranche than an AAA-rated corporate bond because the corporate bond still required 8% of the investment as regulatory capital, whereas the AAA-rated securitization tranche only required 1.6% of the investment as regulatory capital. In addition, the highly rated tranches had higher yields than did other securities with similar ratings (see Coval, Jurek, and Stafford 2009; Iannotta and Pennacchi 2011), so that banks could hold AAA-rated securitization tranches and both earn a higher yield and need less regulatory capital than if they held a corporate bond of similar rating.

Banks benefit from regulatory arbitrage as their regulatory capital becomes more of a binding constraint. However, regulatory arbitrage brings more scrutiny to the bank as well. Poorly performing banks and banks that are almost insufficiently capitalized are more likely to be scrutinized. Furthermore, regulatory arbitrage would be more costly for small banks to the extent that regulatory-arbitrage transactions have fixed costs. With these considerations, we would expect banks with considerable regulatory capital slack not to find regulatory arbitrage profitable. However, we have no direct prediction for banks with little regulatory capital slack because for such banks both the cost and

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[8] For details of the amendment, see www.fdic.gov/news/news/financial/2001/fil0199.html.

[9] With the Basel I regulatory regime, a bank had to hold at least 8% of risk-weighted assets in regulatory capital before the crisis.

[10] As an example, see Goldman Sachs, Global Markets Institute, Effective Regulation: Part 1, March 2009.

benefits of regulatory arbitrage could be high. We would expect banks for which regulatory arbitrage was particularly advantageous to have grown their balance sheet after capital requirements for highly rated tranches decreased in 2001. Then we can develop the following testable predictions:

Regulatory Arbitrage H1. Holdings of highly rated tranches increased with a bank's cost of regulatory capital and fell with a bank's cost of regulatory scrutiny.

Regulatory Arbitrage H2. Large banks and those that engaged in more regulatory arbitrage activities had more highly rated tranches.

1.3 Too big to fail

To the extent that a bank is viewed as too-big-to-fail, everything else equal, its cost of funds does not reflect the full extent of the risks it takes. The proponents of the too-big-to-fail view argue that, because a too-big-to-fail bank does not pay for some of the risks it takes, the bank has incentives to take more of these risks. If a bank is expected to be bailed out whenever it makes large losses, the bank can increase its value by generally taking more total risk. Highly rated tranches of securitizations would not serve this purpose because these securities were designed to pay off fully in most states of the world. If, instead, a too-big-to-fail bank is likely to be bailed out only in systemic crises, it would have incentives to take on more risks that have poor payoffs in systemic crises. Such a bank would have incentives to hold highly rated tranches. With this view, we have the following testable hypothesis:

Too-big-to-fail H1. Banks deemed too-big-to-fail invested more in highly rated tranches of securitizations than other banks did.

The too-big-to-fail explanation for holding highly rated tranches ignores the potential costs associated with being too-big-to-fail. For instance, it can bring more regulatory scrutiny. As discussed in Section 1.2, more regulatory scrutiny could have decreased holdings of highly-rated tranches.

1.4 Other possible explanations

Other highly discussed explanations for holdings of highly rated tranches include incentives of traders and/or managers, and poor risk management. Rajan (2006) raised concerns about the incentives in place in the financial industry and how they might lead to excessive risk taking even before the crisis. A key characteristic of highly rated tranches before the financial crisis is that they had a higher yield than similar highly rated assets. Such a difference can arise in efficient markets simply because some assets have more systematic risk than others (see, for example, Coval, Jurek, and Stafford 2009). If incentives are set properly, executives or traders should not benefit from investing in correctly priced assets that have a higher return only because they have more systematic risk. However, incentives could be set improperly. For example, traders whose performance was judged on profit and loss (P&L), taking into

account regulatory capital, would have had incentives to invest in highly-rated tranches. Banks' P&L increased by the positive carry of these assets and charges for regulatory capital were low. Alternatively, executives whose performance was assessed by the return on equity (ROE) of their bank would also have benefited from investing in highly rated tranches as long as the yield on these securities exceeded the cost of holding them.

There are at least two different arguments related to risk-management failures. One argument is that bank risk management failed to correctly assess the risks of the highly rated tranches, perhaps because of risk model mistakes. Another argument is that the risk management function at certain banks did not have enough influence to limit the holdings of highly rated tranches at the level thought to be appropriate given their assessed risk. Whereas the wrong-model argument cannot be investigated with publicly available data, the latter argument about the role of risk management can be evaluated if it is the case that a more independent and more central role for risk management gives it more influence. With this argument, we would expect banks in which the risk-management function was less central and less independent to have fared worse as a result of having larger holdings of highly rated tranches. Unfortunately, this simple view of risk management is problematic. It is possible for a less independent and less central risk management function to be more influential because it is more integrated in the decision processes of the firm's businesses.

To summarize, this subsection develops the following predictions:

Bad incentives H1. Banks with trading operations and poor incentives invested more in highly rated tranches.

Bad incentives H2. Banks more focused on ROE held more highly rated tranches.

Poor risk management H1. Banks in which risk management was less central and less independent held more highly rated tranches.

2. Estimated Holdings of Highly Rated Tranches

In this section, we explain first how holdings of highly rated tranches are estimated and then provide data on our estimates.

2.1 Methods to estimate holdings of highly rated tranches

Our primary data source is the Consolidated Financial Statements for bank holding companies, form FR Y-9C, published quarterly by the Board of Governors of the Federal Reserve System. We focus on the cross-section of BHCs that are publicly traded in the United States and have data as of December 31, 2006. We drop all BHCs with missing data on total assets or with total assets less than $1 billion. And we end with a final sample of 231 banks as of December 31, 2006, the date we focus on in the majority of our

estimations.[11] The total sample period over which we calculate holdings of highly rated tranches covers March 2002 through December 2008. It starts in 2002 because this is the first year that bank holding companies had to report holdings of securitization tranches by credit rating.

Our variable of interest is designed to measure holdings of what we call highly rated tranches, which are highly rated nongovernment and nonagency securities issued in securitizations and held on BHC balance sheets. Examples include highly rated tranches of subprime residential mortgage-backed securities (RMBSs), commercial mortgage-backed securities (CMBSs), collateralized loan obligations (CLOs), collateralized bond obligations (CBOs), and collateralized debt obligations (CDOs). Bank holding companies did not explicitly report holdings of these securities in their consolidated financial statements during our sample period. Our approach is to "back out" the amount of highly rated tranches banks held on their balance sheets using data from the regulatory-capital portion of the consolidated financial statements (schedule HC-R of the form FR Y-9C). Under risk-based capital guidelines, each asset is assigned a weighting that depends on the type of the asset and its riskiness. BHCs are then required to hold capital corresponding to 8% of their risk-weighted assets. For example, government securities usually have a zero risk weight, whereas agency-sponsored securities are generally assigned a 20% risk weight by virtue of their implicit government guarantees. Securitization tranches with a credit rating of AA or AAA are assigned a 20% risk weight, whereas tranches with credit ratings of A require a 50% risk weight.

Our approach is to identify the amount of securities in the 20% and 50% risk weight categories that are not government- or agency-affiliated. Reporting guidelines name the specific types of securities that are to be included in each risk weight category and instruct BHCs to account for securities at historical cost, as opposed to fair value. For example, the total amount of held-to-maturity securities (line item 35 in Schedule HC-R) in the 20% risk weight category contains various securities issued or guaranteed by the government or government-sponsored agencies and reported in Schedule HC-B.[12] The key to our measure of highly rated tranches is that BHCs are instructed to also include "all other residential MBS," "commercial mortgage pass-through securities," "other commercial MBS," "asset-backed securities," and "structured financial products" that represent the amortized cost of securities rated AAA or AA in this 20% risk category. Thus, the residual amount of securities included in the

[11] We drop BHCs that are not in the top tier of the multitiered BHCs to avoid double counting. To mitigate the influence of outliers and focus on the depository BHCs, we additionally drop eight BHCs from our sample: three insurance companies, two mortgage brokers, two credit card companies, and one asset management BHC.

[12] These securities are those issued by government-sponsored agencies (line item 2b), residential mortgage pass-through securities issued by FNMA and FHLMC (line item 4a2), securities issued by states or political subdivisions in the U.S. (item 3), and other MBSs (collateralized by MBSs) issued or guaranteed by agencies (line items 4b1 and 4b2).

20% risk category that are not affiliated with the government or government-sponsored agencies represent the amount of AAA- or AA-rated private-label structured debt held by BHCs. The instructions for assets to be included in the 50% risk category are similar but are for A-rated securities. Taken together, the 20% and 50% risk-weighted residuals represent the portion of highly rated (AAA-, AA-, or A-rated) nongovernment, nonagency securities held on BHC balance sheets. In other words, they represent the holdings of highly rated tranches that we seek to measure. We provide the details of the construction of the residual measures, including the relevant FR Y9-C codes, in the Appendix. It is important to note that corporate bonds, regardless of the credit ratings of the issuers, belong to the 100% risk weight category, and therefore holdings of corporate bonds cannot be mistaken for holdings of highly rated tranches. However, our measure does include highly rated asset-backed securities that performed relatively well during the crisis (e.g., highly rated tranches from credit card and car loan securitizations). We cannot separate these types of highly rated tranches from highly rated tranches from subprime and Alt-A securitizations.

Many of the highly rated tranches with 20% or 50% risk weights are accounted for as available-for-sale (AFS) or held-to-maturity (HTM) securities. However, some highly rated tranches, especially in the case of the largest banks, are held separately in a BHC's trading account. The reporting requirements for securities held in trading accounts are different because banks with large trading operations do not have to report holdings of trading assets by risk weight category. Instead, regulatory capital for the entire trading book is obtained from a value-at-risk measure. Therefore, for the banks that are subject to the market risk capital guidelines, we are unable to use the residual approach to back out holdings of highly rated tranches in trading books. To capture holdings of securitization tranches in trading books, we use the total amount of line items that are recorded as trading assets (in Schedule HC-D) and represent nongovernment, nonagency mortgage-backed securities. This approach captures the private-label securitization tranches with mortgage collateral in a BHC's trading account but without differentiating the credit quality of these securitization tranches.[13] Adding the mortgage-backed securitization tranches from the trading account to the 20% and 50% AFS and HTM residual results in our primary (first) measure of highly rated tranches, referred to hereafter as the *Highly rated residual*. This measure overstates holdings of highly rated tranches of MBSs because it includes lower-rated tranches held in the trading book, but it understates holdings of highly rated

[13] Nadauld and Sherlund (2013) show that over 80% of the value-weighted bonds in subprime RMBS deals received a AAA rating, with close to 90% rated at least A. Although we cannot use the residual approach to identify the holdings of highly rated tranches in trading assets, these securities were very likely highly rated. This is especially true in light of the fact that correlation traders in hedge funds were frequent purchasers of the lowest rated (residual) tranches in securitization deals.

tranches of CDOs because the data available from the trading book contain only MBSs.

Our primary analysis investigates the holdings of highly rated tranches before the crisis started. We therefore focus on holdings as of December 31, 2006. Beginning in June 2008, BHCs have been required to explicitly report the amount of CDOs held in their trading accounts if the BHC reported a quarterly average for trading assets of $1 billion or more in any of the four preceding quarterly reports. Four banks reported CDO holdings at that time. We supplement our December 2006 estimates of highly rated tranches by adding the amount of CDOs reported in June 2008 to our first measure, *Highly rated residual*, as of December 2006. The June 2008 values of CDOs likely underreport the value of CDOs held on BHCs' balance sheets as of 2006 because CDO values were written down in the fall of 2007 and early 2008. To account for this possibility, we create our third measure by adding the amount of CDO writedowns (downloaded from Bloomberg) for the time period (December 31, 2006 through the June 30, 2008) to the June 2008 CDO holdings of the relevant banks. Though accounting for CDO writedowns improves our third measure, it still suffers from the fact that banks might have acquired or sold CDOs after 2006. As far as we know, there is no way to adjust our measure for trading subsequent to 2006. The measure also understates CDO holdings as it ignores holdings of less than $1 billion.

Banks held highly rated tranches not only on their balance sheets but also in off-balance-sheet conduits and structured investment vehicles. There are eleven banks with conduits and SIVs in our estimation sample. As the crisis evolved, banks had to take some of the securities held by SIVs back on their balance sheet. Thus, our fourth measure of highly rated tranches also adds assets held in these conduits and SIVs, utilizing the data set provided by Acharya, Schnabl, and Suarez (2013). It is well-known that conduits held a variety of assets besides highly rated tranches. To the extent that conduits and SIVs held other securities besides highly rated tranches, adding the holdings of conduits and SIVs to our on-balance sheet measure of highly rated tranches represents an upper bound of a bank's total highly rated tranches holdings.

In summary, our residual approach yields four separate measures of highly rated tranches. The first is the *Highly rated residual*, which includes 20% and 50% risk-weighted residuals and MBS trading. The second measure, constructed to account for the CDOs held in trading assets, adds 2008 CDOs to our first measure (*highly rated residual + CDOs*, hereafter). The third also adds CDO writedowns and is named hereafter as *highly rated residual + CDOs and writedowns*. Finally, the fourth residual-based measure is called *highly-rated residual + CDOs and writedowns + conduits and SIVs* because it also adds the holdings that are not on the balance sheet.

Deviating from the residual-based approach above, we also compute a fifth measure of highly rated tranches holdings, which we call the *bottom-up highly rated tranches* measure, borrowed from Cheng, Hong, and Scheinkman (2010).

This measure is basically the sum of each line item from the AFS, HTM, and trading asset accounts that correspond to nongovernment, nonagency sponsored securities. It includes *other mortgage-backed securities* and *asset-backed securities* from the AFS and HTM securities (Schedule HC-B). Nongovernment, nonagency mortgage-backed securities from trading assets (Schedule HC-D) are also added to the measure. The Appendix provides the detailed data fields associated with the construction of this bottom-up measure. Although the measure explicitly assesses the amount of nongovernment, nonagency securities held on BHCs' balance sheets, it does not capture the credit quality of these assets. Like our first measure, the bottom-up measure is constructed using data reported at the end of 2006 and therefore does not include CDO holdings in trading accounts. It does not include off-balance-sheet exposures either.

A concern is that banks might have taken positions in highly rated tranches through credit derivatives or might have hedged cash positions through credit derivatives. This concern does not affect our measure of highly rated tranches, as hedged tranches would still be assets for the bank, but it could affect the economic implications of these holdings. The data on credit derivatives does not distinguish between credit derivatives on corporate names versus credit derivatives on RMBSs and CDOs. The extent of the potential problem is limited because in 2006 only twenty bank holding companies bought protection, and only fifteen bank holding companies sold protection. With the caveat that the banks with the largest holdings of highly rated tranches are also the ones that were active in the CDS market, in total, fifteen bank holding companies were net buyers of protection. Among the top three banks, Citigroup and JP Morgan Chase were net buyers of protection, whereas Bank of America was a net seller. The 10-Ks suggest that banks that bought protection were heavily focused on hedging their corporate loan book.

2.2 Estimates of holdings of highly rated tranches

Figure 1 shows the evolution of total dollar holdings of highly rated tranches using our primary *Highly rated residual* measure. At the end of 2006, the last year before the crisis, the banks in our sample held $228 billion of highly rated tranches. The holdings of these tranches increased dramatically since the start of our sample in 2002. In 2002, the total dollar holdings of highly rated tranches were $64 billion. The total dollar holdings keep increasing after the end of 2006, experiencing an especially sharp increase during 2007.

The December 2006 estimate of $228 billion arising from our primary *Highly rated residual* approach should be viewed as a lower bound, given that the sample only includes bank holding companies that are publicly traded in the United States. Relaxing some filters, including the publicly traded requirement, increases the sample size from the 231 banks employed in our regressions to a sample of 439 banks. The *Highly rated residual* in December 2006 measure

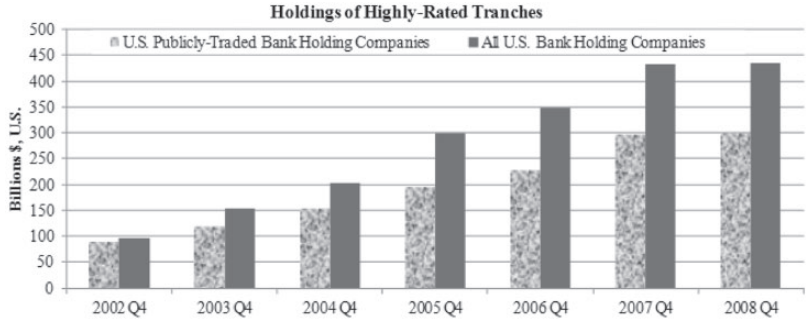

Figure 1
Dollar amounts of holdings of highly rated tranches
This figure plots the aggregate, nominal U.S. dollar amount of holdings of highly rated tranches through time. Our sample runs from 2002–2008 and includes all U.S. publicly traded bank holding companies (BHCs). The plot is created using the highly rated residual measure of highly rated holdings. See Appendix A.1, for a description of this variable.

totals $349 billion in the larger sample of 439 banks.[14] Lehman Brothers constructed an estimate of holdings of private label MBS by banks and thrifts that has been widely cited. According to that estimate, the banks and thrifts in the top fifty in terms of nonagency MBS holdings held $314 billion in nonagency MBSs in mid-2007.[15] Finally, when we consider the highly rated holdings in off-balance-sheet conduits and SIVs, an estimated $255.7 billion for fourteen banks, we arrive at an upper-bound estimate that totals $604.7 billion.[16]

Table 1 shows data on our estimates of holdings of highly rated tranches by BHCs. We always normalize the holdings by bank assets. Panel A shows summary statistics for our primary *Highly rated residual* measure. In contrast to our other measures (except for the bottom-up measure), this measure is available consistently from 2002. In 2006, the median holdings of highly rated tranches (as a ratio of total assets) are 0.15%. Such holdings are of trivial importance for a bank. So, for the typical bank, holdings of highly rated tranches were not a material concern.[17] However, the mean holdings of highly rated tranches are 1.13%, almost ten times the median. Such a result implies that some banks have large holdings of highly rated tranches compared

[14] The larger sample of 439 also includes some financial intermediaries not included in the final sample of 231 that are more comparable to asset management firms than standard depository bank holding companies. These nonstandard intermediaries that appear in the FR Y-9C data report large amounts of highly rated holdings and are largely responsible for the increase in holdings to $349 billion for the full sample as compared with holdings of $228 in our final sample of 231.

[15] Lehman Brothers, Fixed Income U.S. Securitized Products Research, "Who owns residential credit risk," September 7, 2007.

[16] Acharya, Schnabl, and Suarez (2013) provide information on conduits for a sample of banks with larger than $50 billion in assets. Out of twenty banks in our sample that meet the same size filter, only fourteen reported conduits.

[17] Note that the typical bank does not have a trading book. Consequently, for the typical bank, our estimate of highly rated tranches is unbiased.

Table 1
Documenting the holdings of highly rated tranches among U.S. bank holding companies

	Full sample				Large trading-asset banks		Nonzero trading asset banks		Nontrading-asset banks		25 TARP banks	Citigroup	Bank of America	JPMorgan Chase
Year	Obs.	Mean (%)	Med (%)	90th %tile (%)	Obs.	Mean (%)	Obs.	Mean (%)	Obs.	Mean (%)	Mean (%)	Mean (%)	Mean (%)	Mean (%)
Panel A: *Highly rated residual*														
2002	169	1.29	0.10	3.59	13	3.05	35	1.68	121	0.99	1.77	1.96	1.29	0.00
2003	184	1.27	0.06	3.40	13	3.77	37	1.71	134	0.91	2.24	2.26	0.79	0.20
2004	205	1.37	0.02	3.85	14	3.76	36	2.38	155	0.92	2.84	2.74	0.94	0.88
2005	218	1.50	0.10	4.48	14	4.70	37	3.11	167	0.88	3.69	3.54	1.43	0.80
2006	231	1.31	0.15	3.13	14	4.75	40	2.49	177	0.78	3.27	4.78	1.04	0.63
2007	224	1.27	0.20	3.04	12	3.18	47	2.26	165	0.85	2.60	5.06	1.73	1.57
2008	220	1.13	0.11	3.12	11	2.42	47	1.52	162	0.93	1.92	4.39	2.55	2.03
Panel B: *Highly rated residual + CDOs*														
2006	231	1.31	0.15	3.13	14	4.76	40	2.49	177	0.78	3.30	4.79	1.05	0.67
Panel C: *Highly rated residual + DOs and writedowns*														
2006	231	1.33	0.15	3.14	14	4.99	40	2.52	177	0.78	3.42	5.75	1.96	1.09
Panel D: *Highly rated residual + CDOs + writedowns + conduit's and SIV's*														
2006	231	1.51	0.16	3.73	14	6.59	40	2.96	177	0.78	4.81	10.67	5.08	4.25
Panel E: *Bottom-up highly rated tranches*														
2002	169	1.11	0.04	3.49	13	2.01	35	1.56	121	0.89	1.36	1.18	1.37	0.18
2003	184	1.01	0.01	3.15	13	2.95	37	1.53	134	0.67	1.85	1.04	0.84	0.26
2004	205	1.14	0.01	2.64	14	3.09	36	2.31	155	0.69	2.49	1.25	0.52	0.35
2005	218	1.26	0.01	3.26	14	4.14	37	2.80	167	0.68	3.23	1.85	1.18	0.78
2006	231	1.28	0.09	3.17	14	5.04	40	2.47	177	0.72	3.31	3.89	1.83	0.64
2007	224	1.23	0.14	3.15	12	3.56	47	2.13	165	0.80	2.42	4.69	2.56	1.51
2008	220	1.03	0.17	3.24	11	2.37	47	1.32	162	0.85	1.81	3.89	3.19	2.40

This table reports summary statistics of some measures of holdings of highly rated tranches: highly rated residual, highly rated residual + CDOs, highly rated residual + CDOs and write-downs, highly rated residual + CDOs + write-downs + conduits and SIV's, and bottom-up highly rated tranches. See Appendix A for definitions of the variables. The full sample includes all U.S. publicly traded bank holding companies (BHCs). Large trading-asset banks are defined as BHCs with trading assets in excess of $1 billion or BHCs whose trading assets represent greater than 10% of total assets. Nonzero trading asset banks are defined as banks with trading assets greater than $0 and less than $1 billion (or with trading assets representing less than 10% of total assets). Nontrading asset banks are defined as banks with no trading assets. Twenty-five TARP banks are those that received the largest dollar amounts of TARP funds. Beginning with the second quarter of 2008, BHCs with trading assets in excess of $1 billion are now required to report the amount of CDOs and ABSs held in their trading portfolio. Panel B reports statistics for the residual measure plus these CDOs as of 2008. In Panel C, we also include write-downs on CDOs from Bloomberg covering 2006 onward. Panel D includes the total amount of assets held in off-balance sheet conduits and SIV's, as reported by Acharya, Schnabl, and Suarez (2013). Panel E reports bottom-up highly-rated tranches based on a measure borrowed from Cheng, Hong, and Scheinkman (2010).

to the typical bank. The 90th percentile of holdings of highly rated tranches is 3.13%.

In 2006, only fifty-four of the BHCs in our sample reported trading assets. Of these banks, fourteen had trading assets in excess of $1 billion and in excess of 10% of the bank's assets. These "large trading banks" had holdings of highly rated tranches using our narrowest measure averaging to 4.75%. One way to understand the economic importance of such holdings is that the Basel I accord required banks to have capital equal to 8% of risk-weighted assets, half of it in Tier 1 capital. Banks usually hold more regulatory capital than is required. But if a large trading bank has an average risk weight of 50%, a 50% loss on highly rated tranches would be enough to wipe out its Tier 1 required capital.[18] In contrast, the mean of the holdings of highly rated tranches for the banks that did not report trading assets was 0.78%. In Table 1, we also show the holdings of the twenty-five banks receiving the largest dollar amounts of TARP funds. At the end of 2006, the average holdings of these banks were 3.27%, so that these banks on average held more than the 90th percentile of highly rated holdings. Table 1 also presents the holdings of the three largest banks. Although these holdings are large for Citigroup at 4.78%, they are below the mean for both Bank of America (1.04%) and JP Morgan Chase (0.63%).

Table 1, Panel A, reports information on holdings of highly rated tranches using our narrowest measure for other years, from 2002 to 2008. Neither the mean nor the median changes noticeably during that period of time. The mean increases from 1.29% in 2002 to 1.50% in 2005. After 2005, the mean falls, reaching 1.13% in 2008. For the large trading banks, the mean increases more noticeably and drops more sharply after peaking in 2006. However, there are only fourteen large trading banks in 2006. The number of large trading banks falls to twelve by the end of 2007. The large decrease in highly rated tranches for large trading banks in 2007 is due to the merger of the Bank of New York and Mellon. Both of these banks have high holdings, but the resulting entity is not in our sample for 2007 as we keep only the banks that are alive at the end of 2006, the year we focus on in most of our tests. If we look instead at the holdings of banks alive, both at the end of 2006 and of 2007, the mean holdings of highly rated tranches is 2.94% at the end of 2006 and 3.07% at the end of 2007. The three largest banks have each a different pattern. In particular, Citibank's holdings more than double over time (peaking in 2007), whereas neither Bank of America nor JP Morgan Chase exhibit much of an increase in holdings until 2007 and 2008. The holdings of JP Morgan Chase increase from 1.06% in 2006 to 2.55% in 2008. We are unable to ascertain the extent to which this increase results from the acquisitions of Bear Stearns and Washington Mutual in 2008.

[18] If a bank has an average risk weight of 50%, it holds Tier 1 capital corresponding to 2% of assets. Hence, if the bank holds 4.57% of assets in highly rated tranches, a 50% loss is 2.27% of assets, which exceeds Tier 1 capital.

Table 1, Panel B, uses information on CDO holdings. Although adding this information to our measure of highly rated tranches at the end of 2006 is reasonable, doing so to earlier years would make little sense as banks were in the process of increasing their holdings of CDOs before the end of 2006. CDO holdings do not affect the median and have a trivial effect on the mean because only four banks report holdings of CDOs in excess of $1 billion, the reporting threshold. The holdings of highly rated tranches for the banks with large trading books increase only by 0.01%. Table 1, Panel C, adds information on writedowns. Taking into account writedowns has no impact on most banks. However, the holdings of highly rated tranches for Citibank increase further to 5.75%. The holdings of Bank of America increase to 1.96%. Finally, the holdings of JP Morgan Chase are 1.09%.

Table 1, Panel D, further adds assets held in conduits and SIVs, a total value of $214.1 billion for eleven banks. This measure is only available for the end of 2006. Mean holdings for the full sample increase slightly, from 1.33% to 1.51%. The increase is much larger for large trading-asset banks (from 4.99% to 6.59%), especially for Citigroup (from 5.75% to 10.67%), Bank of America (1.96% to 5.08%), and JP Morgan Chase (from 1.09% to 4.25%). To put these numbers in perspective, note that Citi had a ratio of common stockholders' equity to assets of 6.30% at the end of 2006 (Citigroup's 10-K for 2007). Consequently, a loss of 60% on the highly rated tranches would have wiped out Citi's common equity.

Finally, Table 1, Panel D, shows our estimates using the bottom-up approach. There is no meaningful difference between these estimates and the estimates using our preferred measure of *Highly rated residual* for most banks. When we turn to the large trading banks, the bottom-up measure has a mean that is higher by 0.29% in 2006. The two methods yield different estimates for Citibank and Bank of America. For Citibank, the bottom-up method has an estimate that is lower by 0.89%. For Bank of America, the difference of 0.79% is in the opposite direction.

The dollar holdings of highly rated tranches were highly concentrated. This concentration may not be surprising because bank assets are highly concentrated as well. Using our narrow measure, we find that half of the holdings of the banking sector in our sample were held by the three banks with the largest assets, and these banks also held half of the assets of the banking sector. Further, the top five banks by assets held 60% of the holdings.

In summary, for most banks, holdings of highly rated tranches as a proportion of assets were less than 1% of assets. These holdings were small for some large banks, such as JP Morgan. But the average holdings of highly rated tranches by the banks with large trading assets were more than three times greater than the average holdings of these tranches by all banks. The average total securities holdings of banks with large trading assets were only 24% higher than the average securities holdings of the banks without large trading assets.

Consequently, banks with large trading assets quite clearly allocated much more of their securities holdings to highly rated tranches.

3. Bank Risk and Holdings of Highly Rated Tranches

In this section, using traditional measures of bank risk, we first examine whether the banks with higher holdings of highly rated tranches were riskier before the crisis. We then turn to an assessment of whether the banks with higher holdings performed worse during the crisis.

3.1 Holdings of highly rated tranches and bank risk before the crisis

We investigate whether holdings of highly rated tranches were correlated with common proxies of bank risk before the crisis. If holdings were a reflection of a bank's willingness to take more risk, we would expect a bank with larger holdings to be riskier along a number of different dimensions. Note that we are not arguing that the holdings themselves would increase the risk measures of banks. At the time, highly rated tranches of securitizations were considered to be assets with extremely low risk, so that they would not have impacted risk measures in a meaningful way. However, if banks that were willing to take more risk held these highly rated tranches, then we should expect banks with more highly rated tranches to be more risky.

In Panel A of Table 2, we present results using the *Highly rated residual* measure of highly rated tranches as of 2006 year-end. Our first measure of risk is the bank z-score. The bank z-score (see Boyd, Graham, and Hewitt (1993) and Laeven and Levine (2009)) is measured as the ratio of the return on assets plus the capital-asset ratio divided by the standard deviation of the return on assets. In other words, it is a measure of distance-to-default. The numerator is measured as of the end of 2006, whereas the volatility in the denominator is calculated using the prior six years' return on assets. A higher distance-to-default means that a larger negative return is required to render the bank insolvent. Regression (1) shows that there is no relation between the z-score and holdings of highly rated tranches. Regression (2) adds several control variables to the regression. We control for bank attributes, such as the bank's stock returns over the previous year, the market-to-book ratio, "other" holdings of held-to-maturity and available-for-sale securities, and "other" trading securities.[19] We also include two control variables for bank size. We allow the slope in the relation between highly rated holdings and bank asset size to differ for assets above $50 billion as a simple way to capture the effect of being too-big-to-fail on holdings.[20] These controls are admittedly limited, but we want to give the

[19] The term "other" securities generally refers to holdings of government, agency, and non-highly-rated private-label securities. The Appendix contains a precise description of securities included in our measures of "other" H.T.M. and A.F.S. securities and "other" trading securities.

[20] Banks with assets greater than $50 billion are treated differently under the Dodd-Frank Wall Street Reform and Consumer Protection Act.

Table 2
Bank risk and holdings of highly rated tranches

		Measures of holdings of highly rated tranches			
		Highly rated residual		Highly rated residual + CDOs and writedowns + conduits and SIVs	
		Panel A		*Panel B*	
	Regressions	Without controls	With controls	Without controls	With controls
Log z-score	(1)-(2)	−0.004	0.003	−0.005	0.003
		(−0.636)	(0.489)	(−0.778)	(0.391)
Adjusted R-squared		−0.004	0.137	−0.003	0.223
ROA volatility	(3)-(4)	1.719	−1.399	2.065	−1.517
		(0.663)	(−0.457)	(0.788)	(−0.503)
Adjusted R-squared		−0.001	0.139	−0.003	0.223
Stock return volatility	(5)-(6)	−1.279	1.372	−2.106*	1.677
		(−1.161)	(0.671)	(−1.799)	(0.840)
Adjusted R-squared		0.000	0.149	0.006	0.236
Market leverage	(7)-(8)	−0.086	0.533	−0.123	0.578
		(−0.100)	(0.628)	(−0.138)	(0.676)
Adjusted R-squared		−0.004	0.146	−0.004	0.233
Book leverage	(9)-(10)	0.059	0.091	0.057	0.105
		(0.652)	(0.920)	(0.596)	(1.044)
Adjusted R-squared		−0.002	0.149	−0.003	0.236
Assets/Tier 1 capital	(11)-(12)	0.003**	0.002	0.005***	0.002
		(2.193)	(1.269)	(2.914)	(1.266)
Adjusted R-squared		0.044	0.154	0.079	0.239
Risk-weighted assets/ Tier 1 capital	(13)-(14)	0.001	−0.003	0.003**	−0.002
		(0.993)	(−1.482)	(2.151)	(−1.172)
Adjusted R-squared		−0.001	0.158	0.017	0.238
Net derivatives/assets	(15)-(16)	1.332*	0.757	1.823	0.838
		(1.726)	(1.227)	(1.601)	(1.178)
Adjusted R-squared		0.043	0.156	0.068	0.243
Short-term wholesale funding/assets	(17)-(18)	0.037	−0.024	0.086**	−0.026
		(1.152)	(−0.435)	(2.110)	(−0.463)
Adjusted R-squared		0.001	0.147	0.017	0.234
Observations		204 - 225			

This table documents the relationship between holdings of highly rated securitization tranches and various proxies for bank risk as of December 2006. The left-hand side variable is the highly rated residual in Panel A and highly rated residual + CDOs and write-downs + conduits and SIVs in Panel B. Risk proxies are the banks' z-score, ROA volatility, stock return volatility, market or book leverage, two regulatory measures of leverage, net derivatives as a fraction of total assets, and short-term wholesale funding as a fraction of total assets. Control variables are *$0–$50 Billion*, *>$50 Billion*, *Other HTM and AFS securities*, *Other trading securities*, *Prior returns*, and *Market-to-book.* Appendix A outlines the construction of the measures of highly rated holdings and the explanatory variables. Heteroscedasticity-robust *t*-statistics are in parentheses. The symbols ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

regression the best chance to show that there is a correlation between holdings of highly rated tranches and risk taking in general. We do not show the estimated coefficients of the control variables in Table 2 as our focus is on the correlation between highly rated tranches and the risk measures. Including these control variables in regression (2), the z-score is not correlated with holdings of highly rated tranches.

Regressions (3) to (6) also show no relation between holdings of highly rated tranches and bank risk with or without our control variables, this time

using the standard deviations of the return on assets or the stock return during the year 2006 as proxies. We turn next to measures of leverage. Again, we find no significance whether we use market leverage or book leverage (see regressions (7)–(10)). When we use a version of the regulatory leverage ratio, defined as the ratio of assets to Tier 1 capital, we find a positive relation with holdings of highly rated tranches (see regression (11)). But this relation becomes insignificant when we add our controls in regression (12). In regressions (13) and (14), we use another regulatory measure of risk, namely, the ratio of risk-weighted assets to Tier 1 capital. For a given asset size and regulatory capital, a bank that holds riskier assets with higher regulatory weights would have a larger amount of risk-weighted assets. The coefficient for this risk proxy is not significantly different from zero, and its sign is even negative when we include control variables.

So far, we have seen no significant relation between bank risk and holdings of highly rated tranches before the crisis. Next, we use a measure of credit derivatives because these derivatives can be used by banks to hedge their credit exposures. Using the measure we discussed in Section 2.1, namely, the difference between protection bought and protection sold divided by assets, we find that banks that bought more protection in the credit derivatives markets had larger holdings of highly rated tranches (see regression (15)). The coefficient becomes insignificant when we add our control variables in regression (16). Lastly, we use the ratio of short-term wholesale funding as a fraction of total assets as another measure of risk and do not find any significant correlation with holdings (see regressions (17) and (18) of Table 2, Panel A).

In Panel B of Table 2, we present results for the set of risk proxies using our broadest measure of highly rated tranches, *Highly rated residual + CDOs and writedowns + conduits and SIVs*, as the left-hand side variable. In specifications without control variables, both measures of regulatory capital (*Assets/Tier 1 capital* and *Risk-weighted assets/Tier 1 capital*) and *short-term wholesale funding/assets* have positive and significant coefficients, whereas the *Stock return volatility* variable has a negative and significant coefficient. In specifications including control variables, we find no significance.

A concern with our size variables is that they themselves might reflect risk taking because, for a given amount of equity, banks with more leverage will have more assets. To alleviate this concern, we re-estimate our regressions with only the number of employees as a control variable. The number of employees controls for size, but it is unlikely to reflect a bank's risk taking. We find that our results remain similar. Overall, there is no systematic evidence that banks that held more highly rated tranches were riskier ahead of the crisis. Without controlling for other bank characteristics, there is some evidence that these banks had more regulatory leverage and more short-term funding. However, this evidence no longer holds as soon as we control for a small set of bank characteristics.

3.2 Holdings of highly rated tranches and bank stock returns during the crisis

Banks with higher holdings of highly rated tranches did not appear to have higher risk before the crisis. We now turn to whether they had higher risk ex post, in that they performed worse during the crisis. We do not investigate whether higher holdings caused worse performance; rather we look at whether or not banks that had higher holdings also performed worse ex post. We calculate each bank's buy-and-hold excess return over the equally weighted market return for the time period of July 1, 2007 through December 31, 2008. We then regress these buy-and-hold stock returns on the five different BHC-specific measures of highly rated tranches holdings as of December 31, 2006. To account for potential nonlinearities in the relation between these holdings and stock returns, we sort firms into quintiles based on their holdings and construct dummy variables for banks in each quintile. The quintile with the lowest amount of highly rated holdings serves as the base group. We expect banks in the highest quintiles of highly rated tranches holdings as of December 2006 to be associated with lower stock returns during the subsequent financial crisis.

We control for bank attributes, such as the bank's market capitalization, prior stock returns, market-to-book, and a regulatory-capital leverage measure (the ratio of assets to Tier 1 capital), that are likely to influence stock returns. Again, we control for "other" securities' holdings of held-to-maturity and available-for-sale securities and "other" trading securities in all regressions. We include as independent variables measures of a bank's real estate as well as commercial and industrial (C&I) loan exposure in the form of mortgage and C&I loans, scaled by total assets. Banks also had unused commitments to make residential and commercial real-estate loans. Following Loutskina and Strahan (2011), we control explicitly for such unused loan commitments.

We present the results in Table 3. Firms in the top quintile of highly rated tranches holdings are associated with about 14% lower buy-and-hold excess stock returns during the crisis, on average. For banks in the top quintile, the average of the ratio of holdings of highly rated tranches to equity market capitalization at the end of 2006 is 29.63% (the median is 17.02%). The lower stock returns we document are therefore consistent with the size of the holdings and the magnitude of losses on highly rated tranches that have been documented. For instance, the on-the-run ABX index for AAA tranches fell by more than 50% during that period of time, so that a bank holding 29.63% of its capitalization in highly rated tranches would have lost at least 15% of its equity market capitalization. However, it is important to remember that our measures include holdings of nonsubprime ABS, which performed better during the crisis, and we cannot tell how important these holdings were. The negative coefficient on the top quintile is statistically significant for all measures of highly rated tranches, except for the bottom-up measure. The impact of highly rated tranches holdings on stock returns is lower for banks that have low holdings. Banks in the second highest quintile of holdings experienced 2% to

Table 3
Holdings of highly rated tranches and bank holding company stock returns

	Measures of holdings of highly rated tranches				
	Highly rated residual	Highly rated residual + CDOs	Highly rated residual + CDOs and writedowns	Highly rated residual + CDOs and writedowns + conduits and SIVs	Bottom-Up highly rated tranches
	(1)	(2)	(3)	(4)	(5)
80th %tile - 100th%tile highly rated tranche holdings indicator	−0.134** (−2.249)	−0.134** (−2.249)	−0.138** (−2.301)	−0.143** (−2.338)	−0.080 (−1.227)
60th %tile - 80th%tile highly rated tranche holdings indicator	−0.107 (−1.439)	−0.107 (−1.439)	−0.114 (−1.535)	−0.127* (−1.738)	−0.064 (−0.912)
40th %tile - 60th%tile highly rated tranche holdings indicator	−0.096 (−1.467)	−0.096 (−1.467)	−0.088 (−1.354)	−0.075 (−1.174)	−0.010 (−0.165)
20th %tile - 40th%tile highly rated tranche holdings indicator	−0.095 (−0.999)	−0.095 (−0.999)	−0.095 (−0.992)	−0.095 (−0.996)	0.086 (0.862)
Unused loan commitments	−1.363** (−2.396)	−1.363** (−2.396)	−1.362** (−2.383)	−1.357** (−2.378)	−1.268** (−2.191)
Mortgage loans as % of total assets	−0.786** (−2.266)	−0.786** (−2.266)	−0.784** (−2.283)	−0.789** (−2.284)	−0.805** (−2.243)
C&I loans as % of total assets	−0.808* (−1.921)	−0.808* (−1.921)	−0.818* (−1.970)	−0.838** (−2.031)	−0.851** (−2.065)
"Other" H.T.M. and A.F.S. securities	0.604 (1.441)	0.604 (1.441)	0.609 (1.459)	0.599 (1.421)	0.616 (1.413)
"Other" trading securities	−2.645* (−1.764)	−2.645* (−1.764)	−2.616* (−1.766)	−2.598* (−1.706)	−2.558* (−1.712)
Log market cap	−0.005 (−0.227)	−0.005 (−0.227)	−0.004 (−0.190)	−0.002 (−0.104)	−0.008 (−0.397)
Prior returns	0.149 (0.960)	0.149 (0.960)	0.150 (0.968)	0.151 (0.975)	0.156 (1.008)
Market-to-book	0.116*** (3.223)	0.116*** (3.223)	0.115*** (3.217)	0.115*** (3.226)	0.110*** (3.046)
Assets/ Tier 1 capital	0.002 (0.151)	0.002 (0.151)	0.002 (0.166)	0.002 (0.149)	0.001 (0.0926)
Constant	0.437 (0.745)	0.437 (0.745)	0.420 (0.716)	0.394 (0.677)	0.485 (0.785)
Observations	218	218	218	218	218
Adjusted R-squared	0.235	0.235	0.236	0.237	0.225

This table documents the relationship between BHC stock returns and holdings of highly rated tranches as of December 2006. The dependent variable is buy-and-hold excess return over the equally weighted market return from July 1, 2007 through December 31, 2008. Each regression uses a different measure of highly rated +holdings. Appendix A outlines the construction of the measures of highly rated holdings, as well as the definitions of the main explanatory variables and control variables. Heteroscedasticity-robust *t*-statistics are in parentheses. The symbols ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

3% higher stock returns than did the banks in the top quintile. The coefficient on these banks is not statistically different from zero for all measures, except for the measure that includes holdings in conduits and SIVs as the dependent variable (in Column 4). The coefficients on the lower quintiles are never statistically significant.

As in Loutskina and Strahan (2011), unused loan commitments have a significantly negative impact on stock returns. As expected, banks with higher exposures to real estate through mortgage and C&I loans had significantly more negative stock returns. Other HTM and AFS securities are associated with larger

stock returns, as are firms with higher market-to-book ratios. Prior stock returns, market capitalization, and assets over Tier 1 capital do not have significant coefficients explaining stock returns. Taken together, these results provide evidence that our constructed measures of highly rated tranches holdings are associated with bank stock return performance. Such a result would follow if the performance of these highly rated tranches was unexpected. It would also follow if holdings of highly rated tranches were associated with bank attributes that were generally correlated with poor crisis performance.

4. Why Did Banks Hold Highly Rated Tranches?

In this section, we investigate to what extent the cross-sectional variation in holdings of highly rated tranches is consistent with the hypotheses developed in Section 1 using the estimates of highly rated tranches presented in Section 2. Our typical approach is to estimate regressions in which the dependent variable is highly rated tranches held by a bank, normalized by its assets. When we can, we address the relevant endogeneity issues. We also are able to present falsification tests in some cases. However, not all sources of endogeneity can be addressed, so that our regressions do not establish causality. Rather, they document correlations. If a relevant correlation is consistent with a hypothesis developed in Section 2, this hypothesis gains credibility. If it is not, the burden of proof should shift to those who favor that hypothesis to show why it should be taken seriously despite our finding. Notably, a further limitation of our regression analysis is that, as we discussed extensively, our measures of holdings of highly rated tranches are approximations. Therefore, there might be measurement error in our dependent variable. Measurement error should not bias the coefficients in the regression but, everything else equal, it could reduce the significance of the coefficients.

In all regressions, we control for the return of the bank in 2005–2006, the market-to-book ratio, assets over Tier 1 capital, and the holdings of other securities as of 2006. For the holdings of other securities, we consider separately other securities held to maturity and available for sale as well as other trading securities. Because these holdings exclude the highly rated tranches, there is no mechanical relation between these holdings and holdings of highly rated tranches. Table A2 provides the details of the construction of the explanatory variables used in this section.

4.1 Bank size and holdings of highly rated tranches

Several hypotheses presented in Section 1 predict a relation between bank size and holdings of highly rated tranches. In particular, the too-big-to-fail hypothesis predicts that banks above a given size would hold more highly rated tranches. Further, banks need a minimum scale to engage in securitization. Therefore, we begin by investigating the relation between bank size and holdings of highly rated tranches. Table 4 shows the medians of highly rated

Table 4
Median holdings of highly rated tranches by size vigintiles

	Median holdings of highly rated tranches by size vigintile (%)					
Size vigintile	Highly rated residual	Highly rated residual + CDOs	Highly rated residual + CDOs and writedowns	Highly rated residual + CDOs and writedowns + conduits and SIVs	Bottom-Up highly rated tranches	Ratio of total agency holdings to assets
	(1)	(2)	(3)	(4)	(5)	(6)
1	0.00	0.00	0.00	0.00	0.00	10.63
2	0.00	0.00	0.00	0.00	0.00	11.23
3	0.76	0.76	0.76	0.76	0.47	12.56
4	0.00	0.00	0.00	0.00	0.07	11.99
5	0.03	0.03	0.03	0.03	0.00	12.18
6	0.18	0.18	0.18	0.18	0.11	15.97
7	0.05	0.05	0.05	0.05	0.00	8.05
8	0.05	0.05	0.05	0.05	0.00	12.18
9	0.00	0.00	0.00	0.00	0.00	12.90
10	0.01	0.01	0.01	0.01	0.00	14.44
11	0.00	0.00	0.00	0.00	0.00	10.50
12	0.10	0.10	0.10	0.10	0.01	8.50
13	0.31	0.31	0.31	0.31	0.12	13.58
14	0.82	0.82	0.82	0.82	0.33	12.69
15	0.72	0.72	0.72	0.72	0.59	13.15
16	0.01	0.01	0.01	0.01	0.00	17.62
17	0.34	0.34	0.34	0.34	0.45	13.84
18	1.54	1.54	1.54	1.54	1.52	11.96
19	0.87	0.87	1.34	1.61	0.85	9.07
20	1.82	1.82	1.91	4.67	1.98	10.03

This table reports how median holdings of highly rated tranches (in percentages) change across size vigintiles as of December 2006. Each column uses a different measure of holdings: highly rated residual, highly rated residual + CDOs, highly rated residual + CDOs and write-downs, highly-rated residual + CDOs + write-downs + conduits and SIV's, and bottom-up highly-rated tranches. See Appendix A for the definition of the variables.

tranches holdings for vigintiles. We focus on medians because a few banks are clearly outliers in some vigintiles and influence the mean. Although the median holdings do not increase monotonically with size across vigintiles, the highest median is for the banks in the twentieth vigintile, corresponding to the largest banks, for all measures. Median holdings exceed 1% only among the three largest vigintiles. The difference in median holdings between the largest banks and the next largest banks is most dramatic for our broadest measure, which includes holdings in conduits and SIVs. For that measure, the median for the largest banks is 4.67%, whereas it is 1.61% for the next largest banks. The last column of Table 4 shows the holdings of agency mortgage-backed securities. These holdings are much higher than the holdings of highly rated private-label tranches for each vigintile. Further, there is no consistent relation between size and holdings across size vigintiles for agency securities.

Table 5 presents the results of regressions of holdings of highly rated tranches on various measures of size. We do not show the estimates for the control variables. Panel A of Table 5 reports estimates for all measures using the piecewise nonlinear approach used in Section 3.1. The first variable, named *$0–$50 billion*, captures the relation between holdings of highly rated tranches

Table 5
Holdings of highly rated tranches and bank asset size

	Measures of holdings of highly rated tranches				
	Highly rated residual	Highly rated residual + CDOs	Highly rated residual + CDOs and writedowns	Highly rated residual + CDOs and writedowns + conduits and SIVs	Bottom-Up highly rated tranches
	(1)	(2)	(3)	(4)	(5)
Panel A					
\$0-\$50 Billion	0.763**	0.765**	0.776**	0.996***	0.855***
	(2.453)	(2.462)	(2.498)	(2.982)	(2.797)
>\$50 Billion	−0.066	−0.066	−0.059	−0.050	−0.064
	(−1.612)	(−1.634)	(−1.445)	(−1.045)	(−1.616)
Controls	yes	yes	yes	yes	yes
Adjusted R-squared	0.154	0.158	0.160	0.239	0.174
F-statistic testing $B_1 = B_2$	*6.29*	*6.35*	*6.42*	*8.66*	*8.02*
p-value	*0.013*	*0.0125*	*0.012*	*0.004*	*0.005*
Panel B					
0-10,000 Employees	0.004**	0.004**	0.004**	0.005***	0.004***
	(2.367)	(2.376)	(2.406)	(2.877)	(2.687)
> 10,000 Employees	−0.000	−0.000	−0.000	−0.000	−0.000
	(−1.219)	(−1.255)	(−1.069)	(−0.695)	(−1.281)
Controls	yes	yes	yes	yes	yes
Adjusted R-squared	0.134	0.138	0.143	0.225	0.155
Panel C					
\$0-\$50 Billion	0.929**	0.920**	0.949**	1.231***	1.025**
	(2.232)	(2.212)	(2.291)	(2.863)	(2.517)
\$50 - \$250 Billion	−0.207*	−0.197	−0.206*	−0.248*	−0.208*
	(−1.677)	(−1.598)	(−1.675)	(−1.956)	(−1.719)
>\$250 Billion	−0.030	−0.033	−0.022	0.001	−0.027
	(−0.592)	(−0.648)	(−0.435)	(0.0120)	(−0.561)
Controls	yes	yes	yes	yes	yes
Adjusted R-squared	0.156	0.158	0.163	0.249	0.179
Panel D					
>\$50 Billion indicator	0.016	0.016	0.016	0.022	0.022*
	(1.332)	(1.352)	(1.353)	(1.600)	(1.772)
Controls	yes	yes	yes	yes	yes
Adjusted R-squared	0.042	0.045	0.051	0.113	0.053
Panel E					
>\$100 Billion indicator	0.025	0.026	0.026	0.037*	0.028
	(1.345)	(1.371)	(1.385)	(1.726)	(1.487)
Controls	yes	yes	yes	yes	yes
Adjusted R-squared	0.050	0.054	0.060	0.132	0.054
Panel F					
Stress-test bank	0.003	0.003	0.003	0.011	0.006
	(0.178)	(0.176)	(0.186)	(0.531)	(0.360)
Controls	yes	yes	yes	yes	yes
Adjusted R-squared	0.039	0.042	0.048	0.107	0.037

(*continued*)

Table 5
Holdings of highly rated tranches and bank asset size

	Measures of holdings of highly rated tranches				
	Highly rated residual	Highly rated residual + CDOs	Highly rated residual + CDOs and writedowns	Highly rated residual + CDOs and writedowns + conduits and SIVs	Bottom-Up highly rated tranches
	(1)	(2)	(3)	(4)	(5)
Panel G					
Log assets	0.006**	0.006**	0.006**	0.008***	0.007***
	(2.60)	(2.62)	(2.68)	(3.13)	(2.95)
Controls	yes	yes	yes	yes	yes
Adjusted R-squared	0.086	0.089	0.098	0.173	0.096

This table tabulates the results of an OLS regression of our measures of highly rated holdings on measures of bank size and control variables. Panels A and C include piecewise linear specifications of bank asset size as a measure of bank size. Panel B includes a piecewise linear specification of total bank employees as a measure of bank size. Panels D and F use an indicator variable for BHCs with asset size larger than $50 billion and $100 billion, respectively. Panel F uses a stress-test bank dummy. Control variables included in all regressions, but not reported below, are the banks' stock returns over the previous year, market-to-book ratio, and total assets normalized by its Tier 1 capital as well as "other" securities' holdings of held-to-maturity and available-for-sale securities and "other" trading securities. Appendix A outlines the construction of these measures of highly rated holdings as well as the definitions of the main explanatory variables and control variables. Heteroscedasticity-robust t-statistics are in parentheses. The symbols ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

and assets for the first $50 billion worth of assets. As briefly discussed before, all BHCs with less than $50 billion in assets take the value of their asset size, whereas BHCs with assets greater than $50 billion take the value of $50 billion. The second variable, named *>$50 billion*, takes a value of zero for all BHCs with less than $50 billion in assets, whereas it takes the actual asset size minus $50 billion for BHCs with greater than $50 billion worth of assets. In this way, the estimated coefficients on the piecewise specification are additive, and hence the sum of the two coefficients estimates the relation between asset size and holdings of highly rated tranches. We see banks' holdings of highly rated tranches increase as their size grows but only up to $50 billion. For banks that have more assets than $50 billion, the fraction of assets held in highly rated tranches does not increase with size beyond the fraction held by banks with $50 billion of assets.[21,22] In Panel A of Table 5, we also report F-statistics and associated p-values of a test on the equality of the two estimated coefficients on the size variables. The results indicate that the null hypothesis that the estimated coefficients are not different from each other can be rejected at the 1% level.

[21] We have also estimated the results with the piecewise variables in logs and found similar results when estimated in levels. When we include a continuous measure of size, the log of assets, the coefficient on log size is positive and significant in each specification.

[22] Given that we have only 20 banks with asset size larger than $50 billion, the t-statistic for this variable can be better approximated by a fat-tailed Student's t-distribution (see Imbens and Kolesar (2012) for an explanation of the Behrens–Fisher problem). The threshold t-statistics for 5% and 1% become 2.086 and 2.845, respectively. Using these thresholds, our conclusions on statistical significance remain similar.

An obvious concern is that asset size could be endogenous. As a bank switches from corporate bonds to highly rated tranches, its asset size increases if it makes full use of its existing regulatory capital. In Panel B of Table 5, we use the number of employees as our measure of size because none of the theories we discussed in Section 2 imply that holding more highly rated tranches is associated with having more employees. We see that holdings of highly rated tranches increase with the number of employees but do not increase more for banks with more than 10,000 employees.

With any attempt to estimate a nonlinear relation, one has to be concerned about whether the results are sensitive to the formulation. We do not tabulate the result, but when we use $100 billion as the inflexion point, we find that holdings increase with asset size less than $100 billion, but not with assets larger than $100 billion. Next, in Panel C of Table 5, we allow for a formulation with two inflexion points, one at $50 billion and one at $250 billion. We see no evidence that holdings increase more with assets for banks with holdings in excess of $250 billion. Further, we find that holdings decrease significantly when assets range between $50 billion and $250 billion for four of our measures. A final exercise using asset size is to use an indicator variable for banks with assets in excess of $50 billion or of $100 billion. When we use the indicator variable at $50 billion, our results show a positive and weakly significant relationship with our "bottom-up" measure of holdings, but not for the other measures of holdings (results presented in Panel D of Table 5). When we use the indicator variable for banks with assets in excess of $100 billion, we find that the coefficient on our broadest measure of holdings is positive and statistically significant at the 10% level, but the coefficients for the other measures are not significantly different from zero. Results are presented in Panel E of Table 5. A final approach to identify too-big-to-fail banks is to use the banks that were required to perform stress tests at the beginning of 2009. Panel F of Table 5 shows that these banks did not hold more highly rated tranches than did other banks.

Banks hold securities for liquidity purposes. We would expect large banks to hold fewer securities relative to assets than smaller banks do because there are economies of scale in the optimal size of liquidity buffers. Because of these economies of scale, increases in size beyond some level might not be associated with increases in the liquidity buffers. We find evidence consistent with this explanation. When we estimate our regressions using U.S. Treasuries instead of highly rated tranches (in untabulated results), we find the same relation. Hence, the demand for securities viewed as safe securities before the crisis exhibited the same pattern with respect to size, whether these securities were U.S. Treasuries or highly rated tranches of securitizations.

In summary, there is a relation between size and holdings of highly rated tranches. However, that relation is nonlinear, and there is no evidence that it is stronger for the largest banks. For most regressions, the results are insensitive to the measure of holdings we use. Therefore, for most measures, there is no evidence that more systemically important or so-called too-big-to-fail banks

held more highly rated tranches as a fraction of their assets. In regressions using indicator variables for assets in excess of $50 billion or in excess of $100 billion, these indicator variables are not significant for most of our measures. There is, however, some evidence that banks with more than $100 billion of assets held more highly rated tranches when we use the broader measure that treats SIVs as holdings of highly rated tranches. This evidence suggests that off-balance sheet vehicles may have played a unique role in holdings of highly rated tranches for the largest banks. Though holdings of these tranches through SIVs were undoubtedly a form of regulatory arbitrage, how they could have been the result of the incentives created by too-big-to-fail is not at all clear.

4.2 Securitization by-product hypothesis

We estimate the relation between holdings of the highly rated tranches as of December 31, 2006, and banks' securitization activity. We define a BHC as being securitization-active if the outstanding principal balance of assets sold and securitized with servicing retained or with recourse or other seller-provided credit enhancements is nonzero in any of the years 2003, 2004, 2005, or 2006. According to this definition, forty-nine BHCs in our sample are active in securitization as of December 31, 2006. Regressions, including the piecewise size variables and the standard set of controls employed in previous tables, are presented in Table 6. An important issue with these regressions is that some of our hypotheses apply more directly to holdings of tranches of its own securitizations by a given bank. Available data do not allow us to separate holdings of highly rated tranches issued by the bank from tranches purchased by the bank. Therefore, for some of our securitization hypotheses, our tests are subject to an additional measurement error in the left-hand side variable.

We estimate regressions of holdings of highly rated tranches on bank characteristics and an indicator variable for securitization-active banks. In Table 6, we report estimates in Columns (1) and (2), where we use the *Highly rated residual* and the *Highly rated residual + CDOs and writedowns + conduits and SIVs* measures of highly rated tranches. The securitization-active indicator variable has a significant positive coefficient in both regressions. The coefficient on the indicator variable is 0.015 in the first specification, so that these banks hold 1.5% more of their assets in the form of highly rated tranches. Such an effect is economically significant because the standard deviation of highly rated tranches holdings is 3.1%. The estimated coefficients on the stepwise size variables are diminished, but not wholly subsumed, by the presence of the securitization-active indicator, suggesting that securitization activity is not a manifestation of asset size alone. The results in the second specification, where the dependent variable includes CDOs, writedowns, and off-balance sheet conduits, are similar to those reported in Column (1). The regression estimates for other measures of highly rated tranches—that are not reported—are very similar to those reported in Columns (1) and (2).

Table 6
Securitization activity and holdings of highly rated tranches

	Measures of holdings of highly rated tranches								
	Highly rated residual	Highly rated residual + CDOs and writedowns + conduits and SIVs	Ratio of total agency holdings to assets	Highly rated residual	Highly rated residual + CDOs and writedowns + conduits and SIVs	Highly rated residual	Highly rated residual + CDOs and writedowns + conduits and SIVs	(Highly rated residual $\$_t$ - Highly rated residual $\$_{t-4}$)/ $Assets_{t-4}$	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Securitization-active indicator	0.015**	0.017**	−0.009						
	(2.196)	(2.428)	(−0.605)						
Securitization-league-table indicator				0.014	0.020				
				(0.446)	(0.569)				
Securitization-league-table rank						0.010	0.013*		
						(1.484)	(1.859)		
(Sec. $\$_t$ - Sec $\$_{t-4}$)/$Assets_{t-4}$								0.003*	
								(1.69)	
(Mortgage Sec. $\$_t$ - Mortgage Sec. $\$_{t-4}$)/$Assets_{t-4}$									0.003*
									(1.96)
$0-$50 Billion	0.523*	0.719**	−0.499	0.708**	0.916***	0.656**	0.852***	0.147*	0.147*
	(1.907)	(2.378)	(−1.223)	(2.149)	(2.677)	(2.132)	(2.659)	(1.66)	(1.67)
>$50 Billion	−0.068*	−0.053	−0.024	−0.065*	−0.048	−0.097**	−0.092*	−0.010	−0.010
	(−1.670)	(−1.101)	(−1.138)	(−1.673)	(−1.081)	(−2.272)	(−1.921)	(1.11)	(1.11)
"Other" H.T.M. and A.F.S. securities	0.031	0.028		0.030	0.029	0.033	0.032	−0.001	−0.001
	(1.243)	(1.167)		(1.334)	(1.285)	(1.390)	(1.374)	(0.14)	(0.14)
"Other" trading securities	0.386	0.426		0.315	0.323	0.208	0.187	0.053	0.053
	(1.093)	(1.047)		(0.970)	(0.906)	(0.790)	(0.677)	(1.14)	(1.14)
Prior returns	−0.004	−0.001	−0.063	−0.005	−0.003	−0.008	−0.006	−0.007*	−0.007*
	(−0.398)	(−0.115)	(−1.442)	(−0.519)	(−0.272)	(−0.769)	(−0.590)	(1.87)	(1.87)
Market-to-book	0.004*	0.004*	0.017**	0.004	0.003	0.004*	0.004	0.003**	0.003**
	(1.838)	(1.663)	(2.210)	(1.609)	(1.377)	(1.778)	(1.625)	(2.42)	(2.43)
Assets/ Tier 1 capital	0.002	0.002	0.004	0.002	0.002	0.001	0.001	0.000	0.000
	(1.416)	(1.438)	(1.131)	(1.132)	(1.103)	(0.977)	(0.910)	(1.17)	(1.17)
Constant	−0.027	−0.031	0.127	−0.020	−0.023	−0.025	−0.029	−0.001	−0.001
	(−1.199)	(−1.353)	(1.555)	(−0.842)	(−0.926)	(−1.158)	(−1.346)	(0.21)	(0.22)
Observations	225	225	225	225	225	225	225	3723	3724
Adjusted R-squared	0.176	0.264	0.023	0.154	0.242	0.182	0.284	0.023	0.023

This table tabulates the results of an OLS regression of our measures of highly rated holdings on variables measuring a bank's securitization activity. The *Securitization-active indicator* variable in Columns (1)–(3) is equal to one if the outstanding principle balance of assets sold and securitized with servicing retained or with recourse or other seller-provided credit enhancements is greater than zero. The *Securitization-league-table indicator* in Columns (4) and (5) is equal to one for any BHC that was involved in the underwriting of any type of securitization. *Securitization-league-table rank* in Columns (6) and (7) is equal to the rank of BHC in the league tables of the securitization underwriting, with the minimum of one and maximum of ten. The dependent variable in Columns (8) and (9), "(Highly rated residual $\$_t$– Highly rated residual $\$_{t-4}$)/$Assets_{t-4}$," measures year-over-year changes in the amount of holdings of highly rated tranches, sampled quarterly from 2002 Q1 through 2006 Q4 (see Appendix A, Panel A for a detailed description of the construction of the *Highly rated residual* variable). The variable "(Sec. $\$_t$– Sec. $\$_{t-4}$)/$Assets_{t-4}$" in Column (5) is sampled quarterly and is calculated as the year-over-year change in the total amount of the outstanding principle balance of assets sold and securitized with servicing retained or with recourse or other seller-provided credit enhancements. The variable "(Mortgage Sec. $\$_t$- Mortgage Sec. $\$_{t-4}$)/$Assets_{t-4}$" in Column (6) is sampled quarterly and is calculated as the year-over-year change in the amount of the outstanding principle balance of mortgage assets (1–4 family residential loans and home-equity lines of credit) sold and securitized with servicing retained or with recourse or other seller-provided credit enhancements. Control variables are defined in Appendix A. The sample contains the cross-section of publicly traded U.S. BHCs with relevant data as of December 2006. Heteroscedasticity-robust *t*-statistics are in parentheses. Standard errors used to compute the *t*-statistics reported in Columns 7 and 8 are clustered by year-quarter and by bank. The symbols ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

In Regression (3) of Table 6, we provide a falsification test. The securitization hypothesis does not predict a relation between securitization activity and holdings of agency mortgage-backed securities. We therefore regress the ratio of total agency holdings to assets on the control variables and on the securitization-active indicator. The coefficient on the securitization active indicator is not statistically significantly different from zero in explaining holdings of agency securities.

The measure of securitization we use is a measure based on a bank's own securitization activities. Alternatively, we could use a measure of the participation of banks in the underwriting of securitizations. To do so, we create an indicator variable for any BHC that shows up in the underwriter league tables of any type of securitizations, including subprime RMBSs, CLOs, CBOs, and CDOs ("Securitization-league-table indicator").[23] Out of 231 banks in our December 2006 sample, ten banks meet the criterion. We show the regression estimates with this measure in Columns (4) and (5) of Table 6. We find that these estimates are positive, but not statistically significant. In regressions (6) and (7), we use the rank of the underwriter in the league tables, with the minimum of one and maximum of ten. Banks not in the securitization league tables take a value of zero. The coefficient is positive in both specifications, and it is statistically significant when we use our broadest measure of holdings on the left-hand side.

One concern with the securitization results presented thus far is that the securitization-active indicator variable could be correlated with bank characteristics that are not controlled for in regressions (1) and (2). To address this possibility, we estimate regressions of changes in holdings of highly rated tranches on changes in the level of securitization activity since 2002. The use of changes has the advantage of helping account for the possibility of an omitted variable bias in the estimates on the securitization-active indicator reported in Columns (1) and (2) of Table 6. Pervasive unobserved attributes at the bank level are less likely to be correlated with time-series changes in the variables of interest. Consequently, we expect the relation between the changes to be a more precise estimate of the true relationship between securitization activity and holdings of highly rated tranches.

For the regressions using changes in holdings of highly rated tranches, we can only use our narrow measure as the other measures are not available consistently over time (except for the bottom-up measure). For that purpose, we estimate regressions of the year-over-year change in holdings of these tranches on the year-over-year changes in the outstanding principal balance of assets sold or securitized (with servicing retained or with recourse). We use quarterly data from the first quarter of 2002 to the last quarter of 2006 and normalize the change in holdings of highly rated tranches or outstanding

[23] Data source is Moody's eMaxx Data Services.

balance of securitizations from time $t-4$ to t, using assets as of $t-4$. Results are reported in Column (8) of Table 6. Standard errors are corrected for clustering of observations at the bank and quarter level. The coefficient on the ratio of the change in securitization over lagged assets is positive and significant at the 10% level. In regression (9), the last regression of the Table 6, we focus on the outstanding principal balance of only mortgages sold or securitized and find similar results.

Figure 1 shows that the aggregate dollar holdings of highly rated tranches experienced an especially sharp increase from the last quarter of 2006 to the last quarter of 2007. This increase is supportive of the hypothesis that banks accumulated highly rated tranches rapidly as the market turned because they had trouble selling these tranches. However, even though the aggregate amount of highly rated tranches increased the most from 2006 to 2007, total assets increased as well, so that the large dollar increase is not accompanied by a noticeable increase in percentage holdings. Consequently, the evidence on percentage holdings does not support the view that banks accumulated holdings at a rapid pace in 2007. Their behavior is consistent with having kept their allocation to highly rated tranches roughly constant.

Finally, given our results, the increase in holdings of highly rated tranches should be concentrated among securitization-active banks. In Figure 2, we plot the holdings of highly rated tranches through time separately for securitization-active banks and nonsecuritization active banks. In 2006, securitization active banks had highly rated tranches holdings of 3.1% in comparison to holdings of 0.8% for other banks. For the securitization-active banks, holdings of highly rated tranches increased from 2.1% of total assets in Q1 2002 to 3.3% in Q1 2007, whereas highly rated holdings for the nonactive banks remained virtually unchanged over the same period. A formal test of the 1.2% difference in highly rated holdings between Q1 2002 and Q1 2007 for securitization-active banks yields a t-statistic of 1.30.

As discussed in Section 1, the traditional skin-in-the-game hypothesis would suggest that banks engaged in securitization would hold the most junior tranches of their securitizations. We used the BHC data to try to estimate the holdings of lower-rated tranches. The estimates we obtain suffer from a number of drawbacks that lead us to not present them. However, no matter which choices we make in constructing these estimates, holdings of lower-rated tranches were economically trivial for banks—they could have lost all their investment and not be meaningfully affected—and holdings of highly rated tranches dwarf holdings of lower-rated tranches.

Our analysis is strongly supportive of the hypothesis that banks engaged in securitization held more highly rated tranches (Securitization H1) and the hypothesis that holdings of highly rated tranches increased over time with securitization activity (Securitization H2). We find at best weak evidence that holdings of highly rated tranches for firms active in securitization increased more in 2007 (Securitization H3).

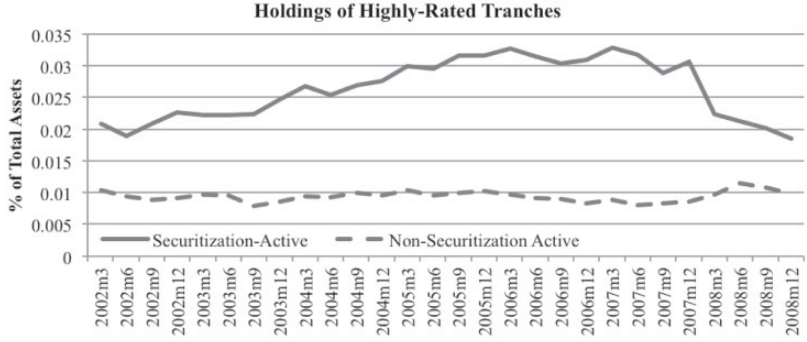

Figure 2
Time-series plot of holdings of highly rated tranches as a percent of total assets
This figure plots the holdings of highly rated tranches as a percent of total assets through time. The sample includes all U.S. publicly traded bank holding companies (BHCs). Banks are deemed "securitization active" if the outstanding principle balance of assets sold and securitized with servicing retained or with recourse or other seller-provided credit enhancements is greater than zero in any quarter within the years 2003–2006. Forty-six banks meet this criterion as of January 2002. The remaining banks are characterized as "nonsecuritization active."

4.3 Regulatory arbitrage

Acharya and Richardson (2009) argue that BHCs find holding highly rated assets advantageous as a form of regulatory capital arbitrage. Regulatory arbitrage occurs because banks have to hold less regulatory capital if, for example, mortgage loans on the balance sheet are transformed into AAA-rated bonds via securitization. Also, as discussed earlier, regulatory arbitrage might have favored holdings of highly rated tranches simply because they had higher yields than other securities with similar capital requirements. With this view, we could see the type of relation between securitization and holdings of highly rated tranches documented in the previous section. Transforming mortgages into highly rated securities can also result in a cheaper source of funding for BHCs through asset-backed commercial paper programs, where commercial paper is issued at a lower cost because it is collateralized by highly rated securities (see Acharya, Schnabl, and Suarez 2013). Finally, Acharya, Schnabl, and Suarez (2013) show that structured investment vehicles were a form of regulatory arbitrage that enabled banks to hold various assets, including highly rated tranches, with almost no regulatory capital. To implement this regulatory arbitrage, banks did not have to hold highly rated tranches on their balance sheet. However, banks that engaged in regulatory arbitrage through SIVs might have held more highly rated tranches on their balance sheets as an inventory available for their SIVs.

We find that eleven bank holding companies sponsored conduits or SIVs in our estimation sample.[24] To investigate the regulatory-arbitrage hypothesis,

[24] Out of eleven BHCs that sponsored off-balance sheet conduits in general, only one, Citigroup, was affiliated with SIVs as a specific type of conduit.

we first test whether a *Conduit dummy* identifying these banks is correlated with holdings of highly rated tranches. As shown in Column (1) of Table 7, the coefficient on the indicator variable for conduits is not statistically different from zero when we use the *Highly rated residual* measure of holdings and have the same controls as in our previous regressions. Not surprisingly, given the result in Column (1), the coefficient is significant in regression (2), when we use our broadest measure, which adds the holdings of off-balance-sheet conduits to on-balance-sheet holdings of highly rated tranches. In other words, holdings of highly rated tranches through conduits did not substitute for on-balance-sheet holdings but were incremental. Notably, however, our measure of holdings through conduits is an upper bound as not all conduit assets were highly rated tranches of securitizations.

We examine next whether BHCs' issuance or sponsoring of asset-backed commercial paper is related to their holdings of highly rated tranches. We construct an indicator variable for all BHCs engaged in any ABCP activity in years 2003–2006, either through direct issuance or through sponsoring credit enhancements in ABCP issuance. In our sample, there are fifteen BHCs in 2006 for which *ABCP activity indicator* is equal to one. Because banks with conduits have ABCP programs, there is considerable overlap between the ABCP indicator variable and the conduit indicator variable. Regressions (3) and (4) show that the coefficients on the ABCP indicator variable are insignificant and are of small economic magnitude. The coefficients on the control variables are mostly consistent with results in previous tables. Estimates of the coefficient on asset size for the first $50 billion of asset size remain quantitatively similar to previous tables, but are not significant in the ABCP specification. If the existence of an ABCP program is a good proxy for a bank's propensity to engage in regulatory arbitrage, that propensity does not seem to be correlated with holdings of highly rated tranches.

We develop an alternative measure of a BHC's propensity to engage in regulatory arbitrage that does not rely on ABCP activity. The rule change of 2001 for capital requirements for tranches of securitizations discussed earlier provides an opportunity to identify BHCs with a propensity to engage in regulatory arbitrage. Although the final rule took effect in January 2002, banks were allowed to delay the application of the rule until December 2002. We consider whether a BHC's use of regulatory-capital arbitrage opportunities arising from the ratings-based capital requirements has any power in predicting its holdings of highly rated tranches in subsequent years. To do so, we calculate the change in leverage, namely, the change in assets over Tier 1 capital, for each BHC in our sample from the fourth quarter of 2000 to the fourth quarter of 2002 and hypothesize that BHCs with the largest change in leverage surrounding the event are those with a higher propensity to engage in regulatory capital arbitrage. This test assumes that banks took active steps to increase their leverage as a result of lower capital requirements, with the caveat that other factors might have affected the change in leverage in this time period. An

Table 7
Regulatory capital arbitrage and holdings of highly rated tranches

	Measures of holdings of highly rated tranches							
	Highly rated residual	Highly rated residual + CDOs and writedowns + conduits and SIVs	Highly rated residual	Highly rated residual + CDOs and writedowns + conduits and SIVs	Highly rated residual	Highly rated residual + CDOs and writedowns + conduits and SIVs	Highly rated residual	Highly rated residual + CDOs and writedowns + conduits and SIVs
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Conduit indicator	0.012	0.052*						
	(0.446)	(1.911)						
ABCP activity indicator			0.008	0.036				
			(0.349)	(1.401)				
Change in leverage, 2000 Q4 – 2002 Q4					0.002	0.001		
					(1.342)	(0.817)		
Market risk equivalent bank indicator							0.015	0.010
							(0.576)	(0.354)
$0-$50 Billion	0.694**	0.692*	0.684*	0.662	0.747*	1.009**	0.632	0.909**
	(1.976)	(1.960)	(1.679)	(1.614)	(1.949)	(2.482)	(1.582)	(2.208)
>$50 Billion	−0.068*	−0.060	−0.065	−0.046	−0.065	−0.049	−0.066*	−0.050
	(−1.675)	(−1.440)	(−1.648)	(−1.056)	(−1.622)	(−1.052)	(−1.667)	(−1.061)
“Other” H.T.M. and A.F.S. securities	0.029	0.030	0.028	0.026	−0.001	−0.002	0.028	0.026
	(1.227)	(1.243)	(1.151)	(1.065)	(−0.0331)	(−0.0604)	(1.163)	(1.066)
“Other” trading securities	0.359	0.312	0.349	0.275	0.356	0.393	0.322	0.383
	(1.079)	(0.924)	(1.069)	(0.815)	(1.023)	(0.980)	(1.047)	(1.030)
Prior returns	−0.005	−0.006	−0.005	−0.005	−0.011	−0.003	−0.005	−0.002
	(−0.515)	(−0.611)	(−0.490)	(−0.499)	(−0.806)	(−0.246)	(−0.460)	(−0.145)
Market-to-book	0.004	0.004	0.003	0.003	0.007	0.006	0.003	0.003
	(1.607)	(1.613)	(1.500)	(1.257)	(1.408)	(1.113)	(1.493)	(1.225)
Assets/ Tier 1 capital	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
	(1.212)	(1.159)	(1.320)	(1.395)	(0.818)	(0.923)	(1.290)	(1.281)
Constant	−0.020	−0.018	−0.020	−0.020	−0.017	−0.027	−0.020	−0.025
	(−0.861)	(−0.783)	(−0.858)	(−0.825)	(−0.491)	(−0.754)	(−0.874)	(−1.012)
Observations	225	225	225	225	140	140	225	225
Adjusted R-squared	0.153	0.290	0.152	0.265	0.141	0.227	0.156	0.238

This table tabulates the results of an OLS regression of our measures of highly rated holdings on proxies identifying banks that are likely to engage in regulatory-capital arbitrage activities. These proxies are an off-balance sheet conduit indicator, an asset-backed commercial paper (ABCP) activity indicator, change in leverage around the regulation change in 2001, and an indicator variable for banks that are subject to market-risk-equivalent capital rules. The construction of each of these variables, dependent variables, and controls are detailed in Appendix A. The sample contains the cross-section of publicly traded U.S. BHCs with relevant data as of December 2006. Heteroscedasticity-robust *t*-statistics are in parentheses. The symbols ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

obvious concern with this test is that there are many reasons why leverage might have increased around the regulatory change, so that our proxy is noisy.

Columns (5) and (6) of Table 7 regress the holdings of highly rated tranches in December 2006 as a function of the change in leverage from 2000 Q4 to 2002 Q4. If banks that took advantage of the change to increase their leverage are those that engage in regulatory arbitrage, we should see a positive relation between holdings of highly rated tranches and the change in leverage around the regulatory change. The change-in-leverage variable is positively related to holdings of highly rated tranches, but the coefficient is not statistically significant.

There has been much discussion that the market risk amendment to the Basel Accord allows banks to hold highly rated tranches in their trading book with very little regulatory capital compared with banks that can only hold the tranches in their banking book. However, as discussed earlier, banks with a trading book might have been holding more highly rated tranches to have an inventory for market-making purposes. The final two regressions of Table 7 use an indicator variable (*Market risk equivalent bank indicator*) for banks that had the right to use their own value-at-risk model to satisfy capital requirements on their trading book.[25] We find no evidence that these banks held more highly rated tranches. We estimate (but do not tabulate) the same regression without the size variables. Without the size variables, the indicator variable is significant, but the R^2 of the regression drops by half. The significance of the size variables is not affected by the presence of the market risk indicator, and the inclusion of the market risk indicator has only a trivial impact on the R^2.

As discussed in Section 2, we would expect banks for which regulatory capital is considered to be more expensive to engage in regulatory arbitrage. Further, we would expect banks that are expected to be subject to more regulatory scrutiny to engage in less regulatory arbitrage. These considerations suggest that banks with large amounts of regulatory capital are unlikely to engage in regulatory arbitrage, whereas banks with smaller amounts would do so as long as their regulatory capital is not so low that it attracts regulatory scrutiny. As seen in Tables 2, 6, and 7, assets/Tier 1 capital do not have a significant coefficient when we include other explanatory variables, implying that banks that are more constrained in regulatory capital do not seem to be holding more highly rated tranches (Regulatory Arbitrage H1).[26] Admittedly, assets/Tier 1 capital is a noisy measure of the extent to which a bank is constrained with respect

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[25] A BHC is subject to the market risk capital guidelines and is thus able to use its own estimates of value-at-risk in calculating capital requirements, if its consolidated trading activity, defined as the sum of trading assets and liabilities for the previous quarter, equals (1) 10% or more of the BHCs total assets for the previous quarter or (2) $1 billion or more. The Federal Reserve may include or exempt a BHC as it feels appropriate. Our December 2006 sample of 231 BHCs includes fourteen BHCs that meet the market risk capital guidelines.

[26] As a simple test to allow for the possibility that banks with low regulatory capital are subject to more regulatory scrutiny, we re-estimate our regressions eliminating the banks with low Assets/Tier 1 ratios. The coefficient on regulatory capital is unchanged.

to regulatory capital. First, regulators could require some BHCs to hold more than 4% of Tier 1 capital. Hence, if the BHCs engaged in securitization tend to have higher capital requirements imposed on them by the regulators, they might have a lower cushion. Second, there are multiple capital requirements, so that the one we focus on might not be the binding one for a BHC in our sample, giving the illusion that the BHC has a large cushion when it does not.

Finally, we consider the possibility of BHCs having engaged in regulatory arbitrage through the securitization channel itself. From a regulatory capital standpoint, holding a portfolio of mortgages in the form of highly rated securitizations is cheaper for banks than for them to hold an unsecuritized portfolio of mortgages. This is because AAA-rated securitizations, for example, carry a 20% risk-weighting, whereas unsecuritized subprime mortgages carry a 50% risk weight. As such, securitization activity could be an efficient mechanism to transform an expensive portfolio from a regulatory standpoint into a cheaper portfolio.

We provide two pieces of evidence that indicate that banks engaged in securitization did not engage more aggressively in regulatory arbitrage on their balance sheets than did other banks (as opposed to the off-balance-sheet mechanisms documented by Acharya, Schnabl, and Suarez (2013)). First, we examine whether levels of regulatory capital were overly aggressive among securitization-active banks. For each BHC, we calculate the regulatory "cushion," which is the ratio of Tier 1 capital to risk-weighted assets, minus the regulatory Tier 1 requirement of 4%. This measure is subject to the caveats discussed previously about measuring regulatory capital constraints for banks. We plot the results in Figure 3. Although securitization-active BHCs do, on average, exhibit a lower regulatory capital cushion, the cushion is neither close to the regulatory boundary nor does it change through time as would be expected of a BHC wanting to push the boundaries of regulatory capital through increased securitization activity.

A second piece of evidence comes from examining the ratio of total assets to risk-weighted assets. To control for bank size, we create a size-based matched sample of securitization-active and non-securitization-active banks and plot the ratio of total assets to risk-weighted assets in Figure 4. A securitization-driven regulatory arbitrage hypothesis predicts that securitization-active banks would amass more total assets for a given level of risk-weighted assets than non-securitization-active banks. Figure 4 demonstrates that the data do not support this view. Rather, securitization-active banks have a lower ratio of total assets to risk-weighted assets than do their counterparts of roughly equal size. Taken together, we interpret the results as being consistent with the view that securitization activity itself, without associated off-balance sheet activity, was not the primary mechanism facilitating regulatory capital arbitrage.

Overall, our evidence provides little support for the hypothesis that banks that engaged more in regulatory arbitrage activities had larger holdings of highly rated tranches on their balance sheet (Regulatory Arbitrage H2). But

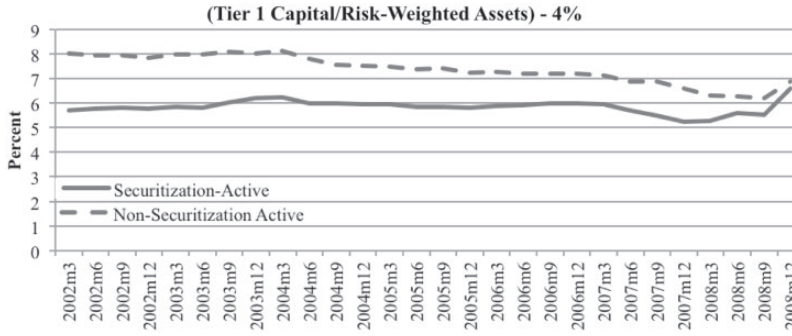

Figure 3
Time-series plot of regulatory "cushion"
This figure plots the regulatory "cushion" of all U.S. publicly traded bank holding companies (BHCs). The regulatory cushion is calculated as the ratio of Tier 1 capital to risk-weighted assets, minus 4%. Banks are deemed "securitization active" if the outstanding principle balance of assets sold and securitized with servicing retained or with recourse or other seller-provided credit enhancements is greater than zero in any quarter within the years 2003–2006. Forty-six banks meet this criterion as of January 2002. The remaining banks are characterized as "nonsecuritization active."

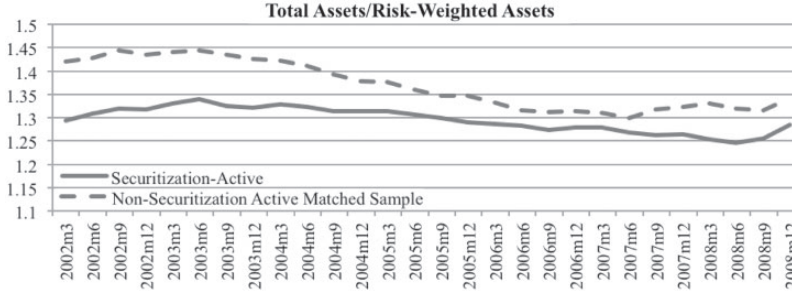

Figure 4
Time-series plot of total assets to risk-weighted assets
This figure plots the ratio of total assets to risk-weighted assets using a sample of U.S. publicly traded bank holding companies (BHCs). The sample includes all securitization-active BHCs and a size-based matched sample of nonsecuritization active BHCs. Banks are deemed "securitization active" if the outstanding principle balance of assets sold and securitized with servicing retained or with recourse or other seller-provided credit enhancements is greater than zero in any quarter within the years 2003–2006.

it is consistent with the view that the use of off-balance-sheet vehicles to hold highly rated tranches to take advantage of lower capital requirements led to higher holdings of highly rated tranches.

4.4 Other possible explanations

The poor incentives hypothesis argues that banks had compensation plans that made playing the carry trade (holding positions in highly rated tranches while borrowing at the firm's cost of funds) and taking nontransparent tail risks advantageous for managers and traders. In this section, we add proxies for

poor incentives to our regressions. Notably, however, endogeneity problems are pervasive through these regressions, so that one should be wary of interpreting them as explaining causal relations. The key issue is that holdings of highly rated tranches and incentives might be determined simultaneously or they might be determined by other variables that we do not include in our regressions. For instance, a bank that has chosen to invest heavily in highly rated tranches may require different governance or different risk management than does a bank that has chosen not to invest in these tranches. This issue could mean that the coefficients on our proxies for incentives are biased. Another source of bias for the coefficients on the incentive proxies is that these proxies are measured with error.

We would expect that poor incentives are more likely to exist in banks with poor governance. To test whether there is a correlation between firm-level governance and holdings of highly rated tranches, we use a *Governance index* that increases with the protection of minority shareholders (see Aggarwal et al. (2011) for a detailed explanation of the index). We find no relation between holdings of highly rated tranches and a bank's governance index as of 2006 (see the first regression of Table 8).

These poor incentives could be at lower levels of a bank—say at the trader level—or at the top level. The data on compensation contracts below the top five officers of banks is not available. However, we would expect the incentive problems due to traders' compensation to arise in banks that have trading operations. Regressions (7) and (8) of Table 7 show that there is no evidence that banks with larger trading portfolios have more highly rated tranches. In untabulated results, we also re-estimate the regressions of Table 7 with an indicator variable for any bank with nonzero trading assets and still find no significance for the trading-asset indicator variable.

We construct several measures of properties of the CEO's compensation and test whether these measures can explain differences in holdings of highly rated tranches (see Table A2 for a detailed description of the managerial-compensation measures). Results are presented in Table 8. Our first measure calculates the elasticity of total managerial compensation to a BHC's return on equity, where the ROE is calculated as net income divided by total common equity as of the fiscal year-end.[27] ROE is a performance measure that is not risk adjusted, and it does not account for the cost of equity. Therefore, a bank's ROE can be increased through carry-trade positions and with leverage. Highly rated tranches had higher yields than did other similarly rated securities. Hence, to the extent that these tranches bolster non-risk-adjusted firm performance, managers with a higher elasticity of compensation to non-risk-adjusted performance would find holding more highly rated tranches advantageous. The second

[27] The numerator of the compensation-ROE elasticity is calculated as the change in compensation from 2001–2006 divided by 2001 levels of compensation. The denominator is calculated as the change in ROE from 2001–2006 divided by 2001. ROE details are provided in the Appendix.

Table 8
Other possible explanations for holdings of highly rated tranches

	Highly rated residual measure of holdings of highly rated tranches							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Governance index	−0.013							
	(−0.688)							
High-compensation elasticity		−0.005						
		(−1.181)						
Compensation residual			0.001					
			(0.692)					
Bonus-per-salary				−0.002				
				(−0.677)				
Equity risk (%)					0.009			
					(0.472)			
Dollar gain from +1%						−0.000		
						(−0.0473)		
CEO ownership %							0.009	
							(0.631)	
Risk management index								−0.019
								(−0.597)
$0-$50 Billion	0.796**	0.819**	0.783**	0.846**	0.766**	0.761**	0.787**	0.917
	(2.372)	(2.512)	(2.463)	(2.463)	(2.382)	(2.379)	(2.450)	(1.173)
>$50 Billion	−0.067	−0.066	−0.067	−0.062	−0.068*	−0.068*	−0.067*	−0.054
	(−1.622)	(−1.617)	(−1.640)	(−1.585)	(−1.681)	(−1.677)	(−1.654)	(−1.171)
"Other" H.T.M. and A.F.S. securities	0.026	0.028	0.025	0.027	0.024	0.024	0.026	0.022
	(1.047)	(1.098)	(1.009)	(1.074)	(0.886)	(0.864)	(0.999)	(0.232)
"Other" trading securities	0.393	0.368	0.371	0.440	0.366	0.367	0.372	0.139
	(1.109)	(1.044)	(1.065)	(1.262)	(1.070)	(1.070)	(1.070)	(0.621)
Prior returns	−0.005	−0.004	−0.003	−0.002	−0.005	−0.006	−0.004	−0.026
	(−0.497)	(−0.411)	(−0.295)	(−0.187)	(−0.397)	(−0.431)	(−0.349)	(−0.651)
Market-to-book	0.004	0.004	0.004	0.004*	0.006*	0.006*	0.004	0.005
	(1.591)	(1.516)	(1.370)	(1.794)	(1.736)	(1.748)	(1.606)	(0.704)
Assets/Tier 1 capital	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.007
	(1.263)	(1.260)	(1.352)	(1.459)	(1.497)	(1.441)	(1.415)	(1.107)
Constant	−0.013	−0.019	−0.026	−0.028	−0.034	−0.032	−0.027	−0.067
	(−0.651)	(−0.853)	(−1.112)	(−1.180)	(−1.185)	(−1.119)	(−1.104)	(−0.792)
Observations	222	219	218	214	192	192	212	61
Adjusted R-squared	0.150	0.161	0.157	0.160	0.158	0.158	0.157	0.039

This table tabulates the results of an OLS regression of our measures of highly rated holdings on various proxies of managerial incentives. The construction of each dependent and independent variable is detailed in Appendix A. The sample contains the cross-section of publicly traded U.S. BHCs with relevant data as of Dec 2006. Heteroscedasticity-robust t-statistics are in parentheses. The symbols ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

regression of Table 8 reports the relation between holdings of highly rated tranches and our elasticity measure. The elasticity variable named *High-compensation elasticity* is equal to one for firms with above-median elasticity of the CEO's total compensation to changes in bank ROE. The relation between holdings and this compensation elasticity is negative, and it lacks statistical significance.

We also consider alternative measures or characteristics of managerial compensation in Columns (3) to (5) of Table 8. First, we examine whether highly rated tranches are larger in banks in which the CEO earns more than CEOs at other banks of similar size. *Compensation residual* (see Cheng, Hong, and Scheinkman 2010) is constructed by computing the natural logarithm (log) of average total compensation from 2003 to 2006. This log average compensation is then regressed on the log of the firm's 2006 market cap. The residual from this regression, estimated in 2006, serves as the compensation residual variable in our cross-sectional regressions of highly rated holdings in 2006. Second, many observers have argued that the so-called bonus culture led to excessive risk taking. The *Bonus-per-salary* variable is calculated as the ratio of the CEO's total bonus to his base salary. Lastly, to test the correlation with option-like features, *Equity Risk* measures the sensitivity of CEO's compensation to volatility.[28] Results indicate virtually no statistically significant relationship between these compensation variables and holdings of highly rated tranches. The standard set of control variables exhibits their usual signs, magnitudes, and significance.

Regressions (6) and (7) of Table 8 investigate the relation between holdings of highly rated tranches and equity incentives of CEOs. The coefficients on our estimates of equity incentives of CEOs are insignificant. In other words, the banks of CEOs with more incentives to maximize shareholder wealth did not hold more or fewer highly rated tranches than did other banks.

In summary, our results are not supportive of the "incentives" hypotheses. One concern is that, given possible errors of measurement in incentive measures, our approach does not have enough power to find a role for incentives. However, for our sample, we find in untabulated regressions that there is a significant negative relation between leverage and managerial ownership or the sensitivity of managerial wealth to the stock price. Given that managerial ownership seems to have a relation with a proxy for risk taking for our sample banks, our results on incentives cannot be wholly attributed to our proxies being inadequate. Further, these proxies have been widely used in the literature and found to be significantly related to a variety of firm policies and to firm valuation.

To investigate whether there is evidence supporting the risk management failure hypothesis, we use the index developed by Ellul and Yerramilli (2013) to

[28] See, for example, Bebchuk and Spamann (2010) for the impact of options on risk-taking incentives.

measure the centrality and independence of risk management within banks. The Risk Management Index (RMI) is available for sixty-one banks in our sample; therefore, the power of our tests is reduced. Smaller banks typically do not have disclosures on the risk management function. The index is a function of whether a bank has a chief risk officer (CRO), whether the CRO is an officer, whether the CRO is one of the top five most highly paid executives, the ratio of the pay of the CRO to the pay of the CEO, the bank's board has an experienced risk committee, the frequency of meetings of the risk committee, and whether the key management-level risk committee reports directly to the board. As the RMI increases, the authors conclude that risk management is more central and more independent in a bank. The last regression presented in Table 8 shows that the index has a negative coefficient, but it is not significant. The interpretation of this result, in our admittedly small sample, is that there is no evidence that the organization of risk management was related to holdings of highly rated tranches.

5. Conclusion

In this paper, we estimate holdings of highly rated tranches of U.S. commercial banks at the end of 2006. We use five different approaches to estimate these holdings on balance sheet as well as off balance sheet and the different approaches lead to similar conclusions. Using a sample of 231 publicly traded U.S. bank holding companies, we find that there is considerable cross-sectional variation in holdings of highly rated tranches of securitizations and that the bulk of the dollar holdings was held by some large banks. The fact that the dollar holdings were concentrated among a handful of banks and that most banks held only an economically trivial amount of highly rated tranches inherently limits the extent of our econometric investigation and what we can learn from our dataset about the determinants of the holdings of the largest banks. The average of the holdings across the banking sector was only 1.3% of assets, but the average of the holdings for the banks with large trading positions was almost 5% or even 10% when we include holdings in off-balance-sheet conduits and SIVs. Yet, even among these banks, there was wide dispersion in holdings. For instance, our estimate of holdings that ignores off-balance-sheet holdings for JP Morgan Chase is less than 1% of assets, but Citigroup had holdings in excess of 5%. When we take into account off-balance-sheet holdings, Citigroup's holdings increase to 11%, whereas JP Morgan Chase holds 4%.

We find that the variation in holdings of highly rated tranches is correlated with the securitization activities of banks. We provide a number of reasons why banks engaged in securitization would have invested more in highly rated tranches. For such banks, holding highly rated tranches could be a way to show that they had skin in the game. Also, banks engaged in securitizations had to hold highly rated tranches as a part of the securitization activities, as these banks made markets in highly rated tranches or held these tranches as inventories. Furthermore, banks that were involved in securitization were better

placed to assess the pricing and risk of highly rated tranches, so that investing in these securities was likely cheaper and easier for them. Consistent with the hypothesis that banks engaged in securitization held more highly rated tranches, we find that banks that were active in securitization between 2003 and 2006, through either origination or providing credit enhancements, held 1.5% larger amounts of highly rated tranches as a fraction of total assets as of December 31, 2006 than the other banks did. Further, we find that holdings of highly rated tranches increased over time for banks as their securitization activities increased. Although our empirical evidence strongly supports the hypothesis that banks engaged in securitizations held more highly rated tranches, because of data limitations, we cannot distinguish among the various reasons why securitization-active banks held more highly rated tranches.

We investigate many of the other hypotheses that have been advanced to explain holdings of highly rated tranches by banks. In regressions, we find that the fraction of a bank's assets invested in highly rated tranches increases with asset size up to some threshold. For the largest banks, this fraction does not increase with asset size. This evidence suggests that the most systemically important banks did not invest a larger fraction of their assets in highly rated tranches than the other large banks did. We find similar results using the number of employees instead of bank assets.

To the extent that regulatory arbitrage motivates banks to securitize, the relation we find between securitization and holdings of highly rated tranches could be evidence of the role of regulatory arbitrage in holdings of highly rated tranches. Although we find that banks engaged in regulatory arbitrage through SIVs held more highly rated tranches when we assume that SIVs and conduits invested only in highly rated tranches, we do not find support for other implications of the regulatory arbitrage hypothesis. In particular, there is no significant correlation between banks' ABCP programs and their holdings of highly rated tranches. If banks that engage the most in regulatory arbitrage are banks that have less slack in terms of regulatory capital than other banks, we show that banks that engaged in securitization do not meet that criterion. It is often argued that banks used the more advantageous capital requirements of the trading book for the purpose of regulatory arbitrage. However, controlling for size, we do not find that these banks with large trading books held more highly rated tranches of securitizations. Lastly, we explore the "bad incentives" and "risk management failure" explanations for holdings of highly rated tranches. None of our evidence supports the hypothesis that banks with worse incentives held more highly rated tranches or the hypothesis that holdings of these tranches were related to observable characteristics of the organization of risk management.

We find that there is a strong correlation between a bank's securitization activity and its holdings of highly rated tranches. This correlation holds both in cross-sectional regressions and in panel regressions. Our investigation provides little support for explanations for the holdings of highly rated tranches that do not use securitization activity as a motivation for these holdings.

Appendix

Table A1
Dependent variables

Variable name	Schedule	Data mnemonic
Highly rated residual: Sum of nongovernment or nonagency mortgage-backed securities (MBSs) as well as asset-backed securities (ABSs) that are rated in the highest three investment-grade (e.g., AAA, AA, or A) categories and nongovernment, nonagency MBSs in trading securities. The measure includes held-to-maturity (HTM) and available-for-sale (AFS) securities with 20% or 50% risk weight minus securities in 20% or 50% risk-weight category that are issued or guaranteed by the government or government-sponsored agencies. All values are at amortized costs, except for MBSs, from trading assets that are recorded at fair values.	Schedules from Form FR Y-9C as of December 2006: HC-R Item 35 (Column D) + Item 35 (Column E) + Item 36 (Column D) + Item 36 (Column E) – HC-B Item 2b (Columns A+C) – Item 4a2 (Columns A+C) – Item 4b1 (Columns A+C) – Item 4b2 (Columns A+C) – Item 3 (Columns A+C) + HC-D Item 4c	bhc21754+bhc51754 bhc21773+bhc51773 -bhck1294-bhck1297 -bhck1703-bhck1706 -bhck1714-bhck1716 -bhck1718-bhck1731 -bhck8496-bhck8498 +bhck3536
Highly rated residual + CDOs: Sum of the "Highly rated residual" and the CDO amounts reported under trading assets in June 2008.	Highly rated residual + Schedule HC-D (from Form FR Y-9C as of June 2008) Item 5a+ Item 5b	Highly rated residual + bhckf649 + bhckf650
Highly rated residual + CDOs and writedowns: Sum of "Highly rated residual + CDOs" and the writedowns on CDOs between December 2006 and June 2008.	Highly rated residual + CDOs + CDO writedowns from Bloomberg	Highly rated residual + CDOs + CDO writedowns from Bloomberg
Highly rated residual + CDOs and writedowns: + conduits and SIVs: Sum of "Highly rated residual + CDOs and writedowns" and the holdings in off-balance-sheet conduits and SIVs.	Highly rated residual + CDOs and writedowns + holdings in conduits and SIVs from Acharya, Schnabl, and Suarez (2013)	Highly rated residual + CDOs and writedowns + holdings in conduits and SIVs from Acharya, Schnabl, and Suarez (2013)
Bottom-up highly rated tranches: Total value of MBSs that are not issued or guaranteed by the government or government-sponsored agencies plus ABSs, using HTM securities at amortized costs and AFS and trading securities at fair values. Note that there is no ABS data for trading securities so the ABS part includes only HTM and AFS securities.	Schedules from Form FR Y-9C as of December 2006: HC-B Items 4a3 (Columns A + D) + 4b3 (Columns A + D) + Item 5 (Column A + D) + HC-D Item 4c	bhck1709+bhck1713 +bhck1733+bhck1736 +bhckC026+bhckC027 +bhck3536

Our main data source is the Consolidated Financial Statements for Bank Holding Companies, the form FR Y-9C. We focus on Schedules HC-B (Securities), HC-D (Trading Assets), and HC-R (Regulatory Capital) to construct our main variables of interest. Below we list their definitions with references to schedules and data mnemonics in the form FR Y-9C.

Table A2
Independent variables

Variable name	Data source and algebraic expression or data mnemonic
$0–$50 billion and >$50 billion: A piecewise linear specification breaking up the asset size into two separate variables. The "$0–$50 billion" variable captures the first $50 billion worth of assets. In constructing this variable, each BHC in our sample takes the value min{BHC asset size, $50 billion}. The ">$50 billion" variable captures asset size in excess of $50 billion. In constructing this variable, each BHC in our sample takes the value max{0, BHC asset size - $50 billion}.	Schedule HC: bhck2170
$0–$50 billion, $50–$250 billion, and >$250 billion: A piecewise linear specification breaking up the asset size into three separate variables. The "$0–$50 billion" variable captures the first $50 billion worth of assets. In constructing this variable, each BHC in our sample takes the value min{BHC asset size, $50 billion}. The "$50–$250 billion" variable captures the asset size in excess of $50 billion but less than $250 billion. In constructing this variable, each BHC in our sample takes the value of min{0, $250 billion - $50 billion}. The ">$250 billion" variable captures the asset size in excess of $250 billion. In constructing this variable, each BHC in our sample takes the value min{0, BHC asset size - $250 billion}.	Schedule HC: bhck2170
>$50 billion indicator: One for banks with assets in excess of $50 billion and zero otherwise.	Schedule HC: bhck2170
>$100 Billion: One for banks with assets in excess of $100 billion in assets and zero otherwise.	Schedule HC: bhck2170
0–10,000 employees and >10,000 employees: A piecewise linear specification breaking up the impact of the employee count into two separate variables. The "0–10,000 employees" variable captures the first 10,000 employees. In constructing this variable, each BHC in our sample takes the value min{BHC number of employees, 10,000}. The ">10,000" variable captures the count in excess of 10,000 employees. In constructing this variable, each BHC in our sample takes the value max{0, BHC number of employees – 10,000}. Ten thousand employees represent the 90th percentile in the distribution of total employees in the cross-section of banks in our sample.	Schedule HC: bhck4150
ABCP activity indicator: Equal to one if a bank has any asset-backed commercial paper (ABCP) activity during the years 2003–2006. A bank is ABCP active if the maximum amount of its credit exposure arising from credit enhancements provided to asset-backed commercial paper conduit structures in the form of standby letters of credit, subordinated securities, and/or other credit enhancements is not zero. Note that we also include the amount of unused commitments to provide liquidity to conduit structures.	Schedule HC-S: Variable equal to one if bhck806 + bhck808 >0 in any year from 2003–2006
Assets/Tier 1 capital: Total assets divided by BHC Tier 1 capital.	Schedule HC-R: bhck2170/bhck8274
Bonus-per-salary: The ratio of total managerial bonuses divided by total managerial salary.	Execucomp
Book leverage: Calculated as 1 – (book value of equity/assets) as of 2006.	Schedule HC: 1 – (bhck3210/bhck2170)
C&I loans: Commercial and industrial loans, scaled by total assets.	Schedule HC-C: (bhck1763+bhck1764)/bhck2170
CEO ownership %: Total CEO ownership divided by total shares outstanding as of year-end 2006. Total ownership is calculated as the sum of delta weighted options and shares owned (both unrestricted and unvested restricted stock).	Execucomp and Compustat
Change in leverage, 2000 Q4–2002 Q4: The change in Tier 1 leverage from 2000 Q4 to 2002 Q4. In November 2001 banks began incorporating a loan's credit rating into calculations of risk-based capital. Prior to the rule change, risk-based capital was calculated based on asset type rather than explicit asset risk, as measured by credit ratings. Firms experiencing the largest increase in leverage surrounding the ratings-based rule change are identified as firms likely to have been engaging in regulatory capital arbitrage.	As of 2002 Q4: (bhck2170/bhck8274)/(bhck2170(t-8)/bhck8274(t-8))

(*continued*)

Table A2
Continued

Variable name	Data source and algebraic expression or data mnemonic
Compensation residual: This variable is constructed by computing the log of average total executive compensation from 2003–2006, which is regressed on the log of firms' 2006 market cap. The residual from this regression, estimated in 2006, serves as the compensation residual variable in the cross-sectional regressions estimated in 2006.	Execucomp and Compustat For the banks that are not covered in Execucomp, we hand-collected data from their proxy statements.
Conduit indicator: One if the BHC is identified as having sponsored a conduit and zero otherwise.	Acharya, Schnabl, and Suarez (2013).
Dollar gain from +1%: The change in CEO wealth per 1% increase in shareholder wealth. It is calculated as market cap * 0.01 * delta-weighted ownership.	Execucomp and Compustat For the banks that are not covered in Execucomp, we hand-collected data from their proxy statements.
Equity risk (%): The percent change in CEO wealth that results given a change in volatility of 1%. The variable is created by calculating the change in option value given a 1% change in volatility. The change in option value for a given change in volatility is then divided by the sum of the value of the delta-weighted option portfolio, stock holdings, and preferred share holdings of the CEO.	Execucomp and Compustat For the banks that are not covered in Execucomp, we hand-collected data from their proxy statements.
Governance index: Index of forty-one firm-level attributes from RiskMetrics. The index increases with the protection of minority shareholders and incorporates measures of board structure, antitakeover provisions, auditor selection, and compensation and ownership structure.	RiskMetrics: Governance index from Aggarwal et al. (2011)
High-compensation elasticity: The elasticity of the CEO's total compensation to changes in bank ROE. Total compensation comprised of the following: salary, bonus, other annual, total value of restricted stock granted, total value of stock options granted (using Black-Scholes), long-term incentive payouts, and all other total. Return on equity is calculated as: net income/common equity total as of fiscal year-end. Bonus elasticity is computed using only the total dollar amount of bonuses paid to the CEO. In our regression framework, we create an indicator variable equal to one for BHCs with above-median levels of comp/ROE elasticity.	Execucomp and Compustat For the banks that are not covered in Execucomp, we hand-collected data from their proxy statements.
Log market cap: Log of December 2006 market capitalization.	CRSP: Market price * shares outstanding
Log market-to-book: Log of the ratio of December 2006 market capitalization to 2006 fiscal year-end book value of equity.	CRSP and Compustat: (Market price*shares outstanding)/book value of equity, fiscal year-end
Log z-score: Log[(ROA + capital ratio)/sigma(ROA)]. ROA and capital ratio in the numerator are calculated as of 2006. Sigma ROA is calculated using quarterly data from 2000–2005.	ROA: (bhck4340/bhck2170) Cap. ratio: (MarketCap2006/bhck2170)
Market Leverage: Calculated as 1 – [market value of equity/(market value of equity + book value of liabilities)] as of 2006. Market value of equity is calculated as 2006 year-end stock price*shares outstanding.	CRSP: Market price * shares outstanding Book liabilities: Schedule HC: bhck2948 for book value of liabilities.

(*continued*)

Table A2
Continued

Variable name	Data source and algebraic expression or data mnemonic
Market risk equivalent bank indicator: Equal to one for any BHC that is subject to the market risk capital guidelines. A BHC is subject to the market risk capital guidelines and thus able to use estimates of value at risk in calculating capital requirements, if it is consolidated trading activity, defined as the sum of trading assets and liabilities for the previous quarter, equals (1) 10% or more of the BHCs total assets for the previous quarter or (2) $1 billion or more.	Schedule HC-R: Variable equal to one if bhck1651 >0 as of December 31, 2006
(Mortgage sec. $\$_t$ - Mortgage sec. $\$_{t-4}$)/Assets$_{t-4}$: Year-over-year change (sampled quarterly) in the total amount of the outstanding principle balance of 1–4 family residential loans and home equity loans sold and securitized with servicing retained or with recourse or other seller-provided credit enhancements.	Schedule HC-S: The $ amount of mortgage securitization activity is calculated as (bhckb705 + bhckb706)
Mortgage loans: Sum of all loans secured by real estate, scaled by total assets.	Schedule HC-C: bhck1410/bhck2170
Net derivatives/assets: The sum of beneficiary credit derivatives – guarantor credit derivatives (all in notional amounts), scaled by total assets. Beneficiary and guarantor credit derivatives are calculated as the sum of CDS, total return swaps, credit options, and "other."	Schedule HC-L: [(bhckc969 + bhckc971 + bhckc973 + bhckc975) - (bhckc968 + bhckc970 + bhckc972 + bhckc974)] /bhck2170 Schedule HC: (bhdmb993 + bhckb995 + bhck3548)/bhck2170
"Other" H.T.M. and A.F.S. securities (gov., agency, and lower-rated private-label H.T.M. and A.F.S. securities): The portion of held-to-maturity and available-for-sale securities held on BHC balance sheets that are government or agency securities. This variable also captures the portion of non-highly-rated nonagency, nongovernment (private-label) securities. It is calculated as the difference between the total HTM and AFS securities on BHCs balance sheet and the total "highly rated residual" HTM and AFS securities on BHCs balance sheet.	HC-B item 8 (Columns A and D) – Highly rated residual (see construction in Table A1) + HC-D item 4c: (bhck1754+bhck1773) – Highly rated residual (see Table A1) – bhck3536
"Other" trading securities (gov., agency, and lower-rated private label trading securities): The portion of trading assets on BHCs balance sheet that are not included in the highly-rated residual. This includes all government and agency securities as well as non-highly-rated private-label securities held on the trading book. It is calculated as the difference between total BHC trading assets and the "all other MBS" portion of trading assets.	HC-D item 12 (Column A) – item 4c (Column A): bhck3545 – bhck3536.
Prior Returns: BHC buy-and-hold returns calculated from January 2005–January 2006.	CRSP
Ratio of total agency holdings to assets: The sum of all agency-issued securities held as H.T.M., A.F.S., and in the trading book, scaled by total assets.	Schedule HC: (bhck1289 + bhck1293 + bhck1294 + bhck1298 + bhck1698 + bhck1703 + bhck1709 + bhck1714 + bhck1718 + bhck1702 + bhck1707 + bhck1713 + bhck1717 + bhck1732 + bhck3532 + bhck3534 + bhck3535)/bhck2170
ROA volatility: Standard deviation in ROA using quarterly data from 2000–2005.	ROA: (bhck4340/bhck2170)

(*continued*)

Table A2
Continued

Variable name	Data source and algebraic expression or data mnemonic
Risk management index (RMI): It is an index that measures the strength of operational risk management at the largest publicly listed bank holding companies (BHCs) in the United States. It is constructed by taking the first principal component of the five key risk management variables: a dummy variable that identifies whether or not the chief risk officer (CRO) is an executive officer at the BHC; a dummy variable that identifies whether or not the CRO is among the top five highest paid executives at the BHC; the ratio of the CRO's total compensation to the CEO's total compensation; a dummy variable that identifies whether at least one of the grey or independent directors serving on the board's risk committee has banking experience; and a dummy variable identifying if the BHC's board risk committee met more frequently during the year compared to the average board risk committee across all BHCs. See Ellul and Yerramilli (2013) for a detailed description of these variables.	Ellul and Yerramilli (2013)
Risk-weighted assets/Tier 1 capital: Risk-weighted assets divided by BHC Tier 1 capital.	Schedule HC-R: bhckA223/bhck8274
(Sec. $\$_t$ – sec. $\$_{t-4}$)/assets$_{t-4}$: Year-over-year (sampled quarterly) change in the total amount of the outstanding principle balance of assets sold and securitized with servicing retained or with recourse or other seller-provided credit enhancements.	Schedule HC-S: The $ amount of securitization activity is calculated as (bhckb705 + bhckb706 + bhckb707 + bhckb708 + bhckb709 + bhckb710 + bhckb711)
Securitization-active indicator: Total outstanding principal balance of assets sold and securitized with servicing retained or with recourse or other seller-provided credit enhancements. The securitization active dummy variable is equal to one for banks that have any positive amount of securitization activity in the years 2003–2006.	Schedule HC-S: Variable equal to one if (bhckb705 + bhckb706 + bhckb707 + bhckb708 + bhckb709 + bhckb710 + bhckb711) >0 in any year 2003–2006
Securitization-league-table indicator: Equal to one for any BHC that was involved in the underwriting of any type of securitization, including subprime RMBS, CLOs, CBOs, and CDOs.	Moody's eMaxx Data Services
Securitization-league-table rank: Equal to zero for all banks in the sample, except the top-ten banks in the securitization league table, which take the value of their league-table rank, in reverse order. (e.g., Citigroup, the top securitization-producing bank in the sample takes the value 10, Bank of America is 9, JPMorgan is 8, etc.)	Moody's eMaxx Data Services
Short-term wholesale funding/assets: The sum of time deposits of $100,000 or more + commercial paper + federal funds purchased and securities sold under agreements to repurchase + other borrowed money with a remaining maturity of 1 year or less+ trading liabilities, scaled by total assets.	Schedule HC: (bhcb2604 + bhck2309 + bhdmb993 + bhckb995 + bhck2322+ bhck3548)/bhck2170
Stock return volatility: Volatility of weekly stock returns calculated using January–December 2006 sample.	CRSP
Unused loan commitments: Unused portion of residential and commercial real estate loan commitments.	Schedule HC-L: (bhck3814+bhck3816)/bhck2170

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