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MORTGAGE-BACKED SECURITIES AND THE FINANCIAL CRISIS OF 2008: A POST MORTEM

Juan Ospina and Harald Uhlig

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Centre for Economic Policy Research
33 Great Sutton Street, London EC1V 0DX, UK
Tel: +44 (0)20 7183 8801
www.cepr.org

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JEL Classification: G01, G21, G23, G24

Keywords: Mortgage-Backed Securities, MBS, financial crisis of 2008, Credit ratings

Juan Ospina - juan.jose.ospina@gmail.com
Banco de la Republica de Colombia

Harald Uhlig - huhlig@uchicago.edu
University of Chicago and CEPR

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Juan Ospina
Banco de la República de Colombia

Harald Uhlig
University of Chicago

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We examine the payoff performance, up to the end of 2013, of non-agency residential mortgage-backed securities (RMBS), issued up to 2008. We have created a new and detailed data set on the universe of non-agency residential mortgage backed securities, per carefully assembling source data from Bloomberg and other sources. We compare these payoffs to their ex-ante ratings as well as other characteristics. We establish seven facts. First, the bulk of these securities was rated AAA. Second, AAA securities did ok: on average, their total cumulated losses up to 2013 are 2.3 percent. Third, the subprime AAA-rated segment did particularly well. Fourth, later vintages did worse than earlier vintages, except for subprime AAA securities. Fifth, the bulk of the losses were concentrated on a small share of all securities. Sixth, the misrating for AAA securities was modest. Seventh, controlling for a home price bust, a home price boom was good for the repayment on these securities. Together, these facts provide challenge the conventional narrative, that improper ratings of RMBS were a major factor in the financial crisis of 2008.

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1 Introduction

post mortem: an examination of a dead body to determine the cause of death[1]

Gradually, the deep financial crisis of 2008 is in the rearview mirror. With that, standard narratives have emerged, which will inform and influence policy choices and public perception in the future for a long time to come. For that reason, it is all the more important to examine these narratives with the distance of time and available data, as many of these narratives were created in the heat of the moment.

One such standard narrative has it that the financial meltdown of 2008 was caused by an overextension of mortgages to weak borrowers, repackaged and then sold to willing lenders drawn in by faulty risk ratings for these mortgage back securities. To many, mortgage backed securities and rating agencies became the key villains of that financial crisis. In particular, rating agencies were blamed for assigning the coveted AAA rating to many securities, which did not deserve it, particularly in the subprime segment of the market, and that these ratings then lead to substantial losses for institutional investors, who needed to invest in safe assets and who mistakenly put their trust in these misguided ratings.

In this paper, we re-examine this narrative. We seek to address two questions in particular. First, were these mortgage backed securities bad investments? Second, were the ratings wrong? We answer these questions, using a new and detailed data set on the universe of non-agency residential mortgage backed securities (RMBS), obtained by devoting considerable work to carefully assembling data from Bloomberg and other sources. This data set allows us to examine the actual repayment stream and losses on principal on these securities up to 2014, and thus with a considerable distance since the crisis events. In essence, we provide a post-mortem on a market that many believe to have died in 2008. We find that the conventional narrative needs substantial rewriting: the ratings and the losses were not nearly as bad as this narrative would lead one to believe.

Specifically, we calculate the ex-post realized losses as well as ex-post realized return on investing on par in these mortgage backed securities, under various assumptions of the losses for the remaining life time of the securities. We compare these realized returns to their ratings in 2008 and their promised loss distributions, according to tables available from the rating agencies. We shall investigate, whether ratings were a sufficient statistic (to the degree that a discretized rating can be) or whether they were, essentially, just "noise", given information already available to market participants at the time of investing such as ratings of borrowers.

[1] The market for non-agency residential mortgage backed securities pretty much died with the financial crisis: new issuance slowed to a trickle. Thus, the title.

We establish seven facts. First, the bulk of these securities was rated AAA. Second, AAA securities did ok: on average, their total cumulated losses up to 2013 are 2.3 percent. Third, the subprime AAA-rated segment did particularly well. Fourth, later vintages did worse than earlier vintages, except for subprime AAA securities. Fifth, the bulk of the losses were concentrated on a small share of all securities. Sixth, the misrating for AAA securities was modest. Seventh, controlling for a home price bust, a home price boom was good for the repayment on these securities.

Table 10 presents more detailed results for these returns, depending on the market segment and assumptions regarding terminal value: these results are presented in greater detail in subsection 5. The most important result here may be that various categories of AAA securities provided an internal rate of return of about 2.44% to 3.31% on average, depending on the assumptions regarding their terminal value. The yield on 10-year treasuries in 2008 was between 3 and 4 percent: the difference is surely smaller than what the standard crisis narrative seems to suggest. It mattered quite a bit, whether the mortgages were fixed rate or floating rate. We do not deny that losses occurred and that these were magnitudes larger than those that should be expected of AAA securities. However, we suggest that these data on the realized returns on AAA RMBS present an interesting challenge to researchers, seeking to place these securities at the center of the storm, tossing world-wide financial markets into the abyss.

Losses were considerably larger on securities with ratings other than AAA. We examine them in considerable detail. Some were practically wiped out as a group, despite rather stellar non-AAA ratings ex ante. The total market share of these securities was below 14 percent of the market for non-agency RMBS, however. Moreover, we calculate that the the total losses on all non-agency RMBS amounted to less than 350 billion dollars: less than 2.5 percent of US GDP or less than half a percent annualized over that period, and quite a bit less than the amount devoted to the 2009 American Recovery and Reinvestment Act or "stimulus" package. We suggest that it is an interesting challenge to craft a theory of a world-wide recession, triggered by the these losses.

We should emphasize that we only examine non-agency residential mortgage backed securities. Agency-backed securities were backed implicitly by the tax payer and explicitly by programs of the Federal Reserve Bank. Therefore their role in the crisis was largely a matter of policy, and investors did not expect losses on investments in these securities to be large. By contrast, the non-agency portion really was the "wild west" of that market, and provides the most stringent restrictions for challenging the conventional narrative. Also, we do not investigate higher layers of leveraging and repackaging, such as, say, AAA-rated collateralized debt securities, backed by a basket of lower-rated mortgage-backed securities. Note that losses here

are just redistributing the losses of the original RMBS. There are a variety of other securities that got their share of blame. None have received quite the attention of non-agency residential mortgage backed securities, though, which are the focus here.

The paper proceeds as follows. Section 2 provides a discussion of the related literature. Section 3 discusses our unique and novel data set, and how we assembled it. Subsection 4 contains our analysis. Subsection 4.1 examines the ratings, in particular their relationship and their predictive value for future losses. Subsection 4.2 examines the depth, probability and distribution of losses. In subsection 4.6 we explore errors in rating from an ex post perspective, and the degree of rating reversals, where securities with higher ratings experienced larger losses than those with lower ones. Subsection 5 examines the resulting annualized returns on an investment at par value, under a range of assumptions on the terminal value. Section 6 concludes.

2 Related Literature

Our paper is mainly related to the extensive literature that studies securitization, housing markets, and their role in the unfolding of the financial crisis of 2008. Our paper is closely related to papers that give more importance to non-sumbrime segments of the market as key determinants of the crisis. Adelino et al. (2016) and Adelino et al. (2017), provide evidence that middle-class borrowers with above-subprime credit scores increased their delinquencies in mortgages during the crisis and were key in understanding the crisis. In addition, Albanesi et al. (2017) explain that credit growth between 2001 and 2007 and mortgage delinquencies during the crisis were driven by mid to high credit score borrowers, while debt issued to high risk borrowers was virtually constant. Moreover, the prime segment disproportionately defaulted on their mortgages, mainly because of the role played by real estate investors who maximized leverage motivated by the prospect of capital gains. These results are consistent with our results that Alt-A securities and Prime securities, especially in the AAA-rated group, did by many measures worse than AAA subprime securities. In line with these papers, our results cast doubt on the so-called "subprime view" of crisis.

Our paper is also related to the literature that explores losses and returns on mortgage-backed securities during the crisis. Partly due to data being more readily available, partly due to the fact that unconventional monetary policy made them part of the Fed's balance sheet, and partly due to their importance as a fraction of the MBS market, most studies have focused on the agency mortgage-backed securities. Diep et al. (2017) focus on the cross-section of agency MBS returns, how prepayment risk is priced, and how risk premia changes over

time. Boyarchenko et al. (2017) study variation on agency MBS spreads over time and across securities, finding that cross-sectional return patterns are explained by pre-payment risk while the time series variation is mostly accounted for a factor that depends on MBS supply and credit risk. Our paper, in contrast, focuses on the returns of the non-agency market and links them to credit risk, which is absent in agency MBS. Unlike for the agency MBS, our return computations cannot be based on trading prices, and traditional empirical asset pricing analysis is impossible. Despite these limitations, our paper makes the contribution of providing measures of returns and how they relate to potentially risk-priced characteristics. As pointed out by Vickery and Wright (2013), there are key institutional characteristics of the agency MBS market that makes its liquidity higher, and while issuances and activity in the non-agency segment of the market remained robust, they declined in the non-agency market. The results of our study suggest points at some features of the non-agency market that have determined this decline. A salient one is the narrative that subprime-AAA securities had large losses, which further diminishes the liquidity and appetite for the non-agency market. A set of papers, including Barnett-Hart (2009), Beltran et al. (2013), Cordell et al. (2012), has set its attention on the non-cash segment of the market, documenting losses on CDOs and more derivative-like structures. There seems to be agreement on the large losses suffered by CDOs and how rating agencies may have failed to assess the risk in their AAA tranches. Our paper shows, however, that losses on CDOs are not coming from widespread losses on MBS, and that the extent of misratings of agency AAA-rated MBS is not comparable to that of CDOs.

Another strand of the literature studies the role and pertinence of credit ratings. A key issue of ratings is what they mean for investors and society as a whole. Our paper, does show that ratings had useful information about the fundamentals of securities, but our results, suggest that credit ratings were not sufficient statistics for non-agency MBS losses (in line with Ashcraft et al. (2011)). Some researchers have proposed that AAA securities are treated like money, and that the AAA-subprime crisis is more of a run on money-like instruments than a default story. [2] For example, McDonald and Paulson (2015) document this interpretation as a possibility for the AIG crisis. However, Chernenko et al. (2014) examine micro-data of insurance companies and mutual funds holdings of fixed income securities and show that not all investors treated all AAA-rated securitizations the same way, and that some of them understood that they could represent different underlying risks. This means that even though the AAA money-like interpretation is a possibility, it may not be the entire story. The fact that the AAA rating is an insufficient statistic is reinforced by Stanton and Wallace (2011) who document that prices for the AAA ABX.HE index CDS during the crisis were inconsistent with any reasonable

[2] We thank Arvind Krishnamurthy for pointing this as a possible explanation of some of our results

assumption for mortgage default rates, and that these price changes are only weakly correlated with observed changes in the credit performance of the underlying loans in the index.

Finally, there is a literature that explores how securitization helped to create conditions for the crisis to happen and how securitization standards are related to the so-called mortgage crisis. Examples of this literature include Keys et al. (2009), Keys et al. (2010) and Keys et al. (2012). These papers build on substantial evidence that securitization contributed to bad lending by reducing incentives of lenders to carefully screen borrowers, and explore different aspects of the securitization process that could have been affected by this moral hazard problem. They find that regulation had the effect of increasing moral hazard as more regulated banks faced less market discipline. They also find that securitization did lower screening standards: loans with higher FICO scores tend to have higher probabilities of default and a higher probability of being securitized. Finally they show that certain loans, particularly those with higher FICO scores also tend to be easier to securitize and they tend to spend less time on a lender's balance sheet. The fact that loans with higher FICO scores had bigger probabilities of defaults is in line with our findings that subprime-AAA securities seemed to have loss rates that were lower than those of AAA-AtlA securities. The fact that loss rates and probabilities of default for AAA-subprime did not increase in the run-up to the crisis as they did for prime and Alt-A securities, further supports the channels stressed by this literature on how the process of securitization could have influenced the crisis. Unlike these papers, our paper sheds some light on the extent to which credit ratings, another aspect of the securitization process, was a sufficient statistic for the risk involved in investing in mortgage-backed securities.

3 The data

We seek to investigate the market for residential non-agency mortgage-backed securities. These securities are excluded from guarantees or insurance by the government agencies "Fannie Mae" (FNMA), "Freddie Mac" (FHLMC) or "Ginnie Mae" (GNMA) due to certain characteristics, such as "jumbo loans" exceeding the limit of, say, $ 333,700 in 2004, loans on second properties such as vacation homes, insufficient documentation or borrowers with credit history problems. At the end of 2003, non-agency MBS/ABS had an outstanding amount of $ 842 billion , constituting 20% of the entire market for MBS, with agency-backed securities constituting the other 80%.

For our investigation, a major challenge was to obtain a suitable data set for these securities. The market is characterized by considerable decentralization. While the appointed trustees of a deal are responsible for providing investors with detailed information about the performance of

the loans underlying the securities every month, there is no centralized repository that collects and organizes the data[3]. In terms of prices, many of these securities do not trade very often, and when they do so the transactions are over-the-counter. This makes it impossible to obtain a suitable time series of transaction prices for individual deals[4].

As there was no readily available, organized data source, we constructed the main data ourselves. We start from the Mortgage Market Statistical Annual 2013 Edition by Inside Mortgage Finance[5]. This publication in Volume II, Table A, Non-Agency MBS Activity, contains a complete list of the RMBS deals, completed over the years 2006-2012. For each deal, the name, the original issuer, the original amount and a few other characteristics are listed. There are a total of 2824 such deals. However, information such as cash flow or losses is not provided here. For our further data base construction, we obtain data from Bloomberg.

For each deal listed by the Mortgage Market Statistical Annual 2013 edition, we search for that deal on Bloomberg. The matching sometimes required a bit of a search, and we managed to find nearly 96 percent of the original list, by principal amount. Once we found the appropriate deal entry, we look for all deals that have similar names going forward and going back in time. Bloomberg lists the deal manager for the original deal. We then also search for all mortgage backed securities from this deal manager from 1987 onwards. Proceeding in that manner, we find a total of 8615 deals, going back to 1987 rather than just 2006, as in the Statistical Annual. In this way we hope to have minimized the number of deals that we may be leaving out. Each deal generates approximately 17 separate securities or bonds on average, usually with different ratings, for a total of 143,232 securities, each of which we seek to track. Their total principal amount is 5,842 billion dollars. Further details are in Table 1. Table 2 provides an overview of the data we obtained for each security.

[Insert Table 1 about here]

[Insert Table 2 about here]

In this manner, we obtain as complete a universe of RMBS securities emerging from these deals, as seems possible, as well as information about their ratings and monthly cash flow and losses. We downloaded the various pieces of information, security by security, and assembled it into a spread sheet, readable by MATLAB for further analysis. The process took several months to complete, largely due to the download restrictions of Bloomberg. In order to understand our data base construction further, appendix C provides a sample of the information available from

[3]Some companies including Corelogic and Blackbox Logic collect and sell information and analytic tools to market participants

[4]Now the Financial Regulatory Authority (FINRA) provides some summary statistics on prices and volume of daily transactions.

[5]Information about this source can be found here `http://www.insidemortgagefinance.com/books/`

the Statistical Annual as well as from Bloomberg, how to read the available information and some details on how we constructed our data base. The on-line database appendix contains a detailed step by step description of how we built our data. A replication kit is available from the authors for those that seek to replicate our analysis.

Table TA1 in the technical appendix compares the deals in our final database with those in the Statistical Annual. Panel A of that table provides evidence that our database contains about 94% of the deals and about 96% of the issued amount across different types of securities over the 2006-2012 period, which is the available period in the 2013 edition of the Statistical Annual. The fraction covered by our data is about the same across different market segments. Panel B shows the coverage by market segment over time to show that not only the coverage is high overall, but also that it is high consistently over time. The high matching rate for this time period, and the procedure that we followed to search for securities, give us confidence that our conclusions will not follow from having a selected sample.

We complemented this main data set with data on RMBS price indices as well as house prices. For RMBS prices we obtain the ABX.HE indexes from Markit[6] , which are built to represent CDS transactions on Subprime RMBS issued in 2006 and 2007 for different credit rating levels. Finally, we use publicly available house price data at the state level from Zillow to build some of our control variables.[7]

3.1 Database description

Our constructed database contains information for more than 143 thousand RMBS, which were issued between 1987 and 2013 and are part of about 8,500 securitization deals. Table 1 shows the issuance activity over time. The table shows the boom in activity in terms of deals, bonds, market participants (issuers), and deal size from the early 2000s through 2007, and the corresponding collapse after 2008. Most of the deals after 2008 correspond to resecuritizations.

About 99% of the securities in our data, which represent 97% of the dollar principal amount, are private-label (non-agency), non-government backed,[8] non-CDO securities. We will limit our analysis to these securities throughout the paper.

The collected information can be grouped into groups. The first group is the cash flow time series information. This constitutes the bulk of our data. Given downloading limits imposed by Bloomberg, we had to spend several months downloading this information chunk by chunk. For each security we observe the interest payments, principal payments, outstanding balance,

[6]Information about these indexes and how to purchase the data is available here `https://www.markit.com/Product/ABX`

[7]This data can be downloaded at `http://www.zillow.com/research/data/`

[8]The government backed securities include agency securities and also non-agency securities whose underlying mortgages are backed by the Federal Housing Administration (FHA) and the U.S department of Veterans Affairs (VA)

the coupon rate and the losses each month after issuance. The second group of variables allows to identify the security and describe some of its characteristics. These include the Cusip ID, deal names, deal managers names, dates of issuance, coupon type and frequency, maturity date, type of tranche, notional amounts, as well as the credit rating assigned by up to 5 different credit rating agencies upon issuance. A third group of variables is related to the collateral of the securities, i.e. the underlying mortgages. These include information on the composition of the mortgages by type of rates (adjustable rates vs fixed rate mortgages), by type of occupancy (vacation home, family home, etc), by purpose of the mortgage (equity take out, refinance, purchase), or by geography (at the state level). This group of variables also includes information commonly used to assess the risk of pools of mortgages. We observe moments of the distribution of the credit scores, loan size, and loan to value ratios across the mortgage loans underlying a deal. A final group of variables include variables that can help us classify securities (for example agency vs non-agency, residential vs non-residential MBS) and commonly used metrics in mortgages backed security analysis such as weighted average maturity (WAM), weighted average coupon (WAC), and weighted average life (WAL). In the on-line appendix we list and describe all the variables in the raw data.

[Insert Table 1 about here]

3.2 Classifying Securities into Market Segments

The most common classification used in the market and one that has determined the narratives of the crisis yields three main categories of MBS: Sub-prime, Alt-A, and Prime (or jumbo)[9]. This classification is available from the Mortgage Market Statistical Annual and it is based on the classification of the bulk of the underlying loans into the same three categories. In general, an RMBS predominantly backed by subprime loans will be classified as a Subprime RMBS.

Prime non-agency mortgages are jumbo loans that are not qualified for agency guarantees because of their size. Alt-A or Alternative A are loans in the middle of the credit spectrum, with missing documentation or with other characteristics that make them ineligible for agency securitization. Subprime loans are loans further down the credit quality spectrum, to the point that they too are ineligible for agency backing. In practice, the classification of a security (and the underlying loans) was the result of the market practice in the securitization business and not a contractual characteristic of the security. This means that we do not have an official field that provides the classification, and therefore we perform the classification ourselves. The

[9]There are other classifications that we largely ignore. As one example, there is the Scratch & Dent category. These are loans of borrowers with the lowest FICO scores, which sometimes could have been originated outside the underwriting guidelines. These will generally fall under the sub-prime category

classification criteria often used by banks involved the FICO score, loan-to-value ratios (LTV), loan size, and the documentation supporting the loan, with the FICO score being the main characteristic.

In order to classify the securities in our database, we used the fact that the Mortgage Market Statistical Annual provides a classification for the deals issued after 2005 to learn from our data what FICO score (or other characteristic) would provide an appropriate classification criteria. Figure 1 compares that classification for deals issued after 2005 to the mean FICO scores, loan sizes and LTVs available from Bloomberg. Clearly the FICO score is the key distinguishing characteristic, although size also provides information. Figure TA1 as well as related figures in the technical appendix further supports this claim. Given the distributions of the FICO scores statistics in Figure 1 and Figure TA1, we found cutoffs that we then used to classify each security in the database as Prime, Alt-A, and Subprime.

[Insert Figure 1 about here]

4 Seven Facts

4.1 Fact 1: the bulk of these securities was rated AAA

Table TA2 in the technical appendix describes the credit rating activity in our database based on the assignment of a rating upon issuance. More than 62% of the securities (which represent 85% by value of principal) had at least 2 ratings. For our analysis, we summarize the ratings by the different agencies into a single index, as follows. We abstract from the rating qualifiers "-" and "+". So for example a BBB+ for us is a BBB and an A- is an A. This should not be too problematic since an A- should be closer to an A than to a BBB. Whenever a security has 2 or more ratings from different agencies we average the rating. For instance, if agency 1 rates it as AAA, and rating agency 2 as AA, and rating agency 3 as AAA, the bond will be AAA.[10] For the case of two agencies, one rating a bond as AAA and one as AA, we solved the tie upwards, so the bond would be AAA. These discrepancies are not common in the data.

With table 3, we can now document our ***first fact***: **The great majority of non-agency RMBS securities were assigned a AAA rating upon issuance**. The table shows the total principal amount in billions of Dollars and in terms of percent of the total by rating category. Almost 87% of the principal amounts had the highest rating of AAA. Most of the other rated securities were investment grade securities (BBB or higher). Those rated below constituted

[10]This clearly requires a mapping of the different ratings across agencies. We used the mapping provided by the Bank of International Settlements, which is available here `http://www.bis.org/bcbs/qis/qisrating.htm`

less than 2% of the market by principal value. Table TA3 in the technical appendix contains additional detail.

[Insert Table 3 about here]

4.2 Fact 2: AAA securities did ok.

A loss occurs, when a scheduled payment is not made or when there is a complete default on the remaining principal and stream of payments. The losses that we observe, are the realized losses as defined in the oficial prospectus of the MBS. The losses are reported in the monthly reports that deal managers send to investors. The losses from defaulted loans first reduce excess cash flow, then reduce the level of overcollaterilization, and to the extent they exceed the amount of excess interest and overcollateralization following distributions of principal on the payment date, are allocated to reduce the principal amount according to the level of subordination of the bond in the capital structure of the deal. We observe the time series of the losses suffered month by month by each of the securities in our data. This allows us to calculate the cumulative losses at different points in time and study the differences across ratings, vintages, and market segments. The results presented here are weighted by the original principal amounts of the RMBS's. The technical appendix complements this with unweighted results.

[Insert Table 4 about here]

Table 4 provides a breakdown of the cumulated losses until December 2013 by ratings subcategory. The first column essentially repeats the first column of table 3. The numbers are now somewhat smaller, since the securities involved in table 3 are all the non-agency RMBS of our database, this is, all securities issued between 1987 and 2013[11], whereas the calculations for table 4 only used securities issued up to 2008. From here onwards all the results only use securities issued through 2008. Table TA4 in the technical appendix provides additional detail. We have also plotted the losses over time and according to rating subcategories: these plots are provided in the technical appendix as figures TA2 and TA3. The summary of these plots is that losses started to occur only after the end of 2007 and the onset of the financial crisis, and that they look like having mostly converged until the end of December 2013, except perhaps for the losses on the AAA securities. As of December 2013, AAA securities taken together still had $341 billion of cushion coming from lower-rated bonds. Given that all the losses over 6 years from 2008 to 2013 (both included) did not reach this amount and given the recovery of

[11] Including the information up to 2013 for the activity of agencies is to provide a complete description of our data. Given the fall in securitization activity after 2008, the numbers change a little bit, but the messages do not.

the US economy, we We therefore conjecture with some confidence, that the final loss numbers will be somewhat, but not substantially higher, once one calculates them in, say, 2040.

Table 4 documents our ***second fact***: **AAA securities did ok: on average, their total cumulated losses up to 2013 are 2.3 percent.** This also emerges from section 5 below, where we examine the realized returns in greater detail. Losses for other rating segments were substantially higher, e.g. reaching above 50 percent for non-investment grade bonds. Here, it may be good to bear in mind our first fact, however, that the bulk of securities was rated AAA, as is evident once again from table4. The overall cumulated losses on all RMBS until December 2013 amounted to 6.5 percent. It was the AAA segment in particular that drew the most attention in the discussions regarding ratings. Nobody should be utterly surprised to incur losses on non-investment grade bonds, for example. We therefore focus our discussion here on the AAA segment, while not denying the substantial losses in the other segments.

Cumulative losses of 2.2% of principal on AAA-rated securities surely is a large amount, given that rating. Such losses after six years may be expected for, say, BBB securities [12], and not for AAA securities. AAA securities are meant to be safe securities, and losses should be extremely unlikely. From that vantage point, an average 2.2% loss rate is certainly anything but "ok". We have chosen this label not so much in comparison to what one ought to expect from a AAA-rated security, but rather in comparison to the conventional narrative regarding the financial crisis, which would lead one to believe that these losses had been far larger. Ultimately, of course, different judgements can be rendered from different vantage points: our main goal here is to simply summarize the facts.

4.3 Fact 3: the subprime AAA-rated segment did particularly well.

[Insert Table 5 about here]

We break down the analysis by market segment defined by loan type (Prime, Alt-A, and Subprime). Table 5 shows the results and documents the ***third fact***: **the subprime AAA-rated RMBS did particularly well.** AAA-rated Subprime Mortgage Backed Securities were the safest securities among the non-agency RMBS market. As of December 2013 the principal-weighted loss rates AAA-rated subprime securities were on average 0.42% We do not deny that even the seemingly small loss of 0.42% should be considered large for any given AAA security. Nonetheless, we consider this to be a surprising fact given the conventional narrative for the causes of the financial crisis and its assignment of the considerable blame to the subprime market and its mortgage-backed securities. An example of this narrative is provided by Gelman

[12] see the table available from Moody's in in figure TA9 and also available per `http://siteresources.worldbank.org/EXTECAREGTOPPRVSECDEV/Resources/570954-1211578683837/Bielecki_Moodys_Rating_SME_transactions.pdf`

and Loken (2014)[13]: "We have in mind an analogy with the notorious AAA-class bonds created during the mid-2000s that led to the subprime mortgage crisis. Lower-quality mortgages —that is, mortgages with high probability of default and, thus, high uncertainty—were packaged and transformed into financial instruments that were (in retrospect, falsely) characterized as low risk".

4.4 Fact 4: later vintages did worse than earlier vintages, except for subprime AAA securities

[Insert Table 6 about here]

[Insert Table 7 about here]

We calculate the average loss rate and its standard deviation per vintage and rating, see table 6 as the vintage-specific counterpart to table 4, or even per vintage-rating-mortgage-type category, see table 7 as the vintage-specific counterpart to table 5. Loss rates mostly rose for later vintages. For example, while there were nearly no losses on AAA-rated securities issued before 2003, their cumulated losses rose to nearly 5 percent for securities issues in the years 2006-2008. It probably does not come as a surprise that later vintages did worse. What may still be up to interpretation is whether this bad performance of the late-vintage RMBS occurred due to the bad luck of issuing securities based on mortgages at the peak of the housing boom, or whether some rating drift was at work. We shall return to that issue, when discussing our seventh fact. What is particularly remarkable here, however, is the stability of the loss rates for the AAA-subprime segment, as the last three columns of the top line of table 7 or the lowest line of the left panel in the middle row of figure TA6 shows: loss rates there were below 0.7% even for the subprime-AAA RMBS issued in the years 2006-2008. These tables, the figure and the remarks thus establish our ***fourth fact***: **later vintages did worse than earlier vintages, except for subprime AAA securities.** Thus, even when controlling for the vintage, it remains a fact that AAA-rated Prime and Alt-A RMBS exhibit loss rates that are worse than AAA-rated subprime-RMBS, while the performance for lower ratings is comparable. We view this as providing supportive evidence for the lower screening effort exerted by financial institutions that found easier to securitized and sell loans of higher-quality borrowers, as documented by Keys et al. (2009, 2010, 2012).

[13]We have chosen this quote because it is quite representative of the conventional narrative during the crisis and useful for our purposes. We have not chosen it as a critique of the article by Gelman and Loken (2014), whose subject of interest is not the RMBS market per se

4.5 Fact 5: the bulk of the losses were concentrated on a small share of all securities.

[Insert Figure 2 about here]

The standard deviations shown in, say, table 7 imply that not all securities behaved the same. Indeed, figure 2 shows that the loss distribution is nearly bimodal. The left panel shows the loss distribution across all RMBS, weighted by principal amount. About 65 percent of the securities lost nothing or less than 5 percent, whereas nearly 20 percent of all securities lost more than 95 percent or even everything. The right panel of figure 2 shows that distribution broken down by credit rating. One can see the same bimodality, rating-by-rating. For the AAA-rated securities, we obviously obtain a much larger share in the "near-to-no" losses bin, but even there, the worst bin contains more securities, weighted by principal amount, than those bins for losses anywhere between 40 and 80 percent. A similar statement in reverse holds for the non-investment grade bonds. With this, we establish our ***fifth fact***: **the bulk of the losses were concentrated on a small share of all securities.**

4.6 Fact 6: the misrating for AAA securities was modest

In this section, we examine the relationship of the ex-ante ratings and other bond characteristics to the ex-post performance. This may help shed light on the question of the appropriateness of the ratings. Obviously, we only see one particular history unfold, and all securities were subject to one large aggregate turn of events: one therefore needs to read this comparison with the appropriate grain of salt.

We present two exercises. In the **first exercise**, we compare the realized losses of securities to Moody's expected losses by rating. Moody's has published a table of "Idealized Cumulative Expected Loss Rate" which we present as reference in the technical appendix in figure TA9.[14] For example, in 10 years a BBB- security would be expected to have a loss rate of approximately 3.35%. For each security, we assign an "ex-post rating" based on its actual realized loss rate, converting it into the rating using the loss table by Moody's at the six-year horizon to 10-year horizon, depending on the vintage of the security. For a 2008 security we use the six-year horizon, for a 2007 a seven year horizon, and so forth. So, if a given security had a realized loss rate between the AAA and the AA expected loss rate on Moody's table (between 0.0055% and 0.22% in 10 years), the security receives an ex-post rating of AA. We then compare the

[14]The table is originally available here `https://www.moodys.com/sites/products/productattachments/marvel_user_guide1.pdf` or here`http://siteresources.worldbank.org/EXTECAREGTOPPRVSECDEV/Resources/570954-1211578683837/Bielecki_Moodys_Rating_SME_transactions.pdf`

ex-ante rating with the ex-post rating. Figure 3 presents the resulting distributions. The solid line is the fraction of securities by original rating (ex-ante), whereas the dotted line shows the distribution of the constructed ex-post rating. Overall, the share AAA ratings is the same in both distributions, though there are more securities receiving investment grade ratings ex-ante rather than ex-post.

[Insert Figure 3 about here]

[Insert Figure 4 about here]

Figure 4 shows the fraction of securities for which ex-ante and ex-post ratings coincide (labeled as Correct Rating), those for which the ex-post rating is higher than the ex-ante rating (labeled as Deflated Rating), and those for which the ex-post rating is lower than the ex-ante rating (labeled as Inflated Rating). While about 75% of AAA securities had little to no losses, thus justifying their ex-ante ratings ex post, securities with ratings A and below had a large fraction of inflated ratings. Figure TA10 in the technical appendix provides a three-dimensional version. These two figures reflect the bimodality of the loss distribution, summarized by our fifth fact.

In the **second exercise**, we wish to understand, whether the ratings could have been improved upon at the time, aside from the overall extent of the losses examined above. We seek to calculate the extent to which the inclusion of additional covariates X, available at the time of rating, for a higher-ranked security predicts larger loss probabilities than observed on average for lower-ranked securities. We call this a ratings reversal. Obviously, the information in these covariates would have been useful ex ante only to the extent that their influence on the losses ex post was understood. This is unlikely to be fully the case. One should therefore view our exercise as the best possible scenario for potentially improving on the ex-ante ratings.

More precisely, for any given $\alpha \in [0, 1]$, which we shall call the loss threshold, as well as for each rating, say AAA, we first seek to estimate $P(Loss > \alpha \mid AAA)$ and $P(Loss > \alpha \mid AAA, X)$, given the crisis of 2008. For the former, we estimate this probability with the fraction of AAA-securities, whose losses exceeded α at the end of 2013. For the latter and for each security i rated AAA and with covariates X_i, construct the observation

$$Y_i = 1_{Loss_i > \alpha}$$

indicating, whether the losses for security i exceeded α or not. As covariates, we made use of the available covariates in our data that we deemed possible predictors of the losses, so as to capture what the rating actually adds or misses. Examples include the information we have on

FICO scores and LTV ratios. The available covariates were briefly listed in subsection 3.1 and described in detail in section 2 of the on-line database appendix[15]. We then estimate a linear probability model, per linear regressing these observations Y_i on the covariates X_i. Different values for α generally result in different estimates.

For the ratings AAA and AA, say, we define the gain from including covariates X compared to the raw probability difference as

$$Gain_{AAA,AA}(\alpha) = \frac{E\left[|P(Loss > \alpha|AAA, X) - P(Loss > \alpha \mid AAA)|\right]}{P(Loss > \alpha \mid AAA) - P(Loss > \alpha \mid AA)} \tag{1}$$

where the outer expectation is taking an expectation over the random covariates X. We estimate the numerator by the sample average of $\hat{P}(Loss > \alpha|AAA, X_i) - \hat{P}(Loss > \alpha \mid AAA)$ for all AAA-rated securities i and the probability estimators explained above. We likewise define $Gain_{AAA,A}(\alpha)$, $Gain_{AA,A}(\alpha)$, etc.. We define the probability of rating reversals for AAA-rated securities to AA securities as

$$Reversal_{AAA,AA}(\alpha) = P\left(P(Loss > \alpha \mid AAA, X) > P(Loss > \alpha \mid AA)\right)$$

where the outer probability is likewise taken as an expectation over the random covariates X. We estimate $Reversal(\alpha)$ by calculating the fraction of all AAA-rated securities i, for which $\hat{P}(Loss > \alpha \mid AAA, X_i)$ exceeds $\hat{P}(Loss > \alpha \mid AA)$, with $\hat{P}(\cdot)$ denoting the estimator of $P(\cdot)$ explained above. We likewise construct estimators for $Reversal_{AAA,A}(\alpha)$, $Reversal_{AA,A}(\alpha)$, etc.. We explore different values for α to fully understand the landscape of these gains and rating reversals.

[Insert Table 8 about here]

[Insert Table TA5 about here]

Panel A of Table 8 reports estimates of the gains given by equation 1, for all the pairwise comparisons between a given rating and ratings below it for investment grade RMBS. We see that covariates did carry information that would have been useful to predict losses, and to assign ratings, particularly for the AA, A, and BBB ratings. For AAA ratings, we some gains from the covariates only for low values of alpha. The estimates of rating reversals is reported in panel B of Table 8. It turns out that the value of α matters considerably. If $\alpha = 0$, then we find a 40 percent probability of rating reversal. To understand this, consider the probability of the occurrence of any loss, as shown in table TA5. It turns out that AAA securities were actually

[15] For a detailed list of the covariates employed, refer to MBS Project/Replication/DefaultsAnalysis/Step7

somewhat more likely to incur losses than AA securities: the overall fractions are 28 percent versus 16 percent. We know already, however, that losses on AAA securities are typically small, if they occur at all. Figure 2 shows that the distribution for AAA securities puts more weight on small losses compared to the distribution for other investment grade securities. Thus, as α is increased to, say, 10%, we find a rating reversal probability of only 3%.

A loss threshold of $\alpha = 0$ is perhaps very stringent to judge the appropriateness of the rankings, especially in light of the crisis. Perhaps a loss threshold of $\alpha = 0.1$ or 10%, for which rating reversals are now rare, is quite large, in particular for highly rated securities, though perhaps not dramatically large, given the unfolding of the crisis and given our purposes here. Overall we judge that the rating agencies got the rankings about right, in particular for the AAA-rated securities. We therefore summarize the findings from both exercises as our ***sixth fact***: **the misrating for AAA securities was modest.**

This interpretation and these numbers come with a number of caveats, of course. First, the construction of the securities often implies mechanically, that lower-ranked securities will be hit with losses before that happens to higher-ranked securities. The ranking of securities for any given deal is therefore very unlikely to be incorrect (assuming that rating agencies did indeed check the loss sequencing): the comparison here is more interesting regarding the consistency of rankings for securities across deals. Second, all our inference is conditional on the crisis of 2008: this is the only set of observations we got. We obviously cannot infer anything here about the appropriateness of the ratings or their rankings across all potential futures from 2007 on forward. Finally, we have used the realized losses to estimate the weight on information available a priori, in order to check for rating reversals. Obviously, the rating agencies did not have that information at hand at the time when they had to give their assessments.

4.7 Fact 7: a home price boom was good for repayments.

Given our fourth fact, can we therefore conclude that ratings deteriorated over time and that rating agencies became more generous? This certainly has been a theme in much of the conventional narrative of the crisis. Given the evidence compiled for our forth fact, we cautiously share the view that rating standards have indeed deteriorated in the run-up to the crisis. Moreover, these results are consistent with the findings of Adelino et al. (2015), who argue that middle income borrowers had an increasing relative role in mortgage delinquencies and defaults in the run-up to the crisis. These results are also consistent with the idea that securitization contributed to bad lending by reducing incentives of lenders to carefully screen borrowers, and that lower screening standards happened for relatively high FICO scores as those loans were easier to securitize as argued by Keys et al. (2010).

The deterioration in performance could also have been due to bad luck, though. Consider a security issued long before the peak of the house price boom, and compare it to an otherwise identical security issued just at the peak. The former security is less likely to be subject to losses, since the 2013 value of the underlying home relative to the original purchase price is higher for the former compared to the latter. If one views the arrival of the house price decline as a random event, unrelated to current level of house prices, one could argue that the resulting higher losses for the later vintages were just a stroke of bad luck, and not the result of a more liberal rating.

[Insert Table 9 about here]

To explore this issue, we exploit the cross-state variation in house price developments as well as the state-specific performance of the RMBS. For each security in our data set, we know the top five states in terms of the locations of the underlying mortgages, and the fraction of the total principal invested there. In table 9, we estimate a linear regression of the cumulative loss as a fraction of initial principal on the change in house prices, both during the run-up phase from 2000-2006 as well as the crash-phase from 2006-2009. To find the house price change relevant for each RMBS, we have averaged the house price changes over the five top states in which that security was invested, using the relative investment shares to calculate these averages. Our preferred specifications are in columns (3) and (4). There, we find that the increase in house prices decreased losses, but that the subsequent decrease in house prices increased losses for the security. According to column (4), say, an additional increase of house prices from 2000 to 2006 decreased losses by 0.18 percent of principal, while an additional decline of house prices from 2006 to 2009 by one percent increased losses by 0.53 percent. Column (3) provides a rather similar answer. If only the price increase is included or if state dummies are included, with the weights given by the investment shares, these effects (rather naturally) disappear. We summarize the key insight with our ***seventh fact***: **controlling for a home price bust, a home price boom was good for the repayment on these securities.** The results show that it is really the bust, not the boom, which adversely affected the repayments. As an implication, securities issued at a later date were exposed to more of the bust and less to the boom, making their losses more likely. Fact 4 holds up even after controlling for the house price boom and bust. The results of the technical appendix shown in figures TA5 through TA8 control for house prices. It does seem, that the credit rating agencies did lower their standards, notwithstanding the fact shown here that exposure to house prices did affect repayments and may have been (at least partially) missed in the rating process.

5 Returns

AAA securities in particular play a special role, in that they are considered to be safe investments. It should be clear from the facts presented so far, that they were not safe, as a group, and that some indeed defaulted dramatically. A complementary perspective is to ask, how much money investors gained or lost from holding these securities to maturity, i.e. to calculate their rates of returns. This is the purpose of this section. Only investment-grade securities were sold at par: so we focus on these.

We have calculated these returns in two ways. The first is to calculate the internal rate of return. This is the rate r that solves net present value equation

$$P_0 = \sum_{t=1}^{T} \frac{i_t + p_t}{(1+r)^t} + \frac{TV_T}{(1+r)^T} \tag{2}$$

where P_0 is the initial value of the security and equal to the principal amount, i_t is the monthly cash flow corresponding to interest payments, p_t is the monthly cash flow corresponding to principal paydown, and TV_T is the terminal value at some date T. The second is to calculate the implied premium θ over a benchmark interest rate r_t, solving

$$P_0 = \sum_{t=1}^{T} \frac{i_t + p_t}{\left(1 + r_t^{t\_bill} + \theta\right)^t} + \frac{TV_T}{\left(1 + r_t^{t\_bill} + \theta\right)^T} \tag{3}$$

This perspective may be particularly appropriate for floating-interest rate mortgages. For the benchmark r_t, we are using the 3-month Treasury Bill. Note that we do not take into account risk prices or term premia in either calculation.

We set T to be December 2013, given our data set. We observe the original principal amount P_0, payments i_t as well as p_t, but we do need to make assumptions regarding the terminal value TV_T. The natural candidate for the terminal value is the outstanding principal balance at time T, which is part of the monthly information that we have for each security. To that end, it is important to understand how past losses affect the outstanding principal value in the data. In a typical prospectus for an RMBS one can find the explanation: realized losses are applied to reduce the principal amount and "if a loss has been allocated to reduce the principal amount of your class of certificates, you will receive no payment in respect of that reduction." From this we conclude that the principal balance recorded in the data at date T already incorporates losses on principal that have occured previously rather than leaving them on the book. However it is possible that there needs to be some additional discounting of the outstanding principal value, because additional losses may be expected in the future. We therefore examine three

different scenarios regarding the terminal value, and assume that all securities are valued at 80%, 90% and 100% of the principal outstanding as of December 2013. In the technical appendix, we provide results for an additional three scenarios, to examine robustness. For the fourth scenario, we assume that each security trades at a loss equal to the loss rate it has suffered up to that point. For the fifth, we assume that each security trades at a loss equal to the mean loss rate of the securities with the same original credit rating and same vintage. The sixth is similar to the fifth, except for using the median loss rate rather than the mean. The overall results did not seem to change much.

[Insert Figure 5 about here]

[Insert Table 10 about here]

[Insert Table 11 about here]

To provide a perspective for the (first) three scenarios shown here, we consulted information provided by FINRA for the month of December 2013, see figure 5. In 2009, the Financial Industry Regulatory Authority (FINRA) made a proposal to collect data for ABS, CDO, and MBS securities.[16] Now daily reports going back to May 2011 with the number of transactions, trade volume, and statistics on transaction prices are publicly available.[17]. From these reports one can see that, as of December 2013, investment-grade securities were mostly trading with prices above 90, and non-investment grade with prices above 75 and generally above 80. We therefore consider our range from 80 to 100 percent to be reasonable.

Table 10 presents results for the realized internal rate of return calculations, for the first three scenarios regarding the terminal value. These results are echoed by the corresponding premium calculations in table 11. It may therefore suffice to comment on the first of these two tables. The most important result here may be that AAA securities provided an internal rate of return of about 2.44% to 3.31%, depending on the scenario. It mattered quite a bit, whether the mortgages were fixed rate or floating rate. For fixed rate mortgages, AAA securities returned between 3.6 and 4.8 percent, depending on the market segment and assumptions regarding the terminal value. For floating rate mortgages, AAA securities returned between 0.4 and 3.8 percent. These results show about a 2 percentage point realized premium of Prime over Subprime securities. This may be surprising at first given that we showed that losses in subprime securities were not particularly worse than in other segments and for AAA were actually lower. One reason behind this is the fact that the fraction of floating rate bonds (almost 90%) in

[16] `https://www.finra.org/newsroom/2009/finra-proposes-expanding-trace-reporting-asset-backed-securities`

[17] Reports are available and can be downloaded at `http://tps.finra.org/idc-index.html`

the subprime segment was higher than the fraction of floating rate bonds in the Alt-A (about 62%) and Prime (about 46%) segments. In a period of low interest rates like the one we consider, floating rate bonds did worse than fixed rate bonds. Overall, though, these returns and premia on AAA RMBS strike us as rather reasonable. It surely is an interesting challenge to construct a theory around these realized returns, which despite being positive above the risk free benchmark, the conventional narrative puts them at the heart of what resulted in a disaster for the world-wide financial system. Finally, tables TA7, TA8, TA9, TA10 in the technical appendix show calculations of the return premium based on individual securities as opposed to pooling cash flows together.

6 Discussion and Conclusion

We have examined the payoff performance, up to the end of 2013, of non-agency residential mortgage-backed securities (RMBS), issued up to 2008. For our analysis, we have created a new and detailed data set on the universe of non-agency residential mortgage backed securities, per carefully assembling source data from Bloomberg and other sources. We have compared these payoffs to their ex-ante ratings as well as other characteristics. We have established seven facts. Together, these facts call into question the conventional narrative, that improper ratings of RMBS were a major factor in the financial crisis of 2008 as well as create an intriguing quantitative challenge to theorists seeking to explain the meltdown of the world-wide financial system due to the performance of highly rated RMBS.

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7 Figures and Tables

Table 1: **RMBS Database: Deals, Securities, Nominal Amounts by Year of Issuance**

This table reports some figures that describe the size of our database of Residential Mortgage Backed Securities by year of issuance. All the information comes from Bloomberg. The securities included in our final database were issued between 1987 and 2013.

Year	No. Deal Managers	No. Deals	No. MBS	Notional ($ Billion)	Average Deal Size ($ Million)
1987 - 1999	35	858	9,462	244.2	284.6
2000	20	227	2,724	93.8	413.2
2001	23	397	5,815	179.9	453.1
2002	30	574	8,255	314.0	547.1
2003	30	788	12,420	475.1	603.0
2004	30	1,106	15,787	723.4	654.1
2005	29	1,361	22,017	1,005.2	738.5
2006	39	1,563	27,184	1,237.4	791.7
2007	35	1,027	19,143	936.1	911.5
2008	20	108	1,541	103.3	956.4
2009	17	151	5,660	170.6	1,129.9
2010	17	135	6,089	155.9	1,154.5
2011	13	101	3,182	68.3	676.5
2012	11	92	1,789	36.5	396.9
2013	13	127	2,164	98.7	776.9
All Years	83	8,615	143,232	5,842.3	678.2

Table 2: **Database Variables**

This table lists some of the data and variables that we gathered from Bloomberg and the 2013 Mortgage Market Statistical Annual about each of the non-agency Residential Nortgage backed Securities in our data. Section 2 in the on-line data appendix contains a detailed description of the variables in our dataset.

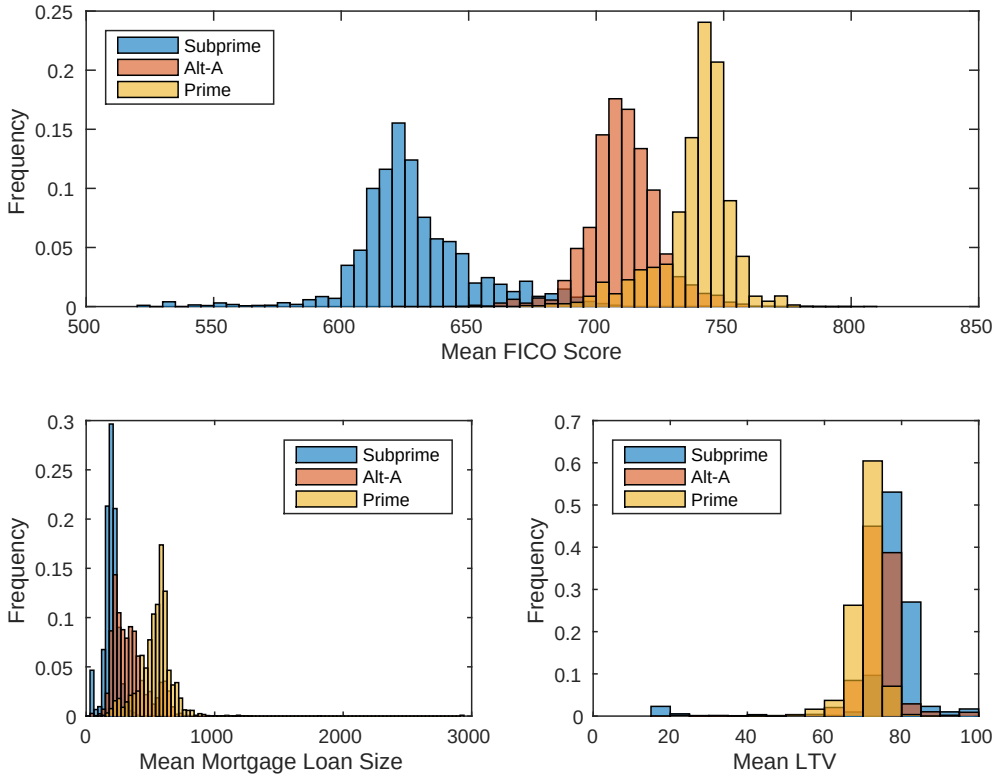
Security Identification	***Credit Rating***
Cusip ID	Current and Original Ratings (5 agencies)
Deal Name	***Other Security Characteristics***
Deal Manager	Credit Support at Issuance
Issuer Company	Original Principal Amount
Security Classification	***Collateral Description***
Deal Type (eg. CMBS, RMBS)	Mortgage Purpose (% Equity Takeout, Refinance)
Collateral Type (eg. Home, Auto, Student)	LTV Distribitution (min, max, mean, 25th, 50th,75th)
Collateral Type (eg. ARM vs FRM)	Credit Score Distribution (min, max, mean, 25th, 50th,75th)
Agency Backed (yes, no)	Mortgage Size Distribution (min, max, mean, 25th, 50th,75th)
Agency (eg. Fannie Mae, Freddie Mac)	MBS metrics 1: Weighted Average Coupon
Dates	MBS metrics 2: Weighted Average Life
Issue Date	MBS metrics 3: Weighted Average Maturity
Pricing Date	Fraction of adjustable-rate (ARM) and fixed-rate (FRM) mortgages
Maturity Date	Occupancy (% of Owner, Investment, Vacation)
Security Description	***Geographic Information***
Bond type (e.g. Floater, Pass-through, Interrest Only)	Fraction of mortgages in top 5 states
Tranche Subordination Description	***Cash Flow and Losses***
Coupon Type (e.g. Fixed, Floating)	Monthly Interest and Prinicipal Payment
Coupon Frequency (e.g. Monthly)	Monthly Outstanding balance
Coupon Index Rate (e.g. 3M-libor)	Monthly Losses

Table 3: **Non-Agency RMBS 1987-2013: Credit Rating Composition**

This table shows the total of principal amounts by credit rating. The credit rating corresponds to the rating assigned to a bond upon issuance. If several ratings were given, we have taken an average. This table illustrates fact 1: The great majority of non-agency RMBS securities were assigned a AAA rating upon issuance. The calculations in this table include all securities in the database, even those issued after 2008.

Rating	**$ Billion**	**Pct.**
AAA	4,535.1	86.9
AA	297.0	5.7
A	212.3	4.1
BBB	118.4	2.3
BB	40.1	0.8
B	13.6	0.3
CCC	0.3	0.0
CC	0.6	0.0
C	3.3	0.1
Rated	5,220.5	91.7
Not Rated	472.1	8.3

Figure 1: **Distribution of Mean FICO Score, Loan Size, and LTV by Type of Loan**



This figure plots the distribution of the mean FICO score, the mean mortgage loan size and the mean loan to value ratio (LTV) for Residential Mortgage Backed Securities issued between 2006 and 2012 and classified by type of mortgage backing the securities. The classification is done based on information in the Statistical Annual while the data on scores, loan size and LTV is from Bloomberg.

Table 4: **RMBS Losses as of December 2013, by credit rating.**

This table shows the principal amount at issuance as well as the cumulated losses, as of December 2013, broken down by credit rating. We exclude all the MBS bonds for which the original principal amount is only a reference or that can distort our computations. The excluded bonds include bonds with zero original balance, excess tranches, interest-only bonds, and Net Interest Margin deals (NIM). Only bonds issued up to 2008 are part of the computations.

	Principal Amount	Losses	Percentage
All RMBS	4,965.6	313.7	6.3
AAA	4,402.4	94.9	2.2
AA	263.7	87.4	33.1
A	144.9	56.3	38.8
BBB	101.6	47.7	46.9
NIG	53.1	27.9	52.6

Table 5: **RMBS Losses as of December 2013, by credit rating and mortgage type.**

This table shows the principal amount at issuance as well as the cumulated losses, as of 2013, broken down by credit rating and mortgage type (Prime, Alt-A, and Subprime).

	Principal Amount	Losses	Percentage
All Securities			
Prime	1,238.7	37.5	3.0
Alt-A	1,327.3	145.2	10.9
Subprime	1,196.0	119.1	10.0
AAA Rated Securities			
Prime	1,172.7	14.8	1.3
Alt-A	1,210.0	78.9	6.5
Subprime	979.5	4.3	0.4
Investment Grade Ex-AAA Securities			
Prime	54.0	18.4	34.0
Alt-A	96.5	55.3	57.3
Subprime	203.9	104.8	51.4
Non-Investment Grade Securities			
Prime	12.0	4.3	36.2
Alt-A	20.8	10.9	52.7
Subprime	12.7	10.0	78.7

Table 6: **Principal-Weighted Losses in RMBS and Credit Ratings**

This table shows regressions of the cumulative loss as fraction of initial principal as of December 2013 on credit rating dummy variables. The regressions are weighted by the principal dollar amount upon issuance of each RMBS. The constant of the regression corresponds to AAA securities, and we have renamed the constant as AAA. The first column shows the results for the entire sample, i.e. all securities issued since 1987 through 2008. The next 3 columns split the sample by year of issuance into three periods.

Credit Rating	**Full Sample**	**Before 2003**	**2003 - 2005**	**2006-2008**
AAA	0.0218***	0.0002	0.0034***	0.0483***
	(0.0006)	(0.0001)	(0.0007)	(0.0011)
AA	0.3096***	0.001	0.1180***	0.5091***
	(0.0025)	(0.0008)	(0.0028)	(0.0043)
A	0.3620***	0.0055***	0.2000***	0.6572***
	(0.0033)	(0.0008)	(0.0036)	(0.0062)
BBB	0.4480***	0.0334***	0.3152***	0.6655***
	(0.0040)	(0.0013)	(0.0041)	(0.0072)
BB	0.4923***	0.0653***	0.4886***	0.5136***
	(0.0064)	(0.0029)	(0.0075)	(0.0102)
B	0.5812***	0.0938***	0.6989***	0.5619***
	(0.0117)	(0.0042)	(0.0147)	(0.0182)
CCC	0.7360***	0.4125***	0.4102***	0.9465***
	(0.0867)	(0.0558)	(0.0987)	(0.1361)
CC	0.2036***	0.1364	0.0251	0.2005***
	(0.0562)	(0.0964)	(0.1228)	(0.0719)
C or Below	0.3863***	0.0661***	0.6607***	0.3604***
	(0.0225)	(0.0227)	(0.1665)	(0.0274)
Observations	93,902	19,230	38,381	36,291
R-squared	0.3217	0.0852	0.2972	0.485

Standard errors in parentheses
$*p < 0.10, **p < 0.05, ***p < 0.01$

Table 7: **Losses and Credit Ratings by Vintage Group and Type of Mortgage Loan**

This table presents principal-weighted regressions of the cumulative loss as fraction of initial principal as of December 2013 on credit rating dummy variables for all the RMBS in our database issued through 2008 classified by the type of mortgage loan underlying the securities and by 3 vintage groups.

	Prime			**Alt-A**			**Subprime**		
Rating	**Before 2003**	**2003 - 2005**	**2006 - 2008**	**Before 2003**	**2003 - 2005**	**2006 - 2008**	**Before 2003**	**2003 - 2005**	**2006 - 2008**
AAA	0.0000	0.0032***	0.0259***	0.0002	0.0076***	0.0953***	0.0004	0.0013	0.0068***
	(0.0001)	(0.0008)	(0.0015)	(0.0003)	(0.0015)	(0.0015)	(0.0008)	(0.0018)	(0.0020)
AA	0.0001	0.2242***	0.5841***	0.0045**	0.2097***	0.7824***	0.0007	0.0348***	0.6260***
	(0.0007)	(0.0052)	(0.0093)	(0.0019)	(0.0060)	(0.0080)	(0.0040)	(0.0061)	(0.0061)
A	0.0006	0.2837***	0.3071***	0.0080***	0.3620***	0.7260***	0.0151***	0.1566***	0.7600***
	(0.0011)	(0.0075)	(0.0117)	(0.0027)	(0.0094)	(0.0119)	(0.0050)	(0.0077)	(0.0078)
BBB	0.0039***	0.3065***	0.2957***	0.0267***	0.4728***	0.5161***	0.0718***	0.3609***	0.8654***
	(0.0013)	(0.0088)	(0.0146)	(0.0033)	(0.0115)	(0.0117)	(0.0058)	(0.0091)	(0.0094)
BB	0.0163***	0.2850***	0.2303***	0.0499***	0.6415***	0.3546***	0.1113***	0.5755***	0.8861***
	(0.0021)	(0.0095)	(0.0143)	(0.0054)	(0.0173)	(0.0144)	(0.0199)	(0.0191)	(0.0166)
B	0.0336***	0.7159***	0.8828***	0.0863***	0.7765***	0.4816***	0.2448***	0.5133***	0.7463***
	(0.0026)	(0.0165)	(0.0344)	(0.0075)	(0.0254)	(0.0193)	(0.0419)	(0.0580)	(0.0495)
CCC	-	0.2474**	0.9484***	0.9710***	0.6840***	0.8850**	-	0.3836**	0.9931***
	(0.0754)	(0.1091)	(0.2731)	(0.0866)	(0.1954)	(0.3523)	(0.0977)	(0.1949)	(0.1512)
CC	-	0.0109	-	-	-	0.6322***	-	0.1189	-
	(0.1109)	(0.0951)	(0.2628)	(0.1027)	(0.0977)	(0.1078)	(0.1027)	(0.3823)	(0.5566)
C or Below	-	0.7679***	0.9687	0.4963***	-	0.3112***	-	0.3775	0.9932**
	(0.1215)	(0.1359)	(0.5928)	(0.0449)	(0.0219)	(0.0241)	(0.1369)	(0.3712)	(0.5020)
Observations	4,095	13,366	8,015	2,908	8,226	16,001	1,363	6,028	11,314
R-squared	0.0554	0.3468	0.4182	0.1571	0.4329	0.4975	0.1432	0.3217	0.7052
Weighted	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors in parentheses
$*p < 0.10, **p < 0.05, ***p < 0.01$

Table 8: **Credit Rating Reversals**

Panel A presents the calculation of equation (1). Panel B presents the incidence of credit rating reversals. Using our estimated probability model that uses the covariates in our database we compute the fraction of securities of a given credit rating for which we would have predicted a probability of loss bigger than the probability of loss of a lower credit rating if we had had all the information upon issuance. For example, for AAA that switched to AA we compute the fraction of RMBS such that $P(Loss > \alpha|AAA, X) > G(\alpha) = P(Loss > \alpha|AA)$*).*

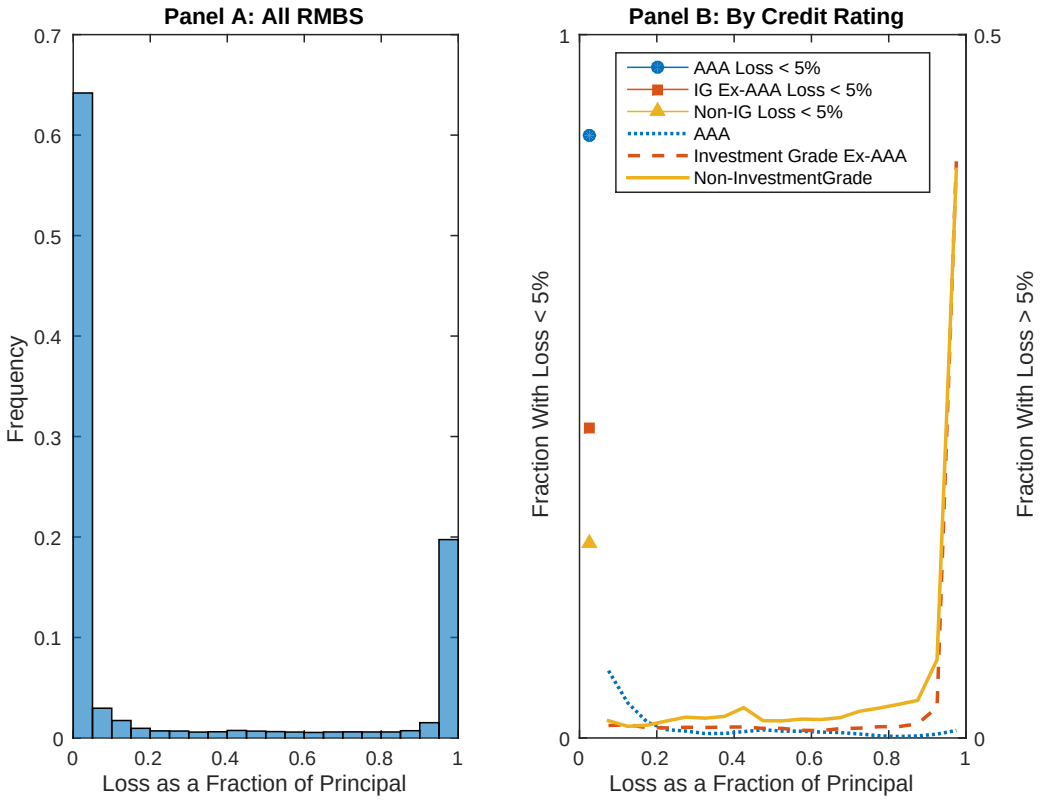
Panel A: Gains from Including Other Covariates

	$\alpha = 0$	$\alpha = 0.05$	$\alpha = 0.1$	$\alpha = 0.25$	$\alpha = 0.5$	$\alpha = 0.75$	$\alpha = 0.9$
Principal Value Weighted							
AAA vs AA	1.65	0.47	0.24	0.12	0.08	0.04	0.03
AAA vs A	2.26	0.58	0.28	0.14	0.08	0.04	0.03
AAA vs BBB	0.82	0.32	0.17	0.09	0.06	0.03	0.02
AA vs A	-8.52	-6.76	-6.69	-11.29	-20.50	-59.50	- -699.95
AA vs BBB	2.27	2.54	2.77	2.59	2.79	2.62	2.54
A vs BBB	1.90	1.94	2.07	2.32	2.82	3.02	3.11

Panel B: Credit Rating Reversals

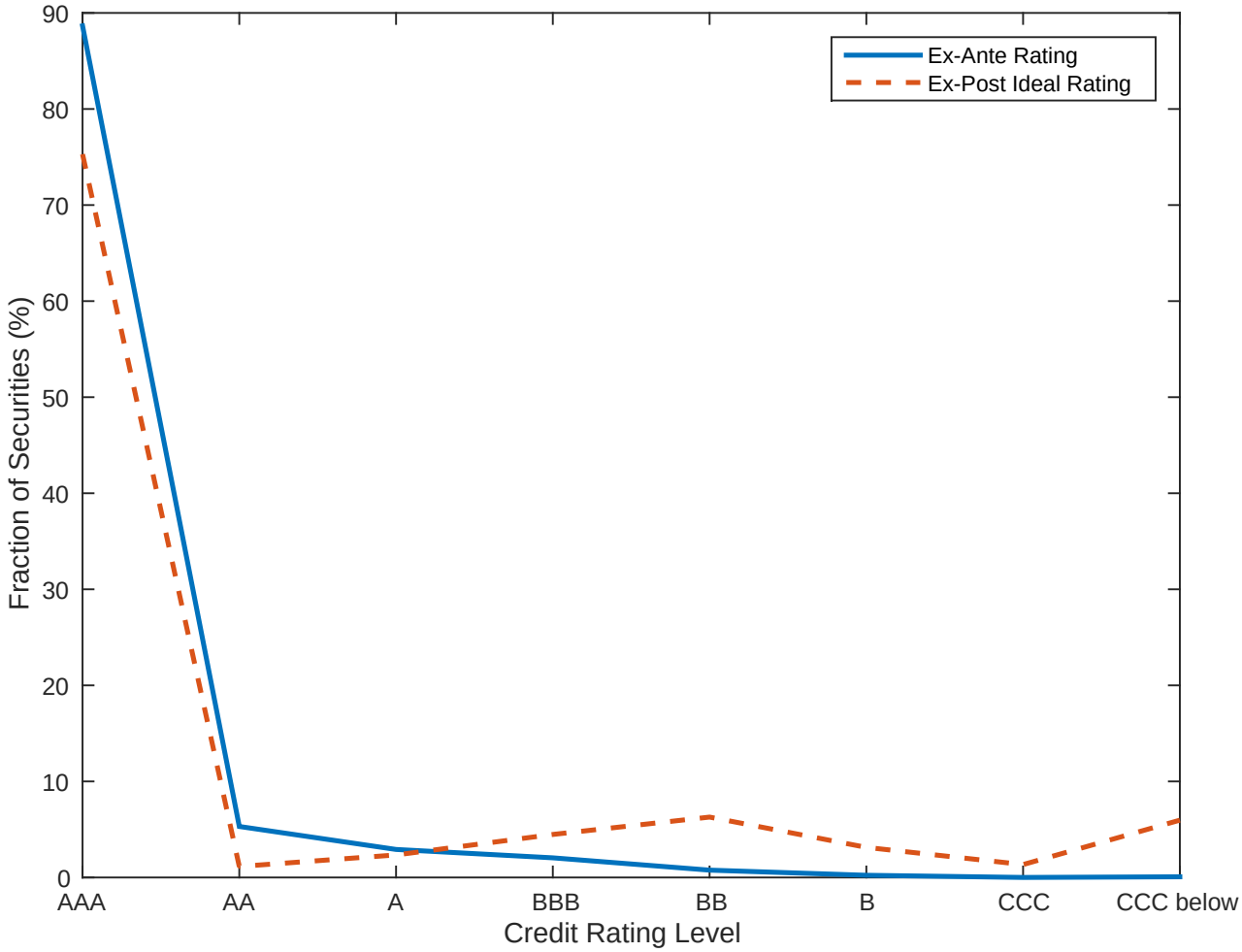
	$\alpha = 0$	$\alpha = 0.05$	$\alpha = 0.1$	$\alpha = 0.25$	$\alpha = 0.5$	$\alpha = 0.75$	$\alpha = 0.9$
Principal Value Weighted							
AAA switched to AA	49.9	13.9	1.0	0.3	0.3	0.0	0.0
AAA switched to A	54.5	21.4	2.3	0.3	0.3	0.0	0.0
AAA switched to BBB	31.2	2.8	0.4	0.3	0.2	0.0	0.0
AA switched to A	75.4	73.2	72.8	71.7	69.0	67.4	66.1
AA switched to BBB	63.8	63.1	63.1	62.8	60.9	59.2	57.8
A switched to BBB	67.4	67.7	67.9	68.1	68.5	67.3	65.4

Figure 2: **Distribution of Loss Size for All RMBS**



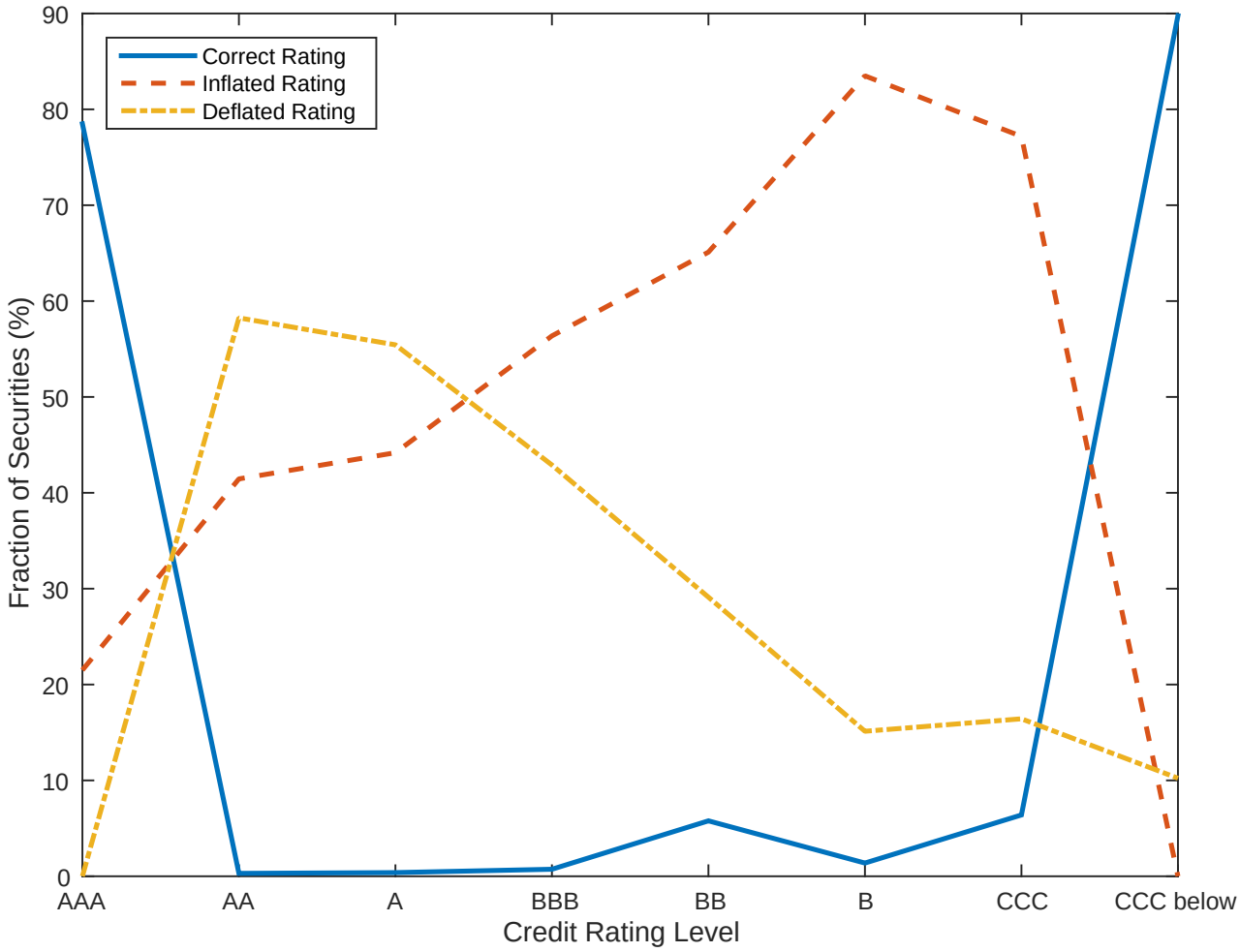
Panel A presents the distribution of cumulative losses as of December 2013 as a fraction of the original principal amount for all the RMBS in our database issued from 1987 through 2008. Panel B shows the distribution of cumulative losses as of December 2013 as a fraction of the original principal amount for different groups of RMBS based on the type of the underlying mortgage loans.

Figure 3: **Ex-Ante vs Ex-Post Ideal Ratings**



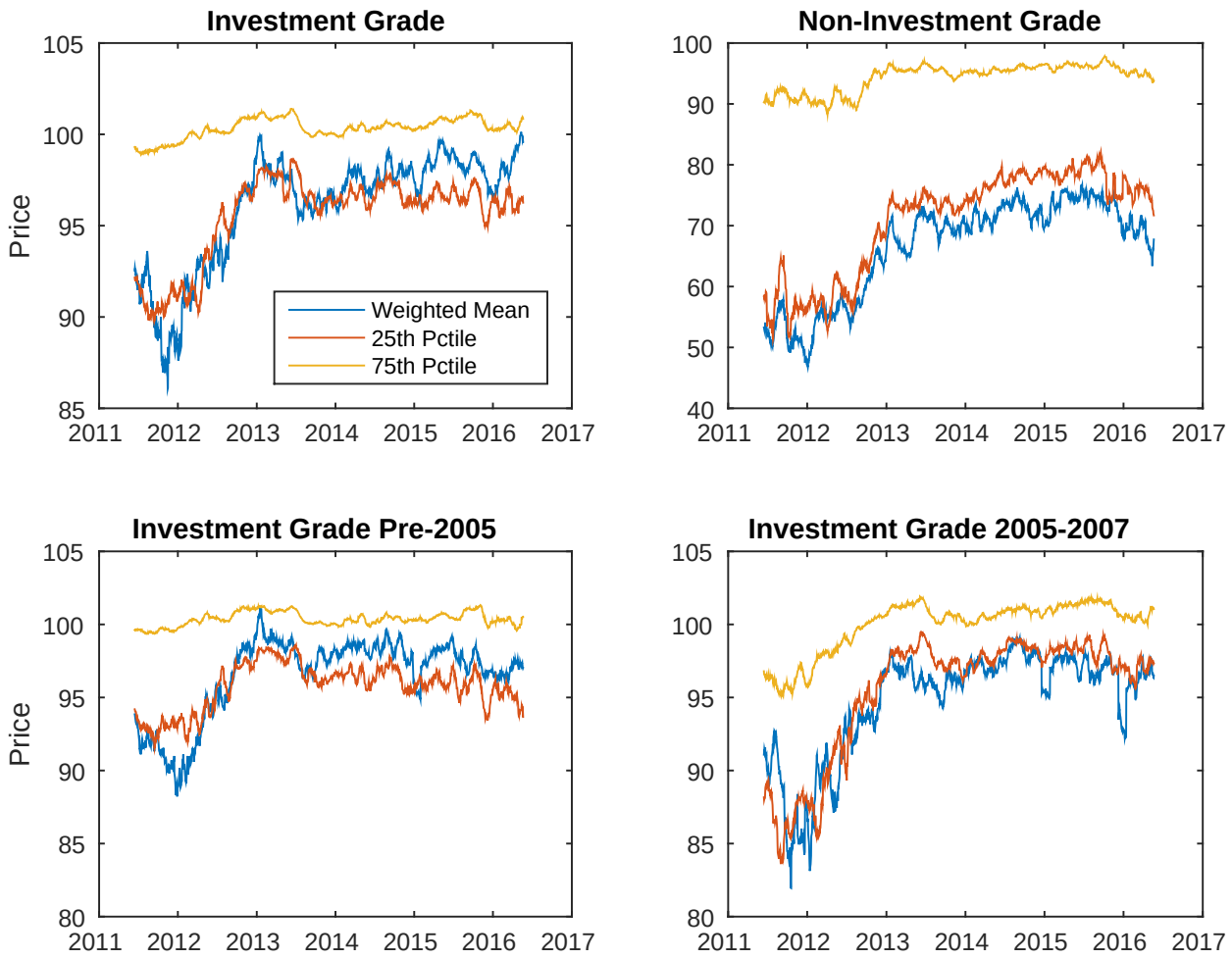
In this figure, for each security, we compare the original credit rating (which we call here Ex-Ante Rating) to the rating that ex-post we would have assigned given the security's realized loss using Moody's idealized Expected Loss Table by Rating, which we present in Figure TA9 in the technical appendix. The solid line shows the fraction of securities that was assigned each rating level. The dotted line shows the fraction of securities that should have gotten each rating level based on their loss as a fraction of original principal. The calculations are all weighted by dollar value of principal

Figure 4: **"Right" and "Wrong" Ratings Based on Moody's Ideal Ratings**



This figure compares the original rating of each security to the rating we would have assigned ex-post based on Moody's idealized Expected Loss Table by Rating. If the two ratings coincide, we say that the security was correctly rated. If the original rating is higher than what it should have been based on realized losses, we say that the security had an inflated rating. Finally, if the original rating is lower than what it should have been based on realized losses, we say that the security had a deflated rating. The calculations are all weighted by dollar value of principal.

Figure 5: **Summary Statistics of Prices Collected by FINRA**



This figure shows summary statistics of daily transaction prices collected by the Financial Industry Regulatory Authority from May 2011 through May 2016 on Non-Agency MBS. The plots at the top break up the statistics by Investment Grade and Non-Investment Grade, while the plots at the bottom break up the statistics by groups of vintages only for Investment Grade securities. FINRA produces this information daily since 2011. The lines in the different figures correspond to 22-day moving averages (daily monthly averages) of the daily values reported by FINRA. Here we report the principal weighted average and the 25th and 75th percentiles of the average transaction price. The daily reports are available here `http://tps.finra.org/idc-index.html`

Table 9: **House Prices and Loss Rates**

This table presents linear regressions to study the relation between the the cumulative loss as fraction of initial principal as of December 2013 and changes in house prices. The variables on the RHS include the variables ΔHP 2000-2006 and ΔHP 2006-2009 which is the appreciation of house prices between 2000 and 2006 and between 2006 and 2009 in the five states that for each MBS have the highest share of the underlying mortgages.

	(1)	(2)	(3)	(4)	(5)
ΔHP 2000 - 2006	0.073***		-0.218***	-0.178***	-0.021
	0.003		0.010	0.012	0.027
ΔHP 2006 - 2009		-0.203***	-0.63***	-0.532***	0.342***
		0.006	0.021	0.020	0.061
AA				0.426***	0.423***
				0.003	0.003
A				0.493***	0.488***
				0.004	0.004
BBB				0.555***	0.55***
				0.005	0.005
BB				0.5***	0.492***
				0.007	0.007
B				0.599***	0.594***
				0.013	0.012
CCC				0.749***	0.74***
				0.087	0.086
CC				0.496***	0.493***
				0.089	0.087
C or Below				0.324***	0.305***
				0.023	0.022
Subprime				0.009***	-0.003*
				0.002	0.002
Alt-A				0.049***	0.032***
				0.002	0.002
Contstant	0.011***	-0.001	0.019***	-0.038***	0.059***
	0.002	0.002	0.002	0.005	0.007
State Dummies	No	No	No	No	Yes
Weighted Dummies	No	No	No	No	Yes
Observations	93,902	93,902	93,902	71,316	71,316
R-squared	0.0059	0.0107	0.0156	0.4345	0.4513
Weighted	Yes	Yes	Yes	Yes	Yes

Standard errors in parentheses
$*p < 0.10, **p < 0.05, ***p < 0.01$

Table 10: **Internal Rate of Return Calculations From Issuance to 2013 by Credit Rating and for AAA also by Type of Mortgage.**

This table presents Internal Rate of Return (IRR) calculations for the RMBS in our database by type of mortgage loan. The IRR solves equation 2. Here we report annualized rates. We present the computation under different assumptions about the terminal value of each security as of December 2013. The 3 columns assume that the security is sold at 80%, 90% *and* 100% *of the outstanding principal amount as of December 2013 respectively. The calculation was done by pooling together the cash flowsof all bonds and creating a super bond.*

Return Statistic	**80% TV**	**90% TV**	**100% TV**
By Credit Rating			
AAA	2.44	2.89	3.31
AA	-7.90	-7.01	-6.21
A	-10.92	-10.10	-9.35
BBB	-13.56	-12.80	-12.11
Inv. Grade Ex AAA	-9.01	-8.15	-7.38
By Type of Mortgage			
AAA Prime	3.61	3.98	4.33
AAA SubPrime	1.61	2.14	2.62
AAA AltA	1.37	2.01	2.61
Fixed Rate MBS			
AAA Prime Fixed	4.25	4.56	4.84
AAA SubPrime Fixed	4.86	4.96	5.04
AAA AltA Fixed	3.64	4.13	4.58
Floating Rate MBS			
AAA Prime Floating	3.03	3.45	3.83
AAA SubPrime Floating	1.45	1.97	2.44
AAA AltA Floating	0.42	1.12	1.76

Table 11: **Premium θ From Issuance to 2013 by Credit Rating AAA also by Type of Mortgage.**

This table presents premium calculations for the RMBS in our database by credit rating using the 3-month Tbill rate as benchmark. The premium IRR solves equation 3. We present the computation under different assumptions about the terminal value of each security as of December 2013. The 3 columns assume that the security is sold at 80%, 90% and 100% of the outstanding principal amount as of December 2013 respectively. The calculation was done by pooling together the cash flows of all bonds and creating a super bond.

Return Statistic	**80% TV**	**90% TV**	**100% TV**
By Credit Rating			
AAA	0.84	1.39	1.86
AA	-9.45	-8.61	-7.66
A	-12.37	-11.6	-10.9
BBB	-15.16	-14.3	-13.56
Inv. Grade Ex AAA	-10.56	-9.75	-8.83
By Type of Mortgage			
AAA Prime	2.16	2.48	2.78
AAA SubPrime	0.06	0.54	1.17
AAA AltA	-0.23	0.51	1.16
Fixed Rate MBS			
AAA Prime Fixed	2.7	2.96	3.39
AAA SubPrime Fixed	3.41	3.46	3.49
AAA AltA Fixed	2.04	2.63	3.13
Floating Rate MBS			
AAA Prime Floating	3.01	3.42	3.84
AAA SubPrime Floating	1.46	1.92	2.39
AAA AltA Floating	0.4	1.09	1.77

On-line Appendix for Mortgage-Backed Securities and the Financial Crisis of 2008: a Post Mortem

April 6, 2018

Abstract

This on-line appendix is divided into three sections. Section A explains in detail, step by step, how we assembled the database for the paper using Bloomberg and the 2013 edition of the Mortgage Market Statistical Annual. Section B provides a brief description of the assembled database and the different variables that we were able to obtain from Bloomberg. This document serves as guide for replication and for understanding the contents of our database. Section C contains additional results, complementing the paper.

A Database Construction

One of the challenges that we faced in developing the project that has led to the paper "Mortgage-Backed Securities and the Financial Crisis of 2008: a Post Mortem" was the construction of the database. On our main source for information, Bloomberg, there is no predefined function that allows the user to obtain a list of all the Mortgage Backed Securities available. In this section we explain step by step how we put together our data in a systematic way and how we used the 2013 edition of the Mortgage Market Statistical Annual to guide our securities search. We also make reference to the files we used in every step and to their location in our replication kit.

Step 1. Find Deals of MBS

To find deals (series) of MBS securities we primariliy used as source the 2013 edition of the Mortgage Market Statistical Annual, which in Volume II (Pages 50 to 108) has a set of tables with lists of what in principle are all the MBS deals from 2006 through 2012. Figure DA1 shows a snapshot of one of such tables. We did not limit our search to these deals. Once we identified the deal name on Bloomberg, we also looked for information on deals that had the same root name for years prior to 2006. For example, a deal found in the statistical annual for year 2007 is Merrill Lynch SURF 2007-BC1. Another sample deal is Wells Fargo Mortgage Backed Securities Trust WFMBS 2007-10. The root name of these two deals are SURF 2007 and WFMBS 2007 respectively. Having identified these deals on Bloomberg, we got information not only for all the SURF 2007 and WFMBS 2007 deals (see Figure DA2), but also for all the deals that have the root SURF and WFMBS, for example WFMBS 2004 (see Figure DA3).

Since our interest was to get as close as possible to the universe of RMBS issued, we also performed searches not based on the list of deals provided by the Mortgage Market Statistical Annual. We looked for deals also based on the names of financial institutions that were involved in structuring and managing securitization deals, in this way broadening the search and not solely relying on one source. In the end, the key to finding deals was to identify what the root names for Bloomberg were. For example, typing JP Morgan Mortgage can lead you to JPMMT Mtge on Bloomberg, which would give a new full list of RMBS deals.

A Series of MBS is a set of Mortgage-Backed Securities backed by the same pool of mortgages. Each security in the series corresponds to a tranche. In order to get identifiers of each individual security we needed to construct a list of all the deals, based on the root names. In order to obtain a list of the series, we would follow these steps:

1. Type on Bloomberg the name of a deal or the name of financial institution. For example,

Figure DA1: **Snapshot of 2013 Mortgage Market Statistical Annual RMBS Deals List**

Non-Agency MBS Activity 2007

(Dollars in Millions)

Date	Deal Name	Amount	Support	Collateral	MBS Type	Subprime	Manager
10-Jan-07	Citigroup Mortgage Loan Trust 2007-WFHE1	$434.22	Sub	FRM/ARM	BC	x	Citi
11-Jan-07	WaMu Asset-Backed Certificates 2007-HE1	$1,360.34	Sub	FRM/ARM	BC	x	WaMu
12-Jan-07	Harborview NIM CI-7 Corp.	$5.70	NIM	NIM	BC	x	RBS GC
12-Jan-07	SACO Mortgage Trust 2007-1	$246.02	Sub	CES	2nd	x	BS
15-Jan-07	Washington Mutual WMABS 2007-HE1	$276.90	Sub	FRM/ARM	BC	x	WaMu
16-Jan-07	MASTR Adjustable Rate Mortgages Trust 2007-1	$2,099.43	Sub	ARM	Alt A		UBS
16-Jan-07	Option One Mortgage Loan Trust 2007-1	$1,749.86	Sub	FRM/ARM	BC	x	LB
17-Jan-07	Bear Stearns ABS Trust 2007-SD1	$279.82	Sub	FRM/ARM	SD	x	BS
17-Jan-07	Carrington Mortgage Loan Trust 2007-RFC1	$857.27	Sub	FRM/ARM	BC	x	Citi
18-Jan-07	Option One Mortgage Securities Re-NIM 2007-1	$75.00	NIM	NIM	BC	x	RBS GC
19-Jan-07	GSAMP Trust Series 2007-SEA1	$127.55	Sub	FRM/ARM	SD	x	GS
19-Jan-07	IndyMac INDX NIM CI-2	$35.76	NIM	NIM	Alt A		RBS GC
19-Jan-07	Morgan Stanley ABS Capital 2007-NC1	$1,214.38	Sub	FRM/ARM	BC	x	MS
19-Jan-07	Option One Mortgage Loan Trust 2007-FXD1	$817.69	Bond	FRM30	BC	x	BA
19-Jan-07	SABR Trust 2007-NC1	$816.82	Sub	FRM/ARM	BC	x	BC
19-Jan-07	SASCO NIM 2006-BC6	$48.40	NIM	NIM	BC	x	LB
19-Jan-07	Soundview CI-22 NIM, Series 2006-EQ2	$36.80	NIM	NIM	BC	x	RBS GC
19-Jan-07	Washington Mutual NIM Trust 2007-HE1	$10.81	NIM	NIM	BC	x	WaMu
22-Jan-07	Soundview CI-21 NIM, Series 2006-WF2	$67.90	NIM	NIM	BC	x	RBS GC
22-Jan-07	WaMu Mortgage PTC 2007-HY1	$3,041.31	Sub	ARM	Prime		WaMu
23-Jan-07	Banc of America Funding 2007-NIM1	$10.79	NIM	NIM	Alt A		BA
23-Jan-07	Countrywide Home Loan Trust 2006-BC5N	$28.87	NIM	NIM	BC	x	CSC
23-Jan-07	GSAMP 2006-FM3-N	$31.22	NIM	NIM	BC	x	GS
23-Jan-07	IXIS Real Estate Capital Trust 2007-HE1	$778.31	Sub	FRM/ARM	BC	x	MS
23-Jan-07	Merrill Lynch SURF 2007-BC1	$789.11	Sub	FRM/ARM	BC	x	ML
23-Jan-07	SHARPS NIM 2006-NC2N	$23.02	NIM	NIM	BC	x	DB
23-Jan-07	SHARPS NIM 2007-OA1N	$25.69	NIM	NIM	BC	x	DB
23-Jan-07	WaMu Mortgage PTC 2007-OA1	$1,100.05	Sub	ARM	Prime		WaMu
24-Jan-07	Accredited Mortgage Loan Trust 2007-1	$755.52	Sub	FRM/ARM	BC	x	LB
24-Jan-07	BSSP NIM Trust 2007-N1 (BSMF 2006-SL6)	$28.63	NIM	NIM	BC	x	BS
24-Jan-07	BSSP NIM Trust 2007-N1 (SACO 2007-1)	$13.23	NIM	NIM	2nd		BS
24-Jan-07	ChaseFlex Trust 2007-1	$450.01	Sub	FRM30	Alt A		JPM
24-Jan-07	CMO Holdings III Ltd. 2007-N1	$93.58	NIM	NIM	BC	x	BS
24-Jan-07	CWALT 2006-OC11N	$29.70	NIM	NIM	Alt A		CSC

This figure shows a snapshot of the table in the 2013 edition of the Mortgage Market Statistical Annual, containing some information on RMBS deals issued in 2007. We used this table specifically to get a list of deals.

typing WFBMS 2007 Mtge will lead to a screen with all the series of MBS whose root name is WFMBS. In this screen one can see a list of all the deals whose root name was WFMBS 2007, including WFMBS 2007-10, which we had identified from the Statistical Annual. See Figure DA2 as an example of what such an screen looks like. In addition, typing WFMBS Mtge can lead to a list for all the deals that have been issued with the root name WFMBS for all years. Figure DA3 shows that the deals under the umbrella WFMBS started in 2004. In this way we went back before 2006 and found the deals issued in the years for which we did not have information from the Statistical Annual. Also, using the names of financial institutions and typing for example JP Morgan Mortgage can lead to JPMMT Mtge on Bloomberg and provide and similar list of deals.

2. With the list of the series on the screen, we went on to export it to Excel. To do this, on Bloomberg go to export or click on the top right-hand corner on the green arrow and drag the list onto Excel.

3. We save the list of tickers of the series.

Figure DA2: **Snapshot of an Example of a Search for a List of Deals in 2007**

WFMBS 2007 Mtge
<Menu> for series list

95) Options | Page 1/2 | Mortgag | View All Classes

25 Series

	CF	Series	Pricing Date	Collateral	Net Cpn	WAC	WAM	Orig Bal at Iss
1)	*	2007 - AR10	12/21/07	Whole ARM	6.30	6.561	21Y 4M	357,537,982
2)	*	2007 - AR3	3/21/07	Whole ARM	5.88	6.143	20Y 8M	488,796,716
3)	*	2007 - AR4	8/27/07	Whole ARM	2.86	3.116	20Y 11M	421,914,996
4)	*	2007 - AR5	10/23/07	Whole ARM	6.14	6.395	21Y 1M	604,977,737
5)	*	2007 - AR6	10/24/07	Whole ARM	2.79	3.049	21Y 1M	1,399,536,070
6)	*	2007 - AR7	11/20/07	Whole ARM	2.83	3.092	21Y 3M	1,116,803,961
7)	*	2007 - AR8	11/26/07	Whole ARM	2.82	3.077	21Y 2M	435,434,104
8)	*	2007 - AR9	11/26/07	Whole ARM	6.21	6.471	21Y 3M	508,489,333
9)	*	2007 - 1	1/11/07	Whole 30yr	6.01	6.272	20Y 6M	600,991,640
10)	*	2007 - 2	2/26/07	Whole 30yr	5.98	6.236	20Y 7M	1,505,652,587
11)	*	2007 - 3	3/27/07	Whole 30yr	6.01	6.272	20Y 7M	1,354,453,990
12)	*	2007 - 4	3/26/07	Whole 30yr	5.99	6.245	20Y 8M	1,800,061,020
13)	Pd	2007 - 5	4/25/07	Wh 30y Relo	5.61	5.866	21Y 3M	461,281,364
14)	*	2007 - 6	4/25/07	Whole 30yr	5.95	6.215	20Y 9M	700,312,919
15)	*	2007 - 7	5/25/07	Whole 30yr	5.93	6.191	20Y 10M	5,100,122,414
16)	*	2007 - 8	6/28/07	Whole 30yr	5.95	6.208	20Y 10M	2,750,025,945
17)	Pd	2007 - 9	6/25/07	Wh 30y Relo	5.67	5.926	18Y 3M	751,843,367
18)	*	2007 - 10	6/28/07	Whole 30yr	6.01	6.275	20Y 11M	1,700,746,270
19)	*	2007 - 11	7/26/07	Whole 30yr	6.00	6.261	21Y 0M	3,954,809,375

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SN 166440 PDT GMT-7:00 G549-105-1 14-Jul-2016 14:28:38

This figure shows a snapshot of the Bloomberg screen in which we searched for the list of deals with root name WFMBS 2007 based on the list of deals provided by the Statistical Annual

Figure DA3: **Snapshot of an Example of a Search for a List of Deals Before 2006**

WFMBS Mtge

95) Options | Page 7/14 | Mortga | View All Classes

249 Series

	CF	Series	Pricing Date	Collateral	Net Cpn	WAC	WAM	Orig Bal at Iss
1)	*	2004 - CC	12/13/04	Whole ARM	2.84	3.098	18Y 6M	300,216,725
2)	*	2004 - D	4/12/04	Whole ARM	2.97	3.351	17Y 9M	357,876,502
3)	*	2004 - DD	12/15/04	Whole ARM	2.83	3.093	18Y 6M	600,082,218
4)	*	2004 - E	4/22/04	Whole ARM	3.08	3.339	17Y 10M	320,489,949
5)	*	2004 - EE	12/21/04	Whole ARM	2.87	3.125	17Y 11M	1,583,069,043
6)	*	2004 - F	5/13/04	Whole ARM	2.91	3.295	17Y 10M	400,536,041
7)	*	2004 - G	5/17/04	Whole ARM	2.87	3.127	17Y 8M	417,087,401
8)	*	2004 - H	5/20/04	Whole ARM	2.88	3.141	17Y 11M	458,184,853
9)	*	2004 - I	6/14/04	Whole ARM	2.83	3.093	17Y 3M	1,651,759,021
10)	*	2004 - J	6/24/04	Whole ARM	2.74	3.001	18Y 0M	426,419,494
11)	*	2004 - K	6/14/04	Whole ARM	2.76	3.017	18Y 0M	1,216,697,217
12)	*	2004 - L	6/23/04	Whole ARM	2.78	3.037	18Y 1M	457,327,472
13)	*	2004 - M	7/26/04	Whole ARM	2.75	3.009	18Y 1M	800,536,770
14)	*	2004 - N	7/26/04	Whole ARM	2.73	2.990	18Y 1M	1,200,723,373
15)	*	2004 - O	7/19/04	Whole ARM	2.74	3.003	18Y 1M	700,153,218
16)	*	2004 - P	8/11/04	Whole ARM	2.74	3.004	18Y 1M	1,522,920,382
17)	*	2004 - Q	8/12/04	Whole ARM	2.74	3.003	18Y 2M	677,971,620
18)	*	2004 - R	8/26/04	Whole ARM	2.74	3.000	18Y 2M	641,321,384
19)	*	2004 - S	8/26/04	Whole ARM	2.78	3.043	17Y 10M	1,777,319,714

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SN 166440 PDT GMT-7:00 G597-598-1 15-Jun-2016 09:59:14

This figure shows a snapshot of the Bloomberg screen in which we searched for the list of deals with root name WFMBS issued before 2006, this is, for the years for which we did not have information from the Mortgage Market Statistical Annual

We downloaded our data in 4 rounds. We have two files with all the series or deals that we downloaded data for. The name of the files are:

- MBSSeriesToDownloadRound1.xlsx. There are three sheets, "Series Sheets 2-50", "Series 80-147" and "Series 150-218". All the information of the bonds corresponding to the series is what we have labeled as round 1 of data downloading.

- MBSSeriesToDownloadRounds2to4.xlsx. There are three sheets, "Series Sheets 300-323, 400-403", "Series Sheets 404-407" and "Series Sheets 408-413". Information corresponding to the bonds of the MBS series in sheets 300 to 307 were downloaded in round 2, for sheets 308 to 323 in round 3, and for sheets 400 to 413 in round 4.

Also, in the same location there is a file called MBSSeriesAndBondsLeftOut.xlsx. In this file we have three sheets. In the first sheet we have the deals that we found on Bloomberg but that we did not download any information for due to our limited access to Bloomberg. In the second and third sheets we have series of MBS and their corresponding list of bonds for which we have information from 1999 onwards but that we did not download information prior to 1999 due also to our limited access to Bloomberg.

The location of files to replicate this step is:

- MBS Project/Replication/Database Construction/Step 1- Find MBS Series

Step 2. Construct a list of the underlying bonds for each MBS series

The purpose of this step is to obtain a list with the Bloomberg tickers of all the underlying bonds (tranches) corresponding to the each of series that we identified in Step 1. This will result in more than 140 thousand securities for which we downloaded detailed data. For example, for the deal that we have been using as example, WFMBS 2007-10, the list of individual bonds making up the deal is shown in Figure DA4.

A challenge at this point is how to obtain a list of all the bonds underlying all the deals that we found in step 1 in a systematic way. The way we overcame this challenge was to follow these steps:

1. On Bloomberg, type XLTP XMBD <GO>. Figure DA5 shows a snapshot of this page on Bloomberg.

2. Select (1) and download the bond generator for Mortgages. This is an Excel file that allows you to enter a list of deals like the one we obtained in Step 1 and get a list of all the bonds underlying the MBS series.

Figure DA4: **Example of a List of RMBS Bonds (Tranches) in a Deal**

95) Options

View All Classes

WFMBS 2007-10 WELLS FARGO MORTGAGE BACKED SECURITIES TRUST

61 Classes

Template Classic

	SSA	CF	Class	Orig(000)	Curr(000)	Cpn	OWAL	Orig Mty	Cusip	Tranche Description
1)		Y	1A1	300,000	50,104	6.000	5.71	7/25/37	949837AA6	PT, SSNR, AS
2)		Y	1A2	50,000	672	6.000	2.59	7/25/37	949837AB4	SEQ, SSNR, AS
3)		Y	1A3	11,446	3,577	6.000	5.24	7/25/37	949837AC2	SEQ, AS
4)		Y	1A4	15,709	4,910	6.000	9.43	7/25/37	949837AD0	SEQ, AS
5)		Y	1A5	101,994	13,363	6.000	3.99	7/25/37	949837AE8	PAC(11), SSNR, AS
6)		Y	1A6	71,354	23,714	6.000	11.97	7/25/37	949837AF5	PAC(11), SSNR, AS
7)		Y	1A7	29,719	3,278	6.000	3.85	7/25/37	949837AG3	PAC(22), AS
8)		Y	1A8	59,907	4,715	6.000	3.02	7/25/37	949837AH1	DRB, SUP, AS
9)		Y	1A9	19,969	1,572	6.000	3.02	7/25/37	949837AJ7	ARB, SUP, AS
10)		Y	1A10	100,000	12,263	5.900	3.92	7/25/37	949837AK4	AD, PAC(11), AS
11)		Y	1A11	1,667	204	6.000	3.92	7/25/37	949837AL2	IO, NTL
12)		Y	1A12	19,158	6,367	6.000	7.77	7/25/37	949837AM0	AD, PAC(11), SSNR, AS
13)			1A13	11,609	0	6.000	0.94	7/25/37	949837AN8	Z, SUP, AS
14)		Y	1A14	47,121	3,164	1.146	3.12	7/25/37	949837AP3	FLT, SUP, AD, AS
15)		Y	1A15	7,854	527	35.124	3.12	7/25/37	949837AQ1	INV, SUP, AD, AS
16)		Y	1A16	12,505	2,544	6.000	5.74	7/25/37	949837AR9	AD, SEQ, AS
17)		Y	1A17	20,117	6,283	6.000	9.99	7/25/37	949837AS7	AD, SEQ, AS
18)		Y	1A18	13,814	6,040	6.000	15.33	7/25/37	949837AT5	Z, SEQ, SSNR, AS
19)		Y	1A19	40,085	848	6.000	2.99	7/25/37	949837AU2	PAC(11), SSNR, AS
20)		Y	1A20	51,693	17,180	6.000	7.79	7/25/37	949837AV0	PAC(11), SSNR, AS
21)		Y	1A21	57,686	710	6.000	2.34	7/25/37	949837AW8	SUP, AS
22)		Y	1A22	40,000	6,681	0.946	5.71	7/25/37	949837AX6	FLT, PT, SSNR, AS
23)		Y	1A23	4,516	956	36.324	7.17	7/25/37	949837AY4	INV, PAC(11), AS
24)		Y	1A24	2,150	90	36.324	2.66	7/25/37	949837AZ1	INV, SUP, AS

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This figure shows a snapshot of the Bloomberg page with all the individual RMBS bonds that make up the sample deal

3. Open the bond generator on Excel enabling macros. Figure DA6 shows a snapshot of this Excel file.

4. Go to the list of series from Step 1, copy it and paste it on the Bond Generator file.

5. Generate the list of tickers of bonds by clicking on the button that activates and runs the macro.

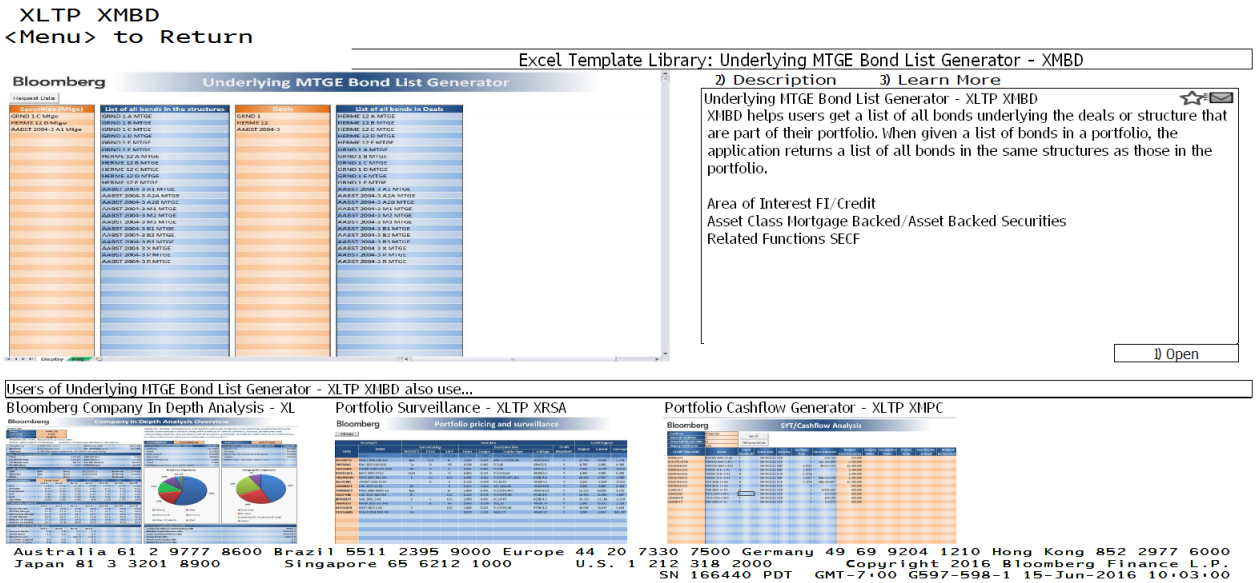
6. Copy paste the tickers of bonds onto an Excel sheet.

We did this for each round of data downloads. In order to be able to download the data on Bloomberg in step 3, we divided list of bonds into parts. So, for example, Sheet2 in the file MBSSeriesToDownloadRound1.xlsx from step 1 contains a list of MBS securities (several tranches of several series). Sheet3 contains some other bonds, Sheet4 other bonds and so forth. Each of these sheets is then saved as TickersSheetY.txt, where Y takes different values to identify each set of bonds. For each round there is a folder with all the txt files. Also, for each round there is a file named "MBS_SheetsToProcessRoundX.txt" (X = 1, 2, 3, 4) which contains the possible values that Y takes in each round.

The location of files to replicate this step is:

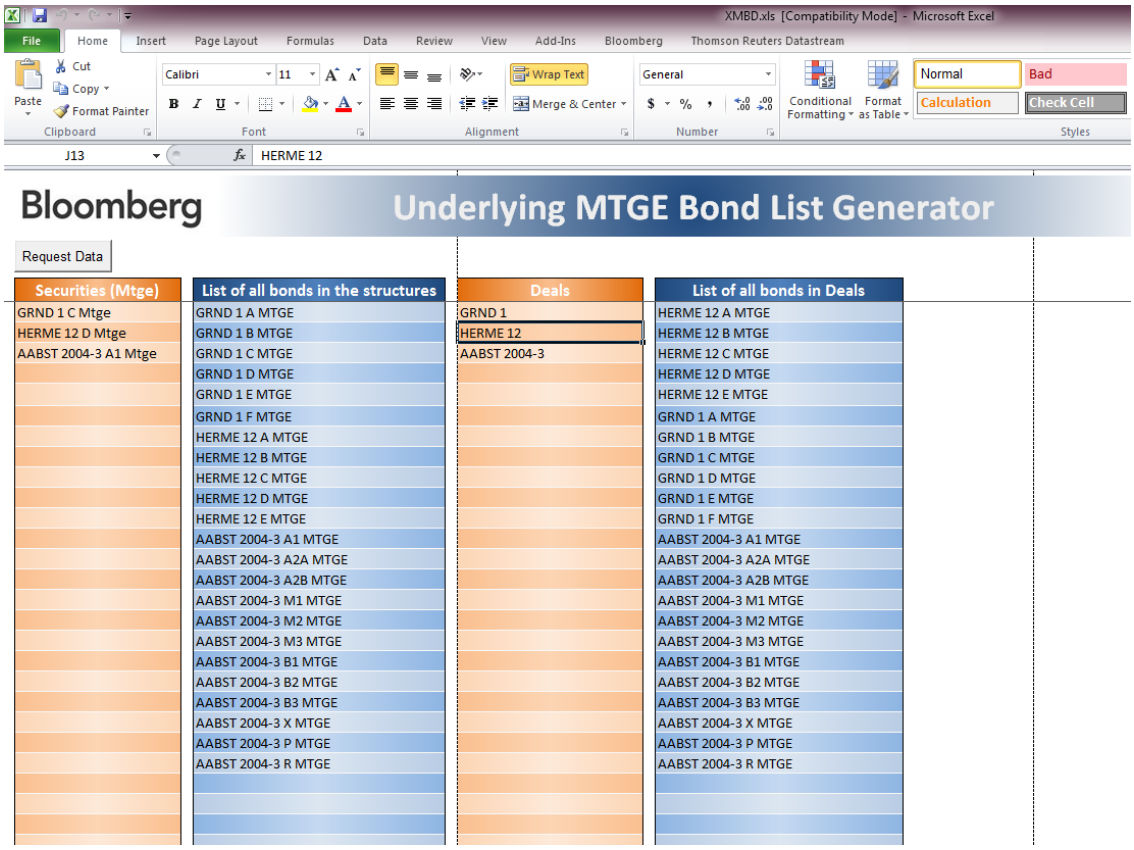
- MBS Project/Replication/Database Construction/Step 2- Get Underlying Bonds

Figure DA5: **Screenshoot of the Page to Obtain the Bond Generator**



This figure shows a snapshot of the Bloomberg page from which the Bond Generator can be downloaded

Figure DA6: **Screenshot of Bloomberg's Bond Generator in Excel**



This figure shows a snapshot of the Excel file that can be used in conjunction with Bloomberg to get a list of all the RMBS underlying a given securitization deal

Step 3. Download first part of data on Matlab

In this step we download the data from Bloomberg into Matlab. To do this first we open the connection between Bloomberg and Matlab by writing on Matlab's command window c=blp(). Then we run the following matlab files on a Bloomberg terminal:

1. Run ReadTickers.m for a file TickersSheetY.txt. This will define the set of MBS securities for which the information is being downloaded depending on the value of Y.

2. Run DownloadDataLosses.m to get information on cash flows. The resulting files are identified as DataSheetY.mat.

3. Run DownloadIdentification.m to get information to identify the security (e.g CUSIP) or of some of its caharacteristics. The resulting files are identified as IDSheetY.mat.

4. Run DownloadRatings.m this to get information on the credit rating. The resulting files are identified as RatingsSheetY.mat.

5. Run DownloadDataSomeMetrics.m to get information on some other characteristics of the securitity. The resulting files are identified as SecuritySheetY.mat.

6. Run DownloadDataGeoPurpose.m to get information on geographic composition and purpose of the underlying loans. The resulting files are identified as GeoSheetY.mat.

The resulting data files are in the folder "Bloomberg Data", with one subfolder per round of downloads.

The location of files to replicate this step is:

- MBS Project/Replication/Database Construction/Step 3 - Download first part of data on Matlab

Step 4. Clean up data and remove error fields from Bloomberg

In this step we organize the data that we downloaded from Bloomberg. Here we make sure that all files for all sheets look the same and have exactly the same information for all securities. We remove a field called Error that sometimes is created as part of the process of downloading data from Bloomberg. The code to do this varies slightly from round to round and can be found in the subfolder "Code and Intermediate Steps". The ouput files from this step which contain the data already cleaned and organized is in the subfolder "Cleaned Bloomberg Data For Step 5".

The location of files to replicate this step is:

- MBS Project/Replication/Database Construction/Step 4 - Clean up Data

Step 5. Put together cash flow data and convert it to text files

In this step we put together all the Bloomberg files to produce consolidated tables, each having the same information on cash flows (Balance, Principal, Coupon, Interest, Losses, and Factor) for all securities. This was done for each round of data downloading separately and therefore there is code and files corresponding to each round. The input files are the original Bloomberg files from step 4.

To get the consolidated tables, execute the following steps in order:

1. Run MBSDatabaseConstruction_Step5_CASHFLOW_dates_RoundX.m for each round (X=1,2,3,4)
2. Run MBSDatabaseConstruction_Step5_CASHFLOW_RoundX.m for each round (X=1,2,3,4)
3. Run MBSDatabaseConstruction_Step5_HISTFACT_dates_RoundX.m for each round (X=1,2,3,4)
4. Run MBSDatabaseConstruction_Step5_HISTFACT_RoundX.m for each round (X=1,2,3,4)
5. Run MBSDatabaseConstruction_Step5_LOSSES_dates_RoundX.m for each round (X=1,2,3,4)
6. Run MBSDatabaseConstruction_Step5_LOSSES_RoundX.m for each round (X=1,2,3,4)

Notice that this code was run on RCC. This code produces the following output files:

- Step5_BalanceAllSecurities_RoundX.txt (X=1,2,3,4)
- Step5_CouponsAllSecurities_RoundX.txt (X=1,2,3,4)
- Step5_DatesCashFlows_RoundX.txt (X=1,2,3,4)
- Step5_DatesHistFact_RoundX.txt (X=1,2,3,4)
- Step5_DatesHistLosses_RoundX.txt (X=1,2,3,4)
- Step5_HistFactAllSecurities_RoundX.txt (X=1,2,3,4)
- Step5_InterestAllSecurities_RoundX.txt (X=1,2,3,4)
- Step5_LossesAllSecurities_RoundX.txt (X=1,2,3,4)
- Step5_Principal_RoundX.txt (X=1,2,3,4)

The location of files to replicate this step is:

- MBS Project/Replication/Database Construction/Step 5 - Put Together Cash Flow Data

Step 6. Reduce Number of Dates for Cash Flows

In this step we take all the dates for which we have information on cash flows, losses, or factor (fraction of outstanding balance after losses and principal payments) and we convert them to monthly dates. For example, if for June 2001, we had some cash flow information for June 5th, June 17th, and June 25th, we would just keep June 2001 as a date/month for which we have information.

To accomplish this, we take the output files from steps 5.1, 5.3 and 5.5, and run the matlab files DateReductionRoundX.m (X=1,2,3,4).This produces the following files:

- Step6_ReducedDatesCashFlows_RoundX.txt (for X = 1, 2, 3, 4)
- Step6_ReducedDatesHistFact_RoundX.txt (for X = 1, 2, 3, 4)
- Step6_ReducedDatesHistLosses_RoundX.txt (for X = 1, 2, 3, 4)

These files will then be used as inputs in Step 8.

The location of files to replicate this step is:

- MBS Project/Replication/Database Construction/Step 6 - Reduce Number of Dates

Step 7. Get first part of the non-time series information for all securities

In this step we obtain the first part of the non-time series information for all the securities in our database. This data includes information like CUSIP numbers, Bloomberg Ticker, Deal Manager, Maturity Dates, Credit Ratings, etc. To accomplish this, run the following matlab code in order:

1. MBSDatabaseConstruction_Step7_Round1.m
2. MBSDatabaseConstruction_Step7_Round2.m
3. MBSDatabaseConstruction_Step7_Round3.m
4. MBSDatabaseConstruction_Step7_Round4.m

Notice that this code was run on RCC. This code takes the original Bloomberg files from Step 4 and produces the following files:

- Step7_DatabaseSecurities_RoundX.txt (for X = 1, 2, 3, 4). We use these files to match our data with the Mortgage Market Statistical Annual.
- Step7_DatabaseSecurities_AllRounds.txt. This file contains variables for all the securities in our database. It is the result of putting together Step7_DatabaseSecurities_RoundX.txt.

The location of files to replicate this step is:

- MBS Project/Replication/Database Construction/Step 7 - Get First Part of Non-Time

Step 8. Reduce the dimension of the data on cash flows

The purpose of this step is to reduce the size of the tables produced in Step 5. The tables in Step 5 have the exact dates when the cash flows or losses were recorded. This means that for a given month, we may have several dates with information. In this step we reduce the information to a monthly frequency. To achieve this, we use the monthly dates from Step 6. In addition, to guarantee that all tables are linked properly, we add Bloomberg ID and Cusips using the tables from Step 7.

To achieve this run the following code:

1. Reducing_BalanceTable_Dimension_RoundX.m (for X = 1, 2, 3, 4)
2. Reducing_CouponsTable_Dimension_RoundX.m (for X = 1, 2, 3, 4)
3. Reducing_FactorTable_Dimension_RoundX.m (for X = 1, 2, 3, 4)
4. Reducing_InterestTable_Dimension_RoundX.m (for X = 1, 2, 3, 4)
5. Reducing_LossesTable_Dimension_RoundX.m (for X = 1, 2, 3, 4)
6. Reducing_PrincipalTable_Dimension_RoundX.m (for X = 1, 2, 3, 4)

Notice that this code was run on RCC. The location of files to replicate this step is:

- MBS Project/Replication/Database Construction/Step 8 - Reduce Dimension of Cash

Step 9. Put together cash flow data from all rounds

In this step we consolidate all the cash-flow related tables so that the data of the four rounds of data downloading are all together. The input files are the output files of Step 8. To perform this step run the matlab code PuttingTogetherCashFlowsForAllSecurities.m. This produces the following output files:

- Step9_BalanceTable_AllRounds.txt
- Step9_CouponsTable_AllRounds.txt
- Step9_FactorTable_AllRounds.txt
- Step9_InterestTable_AllRounds.txt
- Step9_LossesTable_AllRounds.txt
- Step9_PrincipalTable_AllRounds.txt
- Step9_UniquenessSecurities.txt

The location of files to replicate this step is:

- MBS Project/Replication/Database Construction/Step 9 - Put Together Cash Flow

Step 10. Download second part of the data onto Excel

After having organized the data on cash flows we set out to find further variables that give us a better description of each bond or their underlying mortgages. The data was originally collected in five files:

1. Data2ndPart_Rnd1to3_MBSIssuedBefore2003.xlsx. This file contains variables for MBS securities that were downloaded in rounds 1 through 3 and whose issue date was in 2002 or before.
2. Data2ndPart_Rnd1to3_MBSIssuedBetween2003and2005.xlsx. This file contains variables for MBS securities that were downloaded in rounds 1 through 3 and whose issue date occurred between 2003 and 2005.
3. Data2ndPart_Rnd1to3_MBSIssuedBetween2006and2012.xlsx. This file contains variables for MBS securities that were downloaded in rounds 1 through 3 and whose issue date occurred between 2006 and 2012.

4. Data2ndPart_Rnd1to3_MBSIssuedBetween2013and2014.xlsx. This file contains variables for MBS securities that were downloaded in rounds 1 through 3 and whose issue date occurred either in 2013 or in 2014.

5. Data2ndPart_Rnd4.xlsx. This file contains variables for MBS securities that were downloaded in round 4.

This files contain the information exactly as it comes out from Bloomberg. We then convert this Excel Files into tab-separated text files. The resulting files are:

1. Step10_Data2ndPart_Rnd1to3_MBSIssuedBefore2003.txt

2. Step10_Data2ndPart_Rnd1to3_MBSIssuedBetween2003and2005.txt

3. Step10_Data2ndPart_Rnd1to3_MBSIssuedBetween2006and2012.txt

4. Step10_Data2ndPart_Rnd1to3_MBSIssuedBetween2013and2014.txt

5. Step10_Data2ndPart_Rnd4.txt

The location of files to replicate this step is:

- MBS Project/Replication/Database Construction/Step 10 - Put Together Cash Flow

Step 11. Clean and add Cusip numbers to second part of the data

In this step we first put all the data of Step 10 in one table and then we sort it with the goal of having all the securities in the same order as we have them in the other tables. We also add the CUSIP_ID numbers. To do this we run on RCC the matlab file PuttingTogetherCashFlowsForAllSecurities.m. The resulting file is called Step11_MBSSecuritiesDescription2.txt.

The location of files to replicate this step is:

- MBS Project/Replication/Database Construction/Step 11 - Clean Second Part of Data

Step 12. Matching with Statistical Annual

In this step we assess how comprehensive the database that we construct is in terms of its coverage of the non-agency MBS Market. To do this we take the table titled Non-Agency MBS Activity on pages 50 to 108 in Volume II of the Mortgage Market Statistical Annual and match the deals that we downloaded from Bloomberg with those in the table. In principle this table

lists all MBS deals by year from 2006 through 2012. For each round of data download we have a folder with the result of the matching. The matching is based on the fields from Bloomberg that are similar to those in the Statistical Annual's table, specifically the pricing date, issuing date, deal name, deal manager, and notional amount. The results of the matching can be found within the folder "Coverage AllRounds" in the file "MatchingStatAnnualAndBloombergSummary.xlsx"

We also produce a file titled "Step12_MBSMatchedStatsAnnual.txt", which has the following variables:

- Variable1 - names: corresponds to the Bloomblerg ticker
- Variable 2 - CUSIP_ID: it is the cusip number of each bond
- Variable 3 - MBS_TypeStatsAnnual_1: it contains the classification of MBS deal by type of mortage (e.g Prime, Subprime, etc). In some cases, the deal could be classified as Scratch and Dent or Second Lien, and also subprime. In these cases we give priority to Subprime. The values of this variable are: 1 (Subprime), 2 (Prime), 3(Alt-A), 4 (2nd), 5 (re-MBS), 6 (Other), 7 (Scratch & Dent), 8 (Unclassified)
- Variable 4 - NIM: it takes value 1 if the bond belongs to a NIM deal, and zero otherwise
- Variable 5 - MBS_TypeStatsAnnual_2: it contains the classification of MBS deal by type of mortage (e.g Prime, Subprime, etc). In this case Scratch and Dent or Second Lien would have priority over Subprime. The values of this variable are: 1 (Subprime), 2 (Prime), 3(Alt-A), 4 (2nd), 5 (re-MBS), 6 (Other), 7 (Scratch & Dent), 8 (Unclassified)

The location of files to replicate this step is:

- MBS Project/Replication/Database Construction/Step 12 - Matching with Statistical Annual

Step 13. Create classification variables

In this step we construct indicator variables that help us classify securities in certain categories and read certain characteristics more easily. Here we include the information from Step 12 and also add the following information:

- Codes for credit risk ratings for the 5 agencies we have in the data
- Classification dummies for CMBS, RMBS, other MBS.

- Classification dummies for Agency-backed securities and Government-related securities
- Classification dummy for CDOs
- Classification Dummies for types of tranches: IO, PO, Z, floating and inverse floating

The location of files to replicate this step is:

- MBS Project/Replication/Database Construction/Step 13 - Create ClassificationVariables

Step 14. Create Final Tables with Non-Duplicated Securities

In this step we take all the tables and using the file Step9_UniquenessSecurities.txt we remove all duplicated securities to finally have a cleaned dataset.

The location of files to replicate this step is:

- MBS Project/Replication/Database Construction/Step 14 - Create Final Tables
- MBS Project/Replication/Database: This is the directory where our final database

B Database Description

For this paper we have constructed a database that contains detailed information on a comprehensive collection of Non-Agency Mortgage Backed Securities. Our database has data for almost 9,000 MBS deals which translate into 147,606 unique mortgage backed securities issued between 1987 and 2014. These securities were issued by more than 200 firms and have a notional amount of $6.1 trillion, out of which 65% was issued between 2004 and 2007. See Table DA1 for a brief description of the quantities in our data year by year.

Table DA1: **MBS Database Description: Deals, Securities, Firms, And Notional Amounts by Year**

This table reports some figures that describe the size of all the data that we were able to gather from Bloomberg on Mortgage Backed Securities by year of issuance. The original raw data includes securities issued in 2014. Since we started building the database at the beginning of 2014, we do not have a comprehensive sample of securities for this year and therefore the figures should not be seen as representative.

Year	No Deal	No Deal Managers	No of Parent Issuers	No of Issuers	Number of MBS	Notional (US Billion)	Average Deal Size (US Million)
1987-1999	962	36	48	415	10.235	290,6	302,0
2000	235	21	44	168	2.859	99,0	421,4
2001	418	23	56	291	6.114	193,2	462,2
2002	587	30	70	429	8.526	322,5	549,5
2003	802	30	93	668	12.667	486,7	606,8
2004	1.126	30	116	935	16.090	739,2	656,5
2005	1.387	29	140	1.150	22.496	1.031,5	743,7
2006	1.584	39	156	1.376	27.586	1.266,8	799,7
2007	1.040	35	153	925	19.471	960,6	923,7
2008	113	20	35	98	1.579	106,6	943,7
2009	172	17	23	146	5.764	181,7	1.056,1
2010	169	17	26	138	6.414	181,8	1.075,7
2011	113	13	22	88	3.214	79,1	699,8
2012	99	11	20	66	1.826	39,8	401,7
2013	134	13	18	103	2.189	101,2	754,9
2014	44	9	14	29	576	26,6	603,9
All Years	8.985	85	228	6.803	147.606	6.106,8	679,7

In this paper we have focused our attention on private residential MBS. These non-agency MBS make up bulk of our data and are the ones that we restrict our attention to. However, given the broad search that we have conducted, our full database contains some other securities including more than 3,400 CMBS with notional amount of $426 billion. In the collection process some information on Agency MBS was collected. Including the VA (Veteran Affair) loans, which are partially backed by the Government through the U.S Department of Veteran Affairs, only about 1% of the bonds in our data are Government-related, which leaves us with 146,000 private-label MBS. It is also worth noting that our data is not a comprehensive collection of

CDOs. Finally, about 10% of the data corresponds to re-securitizations, which became more common after the financial crisis. Table DA2 presents figures on the number of deals, number of bonds and notional amounts for different classification criteria of the securities in our database.

Table DA2: **RMBS Database: Deals, Securities and Nominal Amounts by Different Classification Criteria**

This table reports some figures that describe the type of mortgage backed securities that comprise our database. All the securities in the database are classified by different criteria as long as the information was available.

Classification Criteria	**Deals**		**MBS Bonds**		**Notional Amount**	
	No.	%	No.	%	$ Billion	%
Type of Collateral						
RMBS	8,631	96.3	143,781	97.4	7,521.99	94.1
CMBS	220	2.5	3,444	2.3	426.00	5.3
Other MBS	97	1.1	328	0.2	32.51	0.4
Unclassified	17	0.2	111	0.1	15.74	0.2
Agency vs Private						
Agency	163	1.8	906	0.6	246.28	3.1
Private Label	8,802	98.2	146,758	99.4	7,749.96	96.9
Government Backed						
Govt.-backed	239	2.7	1,659	1.1	280.74	3.5
Non Govt.-backed	8,733	97.3	146,005	98.9	7,715.50	96.5
Collateralized Debt Obligation						
CDO	96	1.1	579	0.4	197.88	2.5
Non-CDO	8,866	98.9	147,085	99.6	7,798.35	97.5
Resecuritization						
Resecuritization	815	9.1	19,972	13.5	742.35	9.3
Non_Resecuritization	8,178	90.9	127,692	86.5	7,253.89	90.7

The information that we have for each security can be better described by categories. The bulk of our information is the cash flows and losses of each security each month after issuance. We observe the interest payments, principal payments, outstanding balance, the coupon rate and the losses each month.

Some variables help us describe the security and some of its characteristics. These include dates of issuance, coupon type and frequency, maturity date, the type of tranche it represents, its notional amount, and the credit rating assigned by up to 5 different credit rating agencies. Some other variables are related to the collateral of the securities, the underlying mortgages. These include information on the composition of the mortgages by type of rates (adjustable

rates vs fixed rate mortgages), by type of occupancy (vacation home, family home, etc), by purpose of the mortgage (equity take out, refinance, purchase). Other variables are related to commonly-used MBS metrics like WAM, WAC, WAL. Finally, there are variables that not only tell us about the underlying mortgages but also about the risk and the type of the security. These include information on the distribution of credit scores, loan size, and loan to value ratios.

Many of the variables related to MBS vary over time. For example, one can talk about the average loan size at issuance or the average loan size at any other point in time; or one can talk about the credit rating given upon issuance and the current credit rating of a security. For most variables we were able to obtain the values upon issuance. For some of these variables we may have gathered also current information (current meaning the value of the variable at the time we collected the data). For some of these variables the time series information may exist, for some it may not. We are uncertain about the benefit of the "current" value of a variable if we do not have access to the time series. We did not collect information on all the existing time series due to constraints in the amount of information that can be extracted from the data sources in a given month. If needed, these time series could be potentially obtained.

Detailed Description of Files and Variables

We now list and describe each of the files and variables in our database. The database is comprised of the following 9 main files:

1. MBSSecuritiesDescription1.txt
2. MBSSecuritiesDescription2.txt
3. MBSSecuritiesClassification.txt
4. BalanceTableMBS.txt
5. CouponsTableMBS.txt
6. InterestTableMBS.txt
7. PrincipalTableMBS.txt
8. LossesTableMBS.txt
9. FactorTableMBS.txt

The link between all 9 files is the CUSIP ID number of each MBS and its corresponding Bloomberg Ticker. The location of files in the project's folder is:

- MBS Project/Replication/Database/MainFiles

Description

We now describe each file of the database.

File 1. SecuritiesDescription1MBS.txt This file contains variables that describe and characterize a given MBS. It is a txt file, separated by the delimiter '|' (bar) and it can be read in Matlab as a table. By categories, the file contains the following 41 variables in order.

Security Identification

- Variable 1 - Names: it is the ticker of the security on Bloomberg. One can access the information on any security on Bloomberg by typing name and the key MTGE.
- Variable 2 - ID_CUSIP: it is the CUSIP number of the MBS. The number consists of nine characters (including letters and numbers) that uniquely identify a company or issuer and the type of security. This field may be useful to match the database with other databases such as LoanPerformance
- Variable 3 - LEAD_MGR: Name of the financial institution that acted as lead manager (underwriter) in the deal. This field has been used to match MBS with the information in the Statistical Annual.
- Variable 4 - MTG_DEAL_NAME: Name of the MBS deal. For all the securities (tranches) involved in a given deal, this provides the common particle of the Ticker (Bloomberg Name). This field has been used to match MBS with the information in the Statistical Annual.

Security Description

- Variable 5 - MTG_DEAL_TYP: It contains a description of the type of MBS issued in the deal. This field can be used to put MBS into categories such as Commercial MBS, Autos, Residential MBS. A problem is that some of the descriptions are generic (e.g CDO, ABS), and therefore some more information is required to make a full classification.

  - Possible values: ABS, AUTOS, BUSINESS, CDO, CMBS-CMO, CMBS-CONDUIT, CMBS-CTL, CMBS-EURO, CMBS LGR/OTHR FLT, CMBS-PORTFOLIO, CMBS-REREMIC, CMBS- SASB, CMBS-SMALL BAL, CMO, COMMERCIAL, HOME EQT, MANUFCT HM, MBB, MBS, MPT, NPL, re-SEC, STUDENTS, SWAP TRUST

- Variable 6 - SECURITY_TYP: This field provides some information on the type of security issued. It may have information on whether the security is Agency backed or not, the type of loan (residential, commercial, etc) and the type of tranche. This field that can help classify the securities into Residential MBS, CMBS, Agency MBS. Many of the securities have the descriptor "Prvt CMO" so further information is needed.

  - Possible values: ABS Auto, ABS Home, ABS Other, Agncy ABS Home, Agncy ABS Other, Agncy CMBS, Agncy CMO FLT, Agncy CMO INV, Agncy CMO IO, Agncy CMO Other, Agncy CMO Z, Agncy CMO PO, CF, CMBS, Prvt CMO FLT, Prvt CMO INV, Prvt CMO IO, Prvt CMO Other, Prvt CMO Z, Prvt CMO PO, SN

- Variable 7 - SECURITY_TYP2: This field also proivdes information on the type of MBS. We have used it in combination with the previous two fields two classify the securities.

  - Possible Values: ABS, ABS Other, ABS/MEZZ, CMBS, CMO, CRE, RMBS, Whole Loan

- Variable 8 - MTG_CMO_CLASS: It is a particle of the Bloomberg Ticker that identifies the Tranche.

- Variable 9 - COLLAT_TYP: Describes the underlying collateral. It may contain information on the type of mortgage (e.g AltA) the maturity time, the type of rate (e.g ARM). It can be used to help classify the MBS

  - For example, some fields contain the following particles: FNTY FGTY FHTY GNTY G2TY. They all correspond to Agency Pools, Fannie Mae, Freddie Mac and Ginnie Mae.

- Variable 10 - ISSUE_DT: Date in which the security is issued. This field is recorded as a serial date number (see ISSUE_DATE)

- Variable 11 - ISSUE_DATE: format YYYYMMDD for ISSUE_DT.

- Variable 12 - MTG_PX_SPD_DT: Date in which the security was originally priced. Field recorded as a serial number (see PRICING_DATE)
- Variable 13 - PRICING_DATE: format YYYYMMDD for MTG_PX_SPD_DT
- Variable 14 - MATURITY: This field is recorded as a serial date number (see MATURITY_DATE).
- Variable 15 - MATURITY_DATE: format YYYYMMDD for MATURITY
- Variable 16 - CPN_TYP: coupon type of the bond, or type of interest to be paid to investors
  - Possible Values: FIXED, FLOATING, STEP, VARIABLE, ZERO
- Variable 17 - CPN: value of the coupon at time of download. Unfortunately it does not contain the reference rate.
- Variable 18 - MTG_ORIG_AMT: value of the original principal amount of the MBS or, in other words, principal balance at issuance of the security
- Variable 19 - MTG_TRANCHE_TYP_LONG: Description of the Tranches and how they get paid. There are many possible descriptors and securities will generally have several.
  - Some common values:
    * FLT (Floater), INV (Inverse Floater), PT (Pass-Through), IO (Interest Only), R (Residual), Z (Accrual), PO (Principal Only)
- Variable 20 - ORIG_CREDIT_SUPPORT: Original credit support percentage for a CMO class/tranche from ther aubordinate classes in the same CMO deal.

Credit Rating Information

- Variable 21 - RTG_FITCH: Current credit rating (at time of download, March 2014 through February 2015) by Fitch
- Variable 22 - RTG_FITCH_INITIAL: Initial credit rating by Fitch
- Variable 23 - RTG_KBRA: Current credit rating (at time of download) by Kroll Bond Rating Agency

- Variable 24 - RTG_KBRA_INITIAL: Initial credit rating by KBRA
- Variable 25 - RTG_MOODY: Current credit rating (at time of download) by Moodys
- Variable 26 - RTG_MDY_INITIAL: Initial credit rating by Moodys
- Variable 27 - RTG_SP: Current credit rating (at time of download) by Standard and Poors
- Variable 28 - RTG_SP_INITIAL: Initial credit rating by Standard and Poors
- Variable 29 - RTG_DBRS: current credit rating by Dominion Bond Rating Service
- Variable 30 - RTG_DBRS_INITIAL: initial credit rating by Dominion Bond Rating Service

Standard MBS Metrics

- Variable 31 - MTG_ORIG_WAC: Original Weighted Average Coupon of the pool of loans that make up the MBS
- Variable 32 - MTG_ORIG_WAL: Weighted average life as of issuance in Years (expected time to receive principal payments)
- Variable 33 - MTG_ORIG_WAM: Weighted average maturity as of issuance (in Months)

Geographic Information

- Variable 34 - MTG_GEO1_ERL: Percentage of original principal corresponding to the state with highest participation in the MBS
- Variable 35 - MTG_GEO2_ERL: Percentage of original principal corresponding to the state with the second highest participation in the MBS
- Variable 36 - MTG_GEO3_ERL: Percentage of original principal corresponding to the state with the third highest participation in the MBS
- Variable 37 - MTG_GEO4_ERL: Percentage of original principal corresponding to the state with the fourth highest participation in the MBS
- Variable 38 - MTG_GEO5_ERL: Percentage of original principal corresponding to the state with the fifth highest participation in the MBS

Loan Purpose

- Variable 39 - MTG_LOAN_PURPOSE_EQUITY_ERL: The earliest percentage of the Loan Purpose (the reason for the loan) for Equity Take Out
- Variable 40 - MTG_LOAN_PURPOSE_PURCHASE_ERL: The earliest percentage of the Loan Purpose (the reason for the loan) for Purchase
- Variable 41 - MTG_LOAN_PURPOSE_REFINANCE_ERL: The earliest percentage of the Loan Purpose (the reason for the loan) for Refinance

File 2. SecuritiesDescription2MBS.txt This file contains variables that further describe a given MBS. It is a txt file, separated by the delimter '|' (bar). The information is available for all securities issued in 2003 or later. The file contains the following 49 variables in order.

- Variable 1 - Names: it is the ticker of the security on Bloomberg.
- Variable 2 - ID_CUSIP: it is the CUSIP number of the MBS.
- Variable 3 - WALTV_ORIG: Original weighted average amortized loan to original value of the underlying loans comprising the collateral
- Variable 4 - MTG_QRT_LTV_MIN: Lowest original loan to value percentage of any loan in the pool.
- Variable 5 - MTG_QRT_LTV_25: 25th percentile of original loan to value percentage in the pool
- Variable 6 - MTG_QRT_LTV_MED: 50th percentile of original loan to value percentage in the pool
- Variable 7 - MTG_QRT_LTV_75: 75th percentile of original loan to value percentage in the pool
- Variable 8 - MTG_QRT_LTV_MAX: Highest original loan to value percentage of any loan in the pool.
- Variable 9 - MTG_WAOCS: Weighted average original credit score of a pool
- Variable 10 - MTG_QRT_SCORE_MIN: Lowest original credit score of any loan in the pool
- Variable 11 - MTG_QRT_SCORE_25: 25th percentile original credit score in the pool

- Variable 12 - MTG_QRT_SCORE_MED: 50th percentile original credit score in the pool
- Variable 13 - MTG_QRT_SCORE_75: 75th percentile original credit score in the pool
- Variable 14 - MTG_QRT_SCORE_MAX: Highest original credit score of any loan in the pool
- Variable 17 - MTG_QRT_AOLS_MIN: Smallest original size of any loan in the pool
- Variable 18 - MTG_QRT_AOLS_25: 25th percentile original loan size in the pool
- Variable 16 - MTG_QRT_AOLS_MED: 50th percentile original loan size in the pool
- Variable 19 - MTG_QRT_AOLS_75: 75th percentile original loan size in the pool
- Variable 15 - MTG_QRT_AOLS_MAX: Largest original size of any loan in the pool
- Variable 20 - MTG_ORIG_MIN_LOAN_SIZE: Minimum original loan size. It reports the minimum original loan amout for loans currently backing the deal
- Variable 21 - MTG_AVG_ORIG_LOAN_SIZE : Average of original loan size of loans currently backing the deal
- Variable 22 - MTG_AVG_AOLS: Average original loan size
- Variable 23 - MTG_WA_ORIG_LOAN_SIZE: Weighted average of original loan size of loans currently backing the deal
- Variable 24 - MTG_ORIG_MAX_LOAN_SIZE: Maximum original loan size. It reports the maximum original loan amout for loans currently backing the deal
- Variable 25 - MTG_AMORT_TYPE_ARM_ERL: The earliest percentage of the Adjustable Rate Mortgage (ARM) Loans.
- Variable 26 - MTG_AMORT_TYPE_LEVEL_FRM_ERL: The earliest percentage of the Fixed Rate Mortgage (ARM) Loans.
- Variable 27 - CUM_LOSS_PCT: Current Percentage of cumulative loss on the underlying loans comprising the collateral specific to the group to which the security belongs. Cumulative Loss that will not be recovered ans been taken as a writeoff on the balance sheet.

- Variable 28 - ALL_COLLAT_CUM_LOSS_PCT: Current Percentage of cumulative loss on the underlying loans comprising the entire collateral that backs the CMO deal. Not specific to the group to which the security belongs. Cumulative Loss that will not be recovered ans been taken as a writeoff on the balance sheet. Warning. Variables 27 and 28 could coincide. Dividing Variable 29 by variable 28, yields the deal amount
- Variable 29 - ALL_COLLAT_CUM_LOSS: cumulative loss on the underlying loans comprising the entire collateral that backs the CMO deal
- Variable 30 - CPN_FREQ: Number of times per year interest is paid
- Variable 31 - MTG_PX_SPD: Prepayment speed at which the security was originally priced
- Variable 32 - MTG_OCCUPANCY_OWNER_ERL: The earliest percent of the occupancy (the purpose of the property) for owner occupied
- Variable 33 - MTG_OCCUPANCY_INVESTMENT_ERL: The earliest percent of the Occupancy (the purpose of the property) for owner occupied
- Variable 34 - MTG_OCCUPANCY_VACATION_ERL: The earliest percent of the Occupancy (the purpose of the property) for vacation
- Variable 35 - MTG_SINGLE_FAMILY_ERL: The earliest percent of Single Family Mortgaged Properties, the type of properties against which the loans were written
- Variable 36 - MTG_CONDOMINIUM_ERL: The earliest percent of Condominium Mortgaged Properties, the type of properties against which the loans were written
- Variable 37 - MTG_2_4_FAMILY_ERL: The earliest percent of 2-4 Family Mortgaged Properties, the type of properties against which the loans were written
- Variable 38 - MTG_PUD_ERL: The earliest percent of PUD (Planned Unit Development) Mortgaged Properties, the type of properties against which the loans were written
- Variable 39 - MTG_NUM_POOLS: Number if pools/loans backing the deal or collateral group. It seems to be the current value.
- Variable 40 - MTG_NUM_BONDS_DEAL: Number of Tranches in the deal ot collateral group

- Variable 41 - MTG_WHLN_NUMBER_LOAN: The current number of loans, created as collateral for the deal, which are still outstanding
- Variable 42 - ID_BB_PARENT_CO: The Bloomberg Company ID number for te controlling company of the current security
- Variable 43 - ID_BB_COMPANY: Bloomberg number that is assigned to all companies that issue securities
- Variable 44 - TRANCHE_NUM: Tranche number of the security
- Variable 45 - CALLABLE: Indicates whether the security is subject to early redemption through a call privision.
- Variable 46 - ISSUE_PX: Price of the security at issuance
- Variable 47 - MTG_NUM_ORIG_LOAN: Number of loans in the pool as of issuance. It may not be available for most securities
- Variable 48 - MTG_PROPERTY_TYP: The majority type of property the loans were written against
- Variable 49 - RESECURITIZATION_INDICATOR: Indicates if the bond is a derivative of another security. Possible values (Y, N)
- Variable 50 - MTG_IS_AGENCY_BACKED: Indicates if an MBS is backed by a Government Agency. Possible values (Y,N)
- Variable 51 - CMBS_TYP: Describes the types of loans comprising the collaterak of the CMBS. This field may be useful to separate RMBS from CMBS.
- Variable 52 - AIFMD_EXPOSURE_RPT_SUB_AST_TYP: Sub-asset type security classification of the European Securities and Markets Authority. This field may help to identify RMBS

File 3. MBSSecuritiesClassification.txt This file contains variables that can help classify the securities into different categories. The file contains the following 29 variables in order

- Variable 1 - Names: it is the ticker of the security on Bloomberg.
- Variable 2 - ID_CUSIP: it is the CUSIP number of the MBS.

- Variable 3 - MBS_TypeStatsAnnual_1: Classification variables into prime and subprime categories according to Mortgage Market Statistical Annual
- Variable 4 - NIM: Dummy variable that takes the value 1 if the MBS is a Net Interest Margin Bond
- Variable 5 - MBS_TypeStatsAnnual_2: Classification variables into prime and subprime categories according to Mortgage Market Statistical Annual
- Variable 6 - Found: Dummy variable that takes the value 1 if the security was found in the Mortgage Market Statistical Annual
- Variable 7 - SPoors_Rating: Indicator variable for credit ratings by Standard & Poors
- Variable 8 - Moodys_Rating: Indicator variable for credit ratings by Moodys
- Variable 9 - Fitch_Rating: Indicator variable for credit ratings by Fitch
- Variable 10 - KBRA_Rating: Indicator variable for credit ratings by KBRA
- Variable 11 - DBRS_Rating: Indicator variable for credit ratings by DBRS
- Variable 12 - reSec: Dummy variable that takes the value 1 if the MBS is a resecuritization
- Variable 13 - ReSecType: indicator variable to classify resecuritizations
- Variable 14 - RMBS: Dummy variable that takes the value 1 if the MBS is an RMBS
- Variable 15 - CMBS: Dummy variable that takes the value 1 if the MBS is a CMBS
- Variable 16 - OtherMBS: Dummy variable that takes the value 1 if the MBS could not be classified as RMBS or CMBS
- Variable 17 - UnclassifiedMBS: Dummy variable that takes the value 1 if the MBS is not classified as RMBS, CMBS, or other MBS
- Variable 18 - AgencyMBS: Dummy variable that takes the value 1 if the MBS is an Agency-backed security
- Variable 19 - Gov: Dummy variable that takes the value 1 if the MBS is backed by the government
- Variable 20 - CDOs: Dummy variable that takes the value 1 if the securitization is a CDO

- Variable 21 - TrancheIO: Dummy variable that takes the value 1 if the MBS is an interest only tranche
- Variable 22 - TranchePO: Dummy variable that takes the value 1 if the MBS is a principal only tranche
- Variable 23 - TrancheZ: Dummy variable that takes the value 1 if the MBS is an z tranche
- Variable 24 - TrancheFloat: Dummy variable that takes the value 1 if the MBS is a floater
- Variable 25 - TrancheAllFloater: Dummy variable that takes the value 1 if the MBS is a floater or an inverse floater
- Variable 26 - TrancheInvFloat: Dummy variable that takes the value 1 if the MBS is an inverse floater
- Variable 27 - TrancheResidual: Dummy variable that takes the value 1 if the MBS is a residual tranche
- Variable 28 - TrancheX: Dummy variable that takes the value 1 if the MBS is an X tranche
- Variable 29 - TrancheExcess: Dummy variable that takes the value 1 if the MBS is an excess tranche

File 4. BalanceTableMBS.txt This file contains the time series of principal balance at the end of each month for each MBS from April 1987 through September 2014. Since the data was downloaded from March 2014 through February 2015, it is best to use the information in this file up to December 2013. This guarantees that the information was already uploaded on Bloomberg and also that the time of coverage was the same for all securities. It is a txt file separated by the delimiter '|'. It can be read in Matlab as a table. The structure of the file is the following:

- Column 1 - Names: it is the ticker of the security on Bloomberg.
- Column 2 - ID_CUSIP: it is the CUSIP number of the MBS.
- Column 3 through Column 331: Principal Balance at the end of each month from April 1987 through September 2014

File 5. CouponsTableMBS.txt This file contains the time series of coupon rates that were applied on a given month on the principal balance as of the previous month for each MBS from April 1987 through September 2014. Since the data was downloaded from March 2014 through February 2015, it is best to use the information in this file up to December 2013. It is a txt file separated by the delimiter '|'. It can be read in Matlab as a table. The structure of the file is the following:

- Column 1 - Names: it is the ticker of the security on Bloomberg.
- Column 2 - ID_CUSIP: it is the CUSIP number of the MBS.
- Column 3 through Column 331: Coupon rate applied each month from April 1987 through September 2014

File 6. InterestTableMBS.txt This file contains the time series of interest payments at the end of each month for each MBS from April 1987 through September 2014. Since the data was downloaded from March 2014 through February 2015, it is best to use the information in this file up to December 2013. It is a txt file separated by the delimiter '|'. It can be read in Matlab as a table. The structure of the file is the following:

- Column 1 - Names: it is the ticker of the security on Bloomberg.
- Column 2 - ID_CUSIP: it is the CUSIP number of the MBS.
- Column 3 through Column 331: Interest payment of each month from April 1987 through September 2014

File 7. PrincipalTableMBS.txt This file contains the time series of principal payments each month for each MBS from April 1987 through September 2014. Since the data was downloaded from March 2014 through February 2015, it is best to use the information in this file up to December 2013. It is a txt file separated by the delimiter '|'. It can be read in Matlab as a table. The structure of the file is the following:

- Column 1 - Names: it is the ticker of the security on Bloomberg.
- Column 2 - ID_CUSIP: it is the CUSIP number of the MBS.
- Column 3 through Column 331: Principal payment of each month from April 1987 through September 2014

File 8. LossesTableMBS.txt This file contains the time series of losses each month for each MBS from April 1987 through September 2014. Since the data was downloaded from March 2014 through February 2015, it is best to use the information in this file up to December 2013. It is a txt file separated by the delimiter '|'. It can be read in Matlab as a table. The structure of the file is the following:

- Column 1 - Names: it is the ticker of the security on Bloomberg.
- Column 2 - ID_CUSIP: it is the CUSIP number of the MBS.
- Column 3 through Column 331: Losses each month from April 1987 through September 2014

File 9. FactorTableMBS.txt This file contains the time series of a variable called Factor each month for each MBS from April 1987 through September 2014. The factor records what proportion of the principal of a security is still outstanding. It is defined as follows:

$$Factor_t = 1 - \frac{CumulativeLosses_t + CumulativePrincipalPaid_t}{OriginalBalance}$$

Since the data was downloaded from March 2014 through February 2015, it is best to use the information in this file up to December 2013. It is a txt file separated by the delimiter '|'. It can be read in Matlab as a table. The structure of the file is the following:

- Column 1 - Names: it is the ticker of the security on Bloomberg.
- Column 2 - ID_CUSIP: it is the CUSIP number of the MBS.
- Column 3 through Column 331: Factor each month from April 1987 through September 2014

C Additional Results

C.1 Data and RMBS Classification: Additional information.

Table TA1: **Database Coverage of the universe of Non-Agency RMBS**

This table compares our database to the universe of mortgage-backed securities for 2006 to 2012, as listed in the Mortgage Market Statistical Annual 2013 Edition. By value, our database contains about 95% of the Non-agency mortgage-backed securities issued between 2006 and 2012. To make the match between we use the the Mortgage Market Statistical Annual 2013 Edition and Bloomberg we used information on issue dates, the deal manager, the deal name, and the principal amount. We do not present numbers for the period before 2006 because the Statistical Annual Edition 2013 only has information starting in 2006. The principal amount numbers are in $ billion.

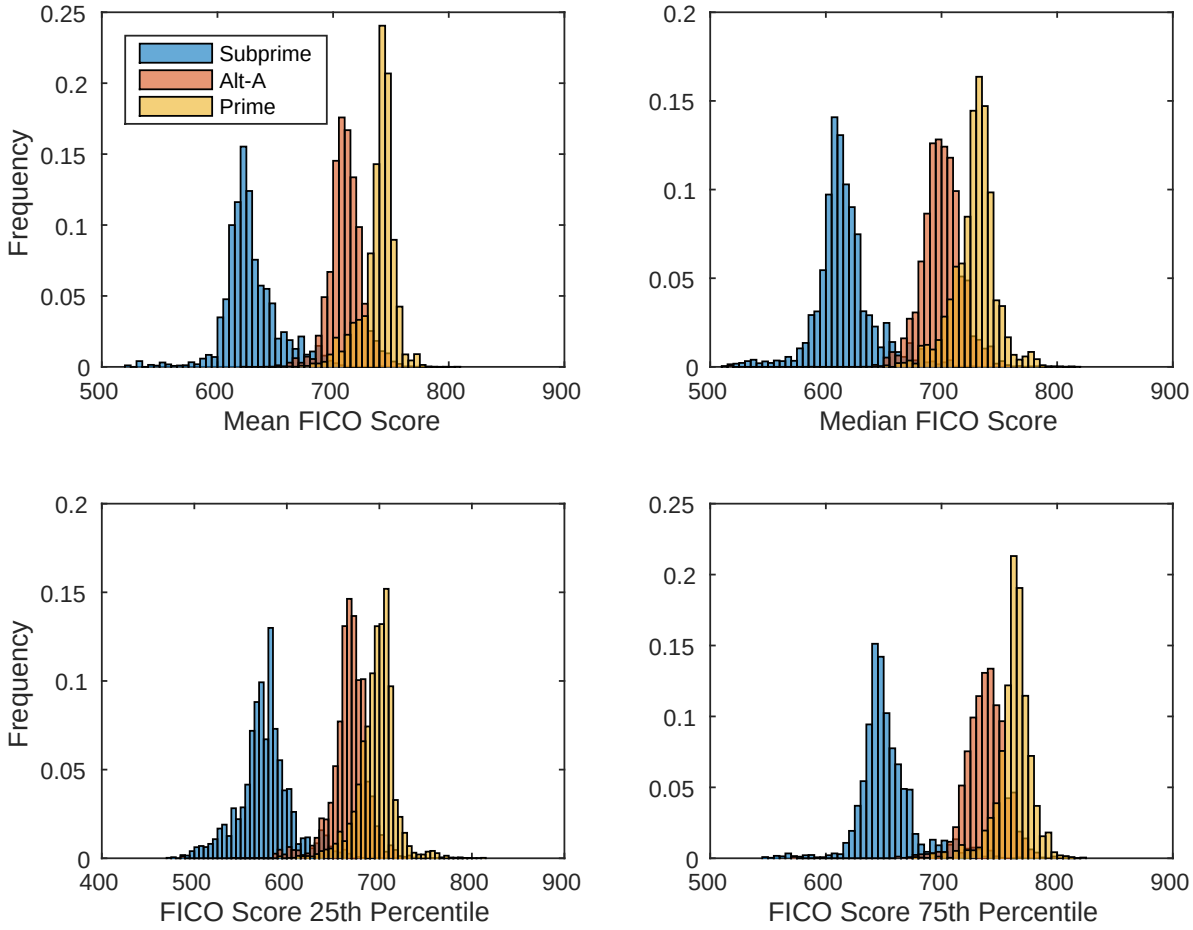
Panel A: Principal Amount and Deals Coverage by Type of Mortgage-backed Security

	Prime		**Alt-A**		**Subprime**		**Other**		**Total**	
	Amount	Deals	Amount	Deals	Amount	Deals	Amount	Deals	Amount	Deals
Unmatched	9.8	15	16.2	30	33.6	52	26.3	90	85.9	187
Matched	406.5	484	596.5	739	656.4	771	304.4	643	1,963.8	2,637
Total	416.3	499	612.7	769	690.0	823	330.7	733	2,049.8	2,824
Pct. Matched	97.7	97.0	97.4	96.1	95.1	93.7	92.0	87.7	95.8	93.4

Panel B: Principal Amount Coverage by Year and Type of Mortgage-backed Security

Type of MBS	**Year**							
	2006	2007	2008	2009	2010	2011	2012	All Years
All								
Principal Amount	1,129.3	697.0	58.6	60.4	63.8	27.6	13.2	2,049.8
Pct. Matched	97.3	93.4	95.2	95.0	97.7	97.3	91.6	95.8
Prime								
Principal Amount	218.79	180.4	7.0	5.5	0.5	0.7	3.5	416.3
Pct. Matched	96.9	98.6	94.4	100.0	100.0	100.0	100.0	97.7
Alt-A								
Principal Amount	362.79	247.4	1.9	-	0.7	-	-	612.7
Pct. Matched	99.1	94.9	72.5	100.0	100.0	100.0	100.0	97.4
Subprime								
Value	470.11	213.4	2.4	0.9	-	0.5	2.8	690.0
Principal Amount	96.6	91.8	97.9	100.0	100.0	100.0	100.0	95.1
Other								
Value	77.57	55.8	47.4	54.0	62.6	26.4	6.9	330.7
Principal Amount	93.8	76.0	100.0	100	100	100	100	92.0

Figure TA1: **Distribution of FICO Scores by Type of Mortgage**



This figure plots histograms for different moments of the distribution of FICO Scores of the mortgage loans underlying the Residential Mortgage Backed Securities in our database. These moments correspond to the value-weighted average, the median, 25th and 75th percentiles of FICO scores upon issuance of the MBS. The histograms are shown by type of mortgage loan (Prime, Alt-A, and Subprime) and only securities issued in the period 2006-2012 are included.

C.2 Fact 1: Additional information.

Table TA2: **Credit Rating Activity of Non-Agency Residential Mortgage Backed Securities: 1987-2013**

This table presents some figures about the credit rating activity in the RMBS market between 1987 and 2013. We refer to rating activity as the participation of credit rating agencies in providing a credit rating to a bond. We measure such activity as both the number of bonds and the principal amount represented, by agency or group of agencies. The calculations are based on the credit ratings assigned upon issuance.

	MBS Bonds		**Principal Amount**	
Rating Activity	**No.**	**Pct.**	**($ Billion)**	**Pct.**
Rated by at least one agency	115,282	81.4	5,214.1	92.0
Rated by 2 or more agencies	87,937	62.1	4,812.3	84.9
Rated by all 3 big agencies	16,324	11.5	1,085.0	19.1
Rated by all agencies	0	0.0	0	0.0
Rated by Standard & Poors	90,006	63.6	4,518.0	79.7
Rated by Moody's	67,036	47.3	3,931.5	69.4
Rated by Fitch	58,692	41.4	2,530.6	44.6
Rated by Kroll (KBRA)	207	0.1	19.7	0.3
Rated by DBRS	7,179	5.1	366.6	6.5
Not Rated	26,348	18.6	453.8	8.0
All Bonds	141,630	100.0	5,667.9	100.0

Table TA3: **Non-Agency Residential Mortgage Backed Securities: Credit Rating Composition 1987-2013**

This table shows the number of bonds and their corresponding principal amounts by credit rating. The credit rating corresponds to the rating assigned to a bond upon issuance. If several ratings were given, we have taken an average. The first 4 columns of the table show amounts and percentages for the entire database. The last 3 columns show the percentages for the principal amount of the bonds rated by each of the three main rating agencies. The last row of the last three columns shows the total principal amount of the bonds rated by each agency, which is the base for the percentage calculations. All bonds issued between 1987 and 2013 are included in the computations.

	MBS Bonds		**Principal Amount**		**Principal Amount By Agency**		
Rating	**No.**	**Pct.**	**($ Billion)**	**Pct.**	**S&P**	**Moody's**	**Fitch**
AAA	65,590.0	56.8	4,535.1	86.9	88.9	89.8	89.8
AA	13,298.0	11.5	297.0	5.7	4.8	5.4	4.1
A	13,355.0	11.6	212.3	4.1	2.9	2.5	3.7
BBB	13,062.0	11.3	118.4	2.3	1.9	1.8	1.8
BB	6,096.0	5.3	40.1	0.8	0.6	0.4	0.4
B	3,865.0	3.3	13.6	0.3	0.4	0.0	0.1
CCC	66.0	0.1	0.3	0.0	0.2	0.0	0.0
CC	22.0	0.0	0.6	0.0	0.2	0.0	0.0
C	51.0	0.0	3.3	0.1	0.1	0.0	0.0
Rated	115,405.0	81.2	5,220.5	91.7	4,523.4	3,931.5	2,531.4
Not Rated	26,774.0	18.8	472.1	8.3			

C.3 Facts 2 and 3: Additional Information.

Table TA4: **RMBS Losses as of December 2013**

This table shows the number of securities with losses and the dollar size of the losses in December 2013, about six years after the beginning of the Subprime crisis in mid-2007. Panel A. breaks down the numbers by credit rating. We exclude all the MBS bonds for which the original principal amount is only a reference or that can distort our computations. The excluded bonds include bonds with zero original balance, excess tranches, interest-only bonds, and Net Interest Margin deals (NIM). Only bonds issued up to 2008 are part of the computations.

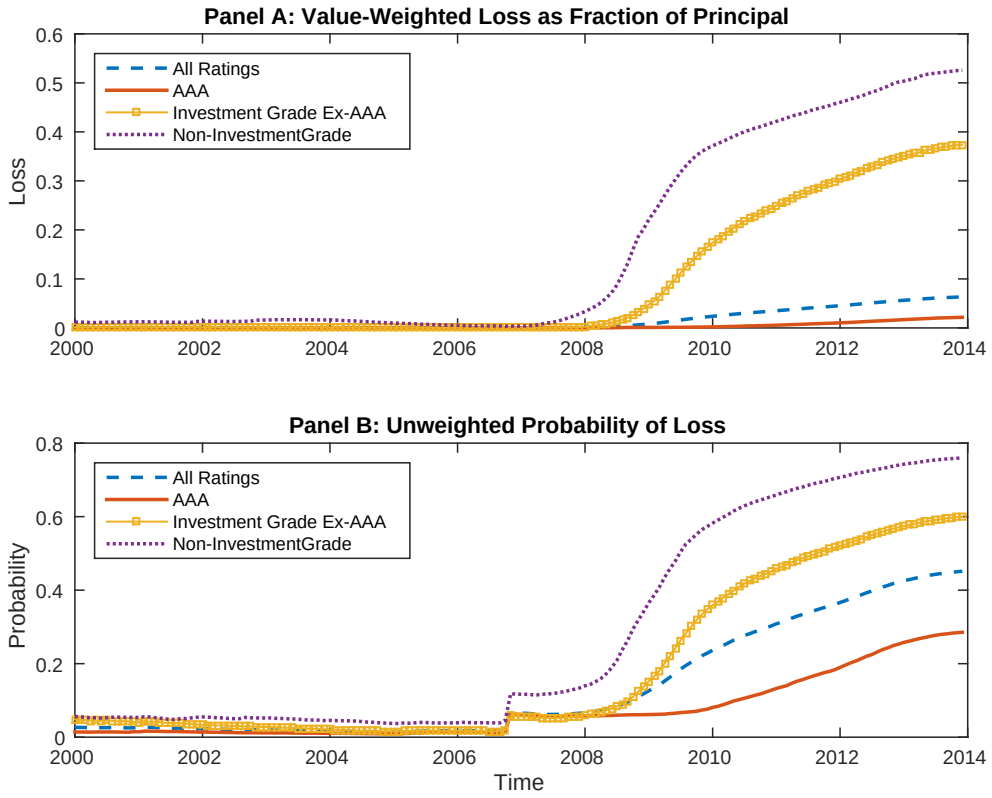
Panel A: Losses by Credit Rating as of December 2013

	Number of Securities			**Dollar Amount**		
	Total	W/ Losses	Pct. Losses	Total	W/ Losses	Pct. Losses
All RMBS	93,902	43,264	45.1	4,965.6	313.7	6.3
AAA	49,188	14,035	28.5	4,402.4	94.9	2.2
AA	12,087	6,290	52.0	263.7	87.4	33.1
A	11,144	6,655	59.7	144.9	55.7	38.4
BBB	12,015	8,213	68.4	101.6	47.7	46.9
NIG	9,468	7,192	75.9	53.1	27.9	52.6

Panel B: Losses by Mortgage Type and Credit Rating as of December 2013

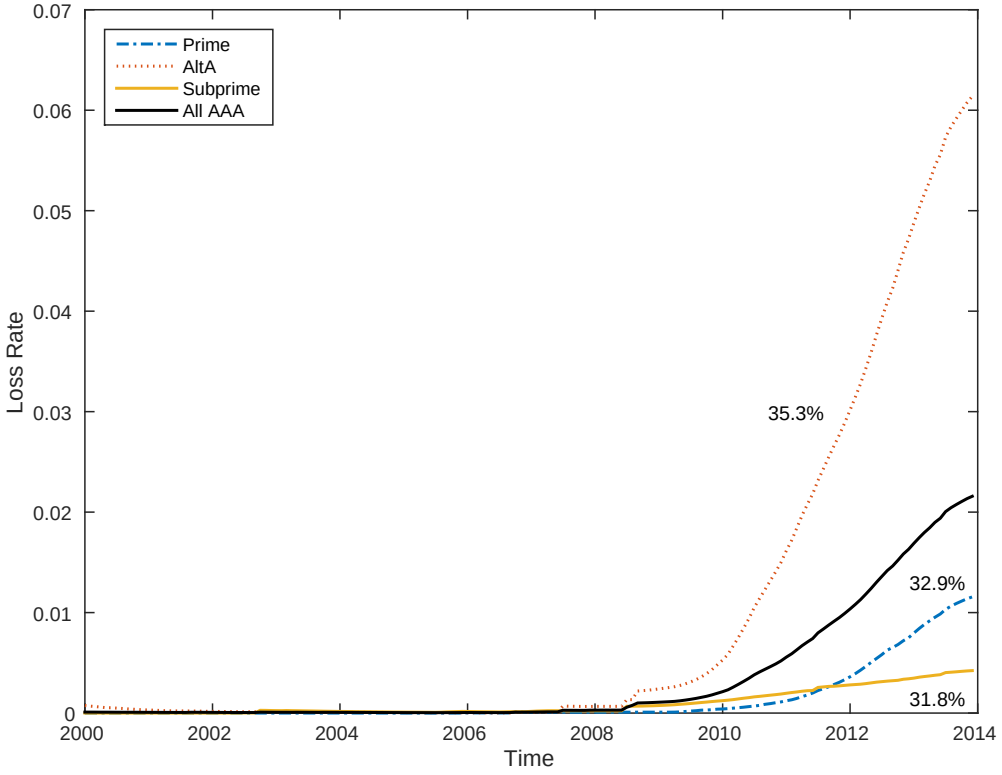
	Number of Securities			**Dollar Amount**		
	Total	W/ Losses	Pct. Losses	Total	W/ Losses	Pct. Losses
All Securities						
Prime	25,476.	11,604	45.6	1,238.7	35.9	2.9
Alt-A	27,135	17,515	64.5	1,327.3	139.9	10.6
Subprime	18,705	9,032	48.2	1,196.0	116.8	9.77
AAA Rated Securities						
Prime	15,610	5,177	33.2	1,172.7	13.6	1.2
Alt-A	14,851	7,466	50.3	1,210.0	74.3	6.1
Subprime	6,509	528	8.1	979.5	4.1	0.4
Investment Grade Ex-AAA Securities						
Prime	6,436	3,736	114.2	54.0	18.0	33.4
Alt-A	9,610	7,708	80.2	96.5	55.0	57.0
Subprime	10,893	7,352	67.5	203.9	102.7	50.4
Non-Investment Grade Securities						
Prime	3,430	2,691	78.5	12.0	4.3	35.9
Alt-A	2,674	2,341	87.5	20.8	10.7	51.4
Subprime	1,303	1,152	88.4	12.7	10.0	78.6

Figure TA2: **Losses and Probability of Loss in RMBS Over Time**



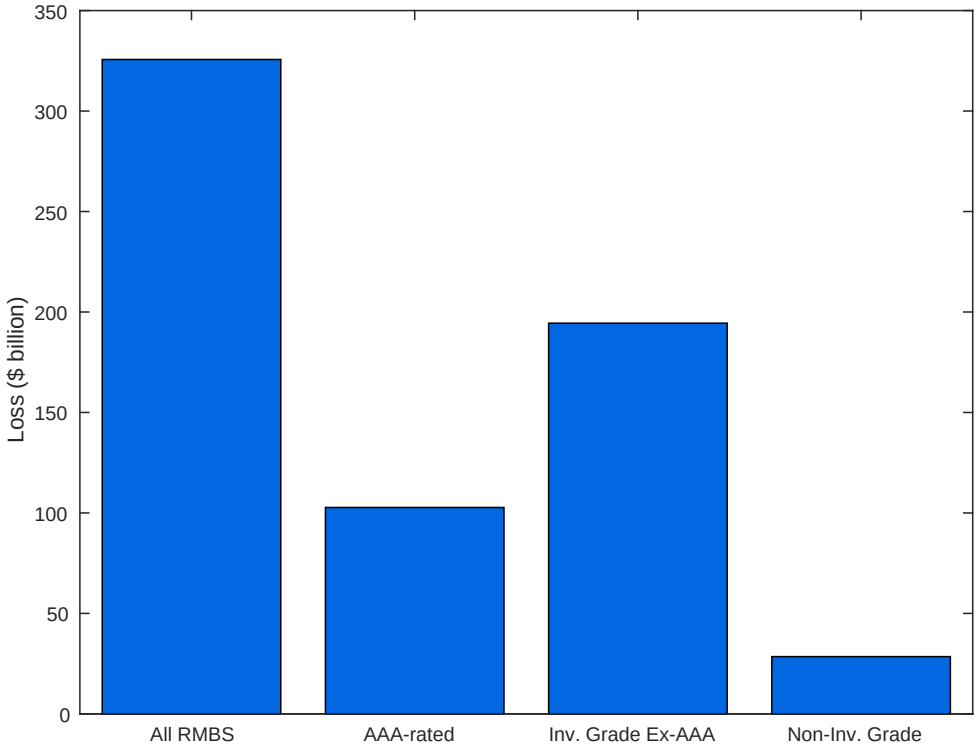
This figure shows the losses as a fraction of principal and the probability of losses incurred by the Residential Mortgage Backed securities in our database during the period 2000-2013. In this figure we group together bonds that had a rating of BB or below into a non-investment grade category, and bonds with ratings of BBB, A and AA into an investment grade category that exclude AAA securities. Panel A plots the cumulative losses as a fraction of principal weighted by the principal amount by credit rating. Panel B plots the fraction of securities that at any point in time have had some principal losses by credit rating. Only bonds issued up to 2008 are part of the computations.

Figure TA3: **Losses Over Time by Type of Mortgage for AAA-Rated RMBS**



This figure plots the losses as a fraction of principal weighted by principal amount for the AAA-rated Residential Mortgage Backed Securities in our database during the period 2000-2013. Securities are classified by type of mortgage loan (Prime, Alt-A, and Subprime). The percentages shown next to the lines correspond to the principal dollar value in AAA securities that belong to each category as a fraction of the total principal value of AAA securities. Only bonds issued up to 2008 are part of the computations.

Figure TA4: **Dollar Amount of Losses in Non-Agency RMBS**



This figure shows the cumulative Dollar amount of losses in RMBS up to December 2013 in billions of dollar. The category Investment Grade Ex-AAA includes AA, A, and BBB rated securities. The Non-Investment Grade Category includes all bonds rated BB and below

C.4 Fact 4: Additional Information

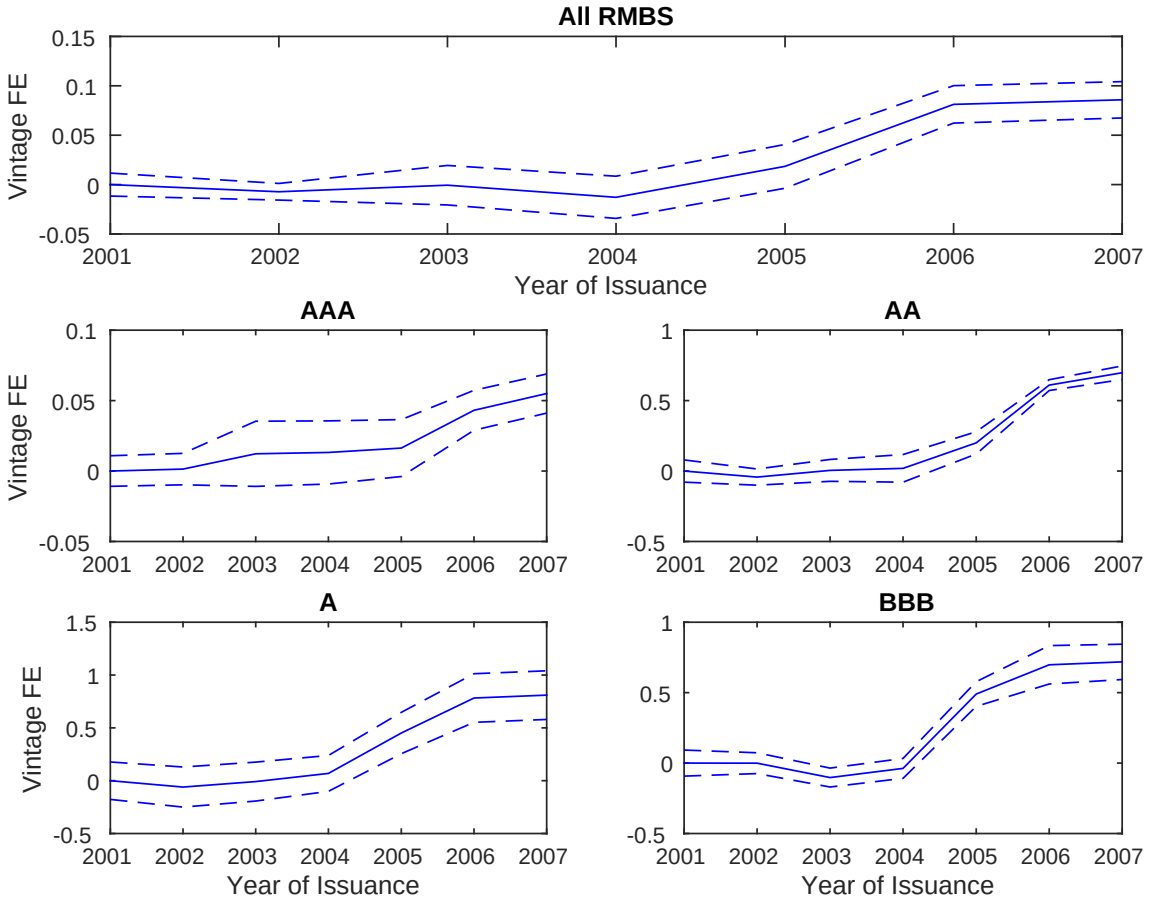
Table TA5: **Principal-Weighted Probability of Loss in RMBS and Credit Ratings**

This table presents linear regressions to study the relation between the probability of incurring losses and credit ratings. The regressions are weighted by the principal dollar amount upon issuance of each RMBS. The LHS in the regression is a dummy variable that takes the value one if the cumulative losses as of December 2013 are strictly greater than zero, and takes the value zero otherwise. The RHS of the regression includes a constant and credit rating dummy variables. In these regressions we only include bonds that have a rating. In this way the constant of the regression corresponds to AAA securities, and we have renamed the constant as AAA. To interpret correctly the other coefficients, one must take into account the constant.

Credit Rating	**Full Sample**	**Before 2003**	**2003 - 2005**	**2006-2008**
AAA	0.2747***	0.0639***	0.1667***	0.4636***
	(0.0016)	(0.0019)	(0.0021)	(0.0028)
AA	0.1603***	0.0207*	0.1010***	0.1667***
	(0.0066)	(0.0107)	(0.0088)	(0.0106)
A	0.2073***	0.0178	0.1472***	0.3351***
	(0.0087)	(0.0111)	(0.0114)	(0.0155)
BBB	0.3177***	0.1690***	0.3168***	0.3136***
	(0.0104)	(0.0170)	(0.0131)	(0.0179)
BB	0.5943***	0.2203***	0.6514***	0.4819***
	(0.0169)	(0.0389)	(0.0238)	(0.0253)
B	0.5885***	0.2264***	0.7656***	0.4303***
	(0.0308)	(0.0560)	(0.0466)	(0.0452)
CCC	0.5822**	0.9361	0.4627	0.5364
	(0.2272)	(0.7475)	(0.3134)	(0.3381)
CC	0.6340***	0.4459	-0.0239	0.5364***
	(0.1472)	(1.2919)	(0.3900)	(0.1785)
C or Below	0.7176***	0.0696	0.8333	0.5364***
	(0.0589)	(0.3045)	(0.5286)	(0.0681)
Observations	93,902	19,230	38,381	36,291
R-squared	0.0370	0.0079	0.0451	0.0376

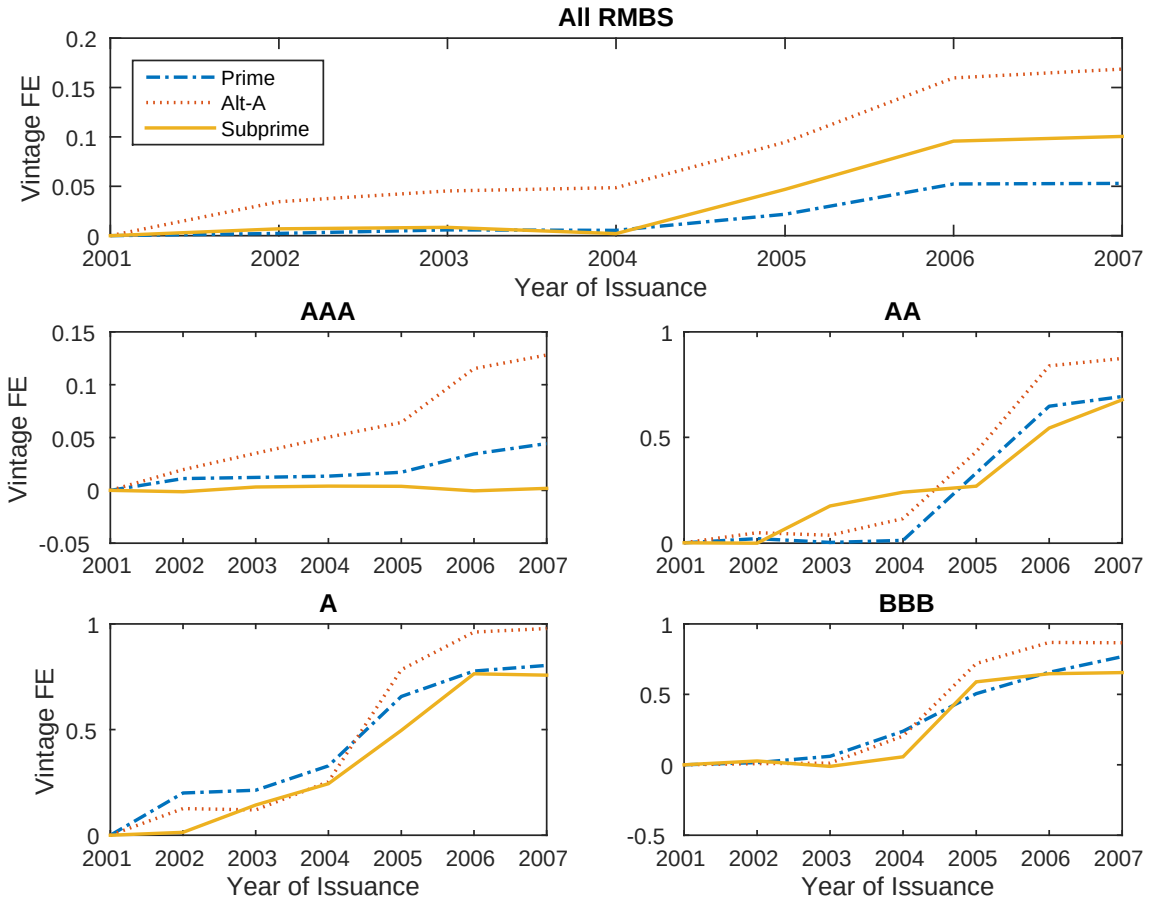
Standard errors in parentheses
$*p < 0.10, **p < 0.05, ***p < 0.01$

Figure TA5: **Vintage Fixed Effects on Weighted Losses**



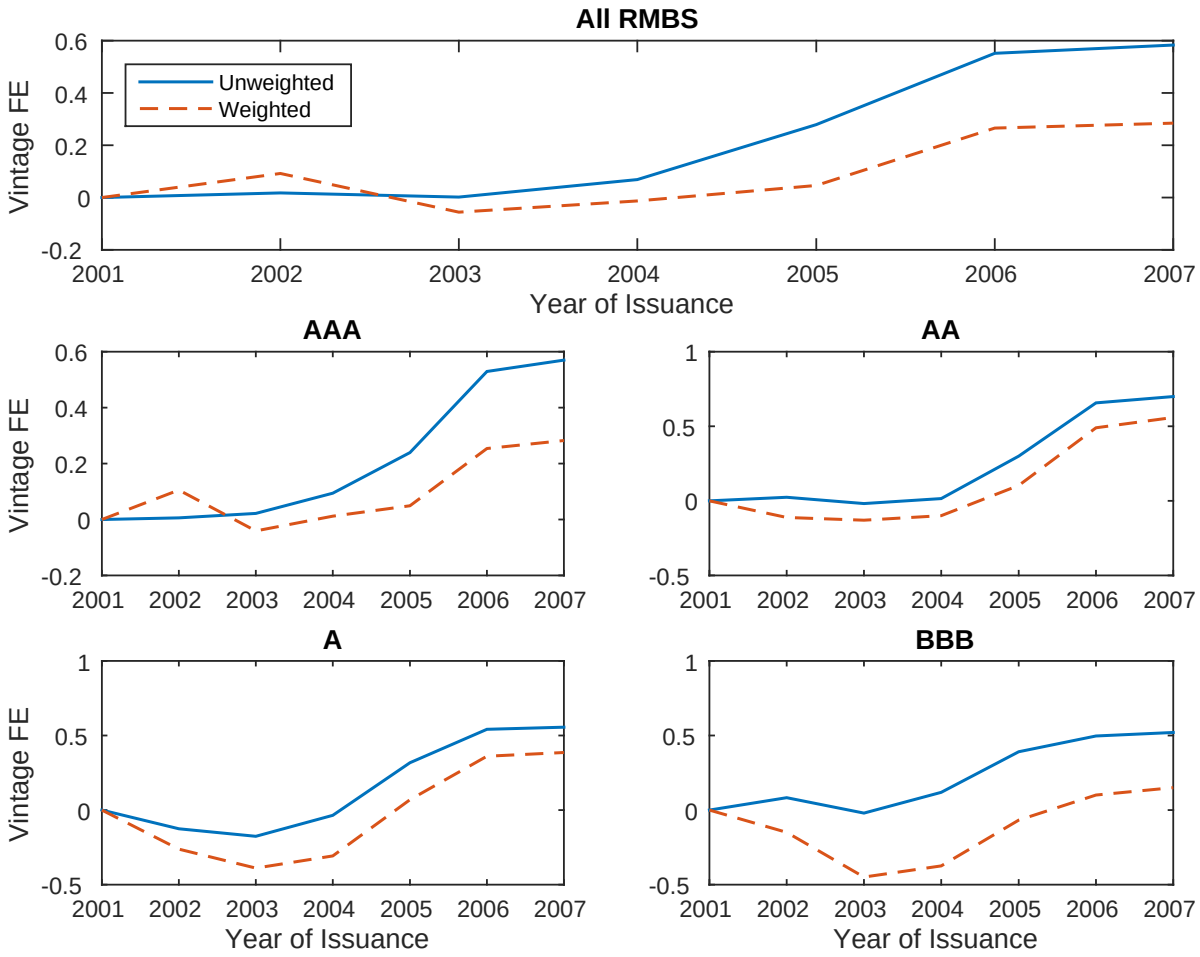
This figure plots the coefficient estimates corresponding to issue year (vintage) dummy variables in linear regressions that have as left hand side variable the cumulative losses as of December 2013 as a fraction of principal and on the right hand side have all the covariates available in our database as controls. The lines are the mean plus/minus one standard error.

Figure TA6: **Vintage Fixed Effects on Weighted Losses by Type of Mortgage Loan**



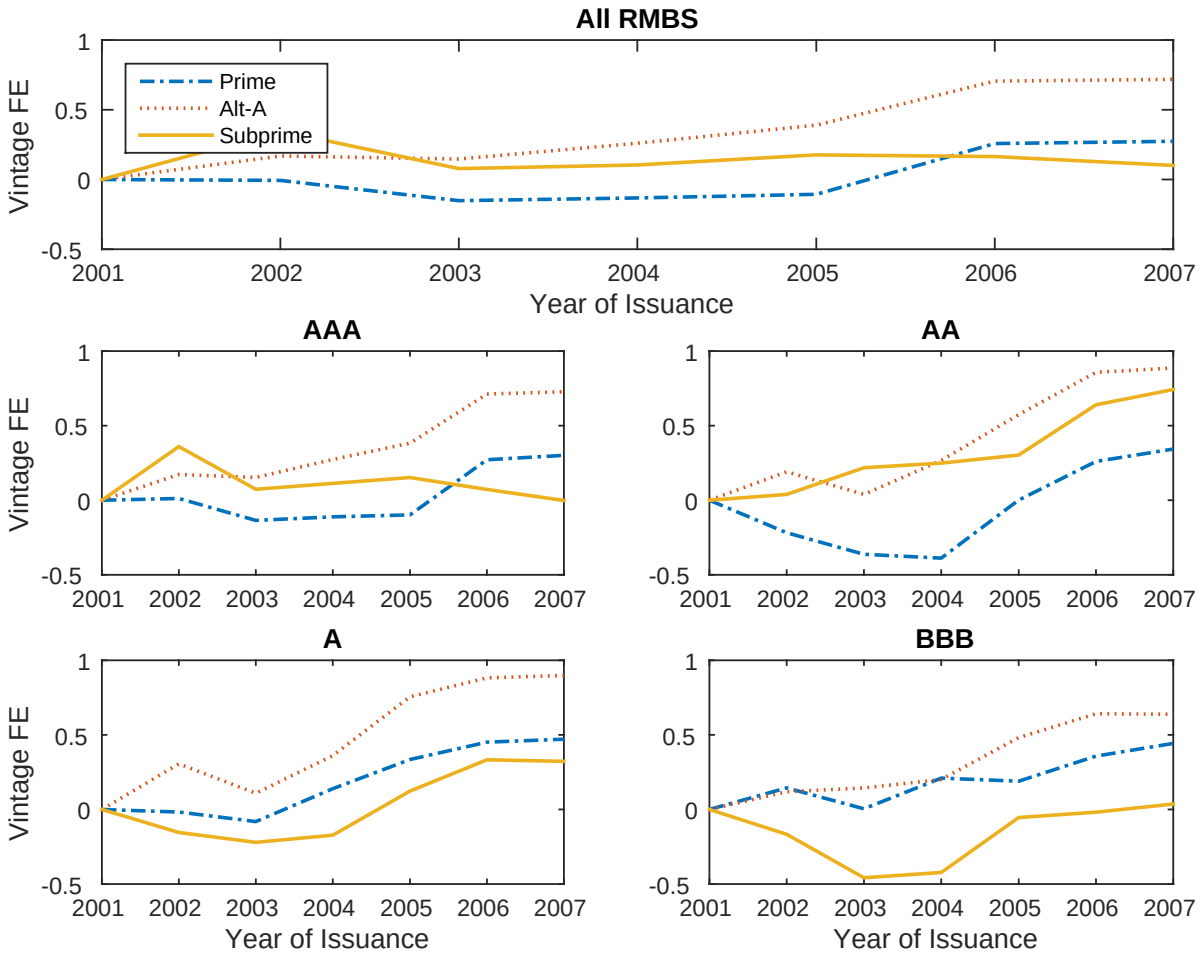
This figure plots the coefficient estimates corresponding to issue year (vintage) dummy variables in linear regressions that have as left hand side variable the cumulative losses as of December 2013 as a fraction of principal and on the right hand side have all the covariates available in our database as controls. The results are broken down by category of mortgage loan: Prime, Alt-A, and Subprime.

Figure TA7: **Vintage Fixed Effects on Probability of Loss**



This figure plots the coefficient estimates corresponding to issue year (vintage) dummy variables in linear regressions that have as left hand side variable a dummy variable that takes the value one if the cumulative losses as of December 2013 are strictly greater than zero, and takes the value zero otherwise. The right hand side have all the covariates available in our database as controls, including issue year dummies.

Figure TA8: **Vintage Fixed Effects on Weighted Probability of Loss by Type of Mortgage Loan**



This figure plots the coefficient estimates corresponding to issue year (vintage) dummy variables in linear regressions that have as left hand side variable a dummy variable that takes the value one if the cumulative losses as of December 2013 are strictly greater than zero, and takes the value zero otherwise. The right hand side have all the covariates available in our database as controls, including issue year dummies. The results are broken down by category of mortgage loan: Prime, Alt-A, and Subprime.

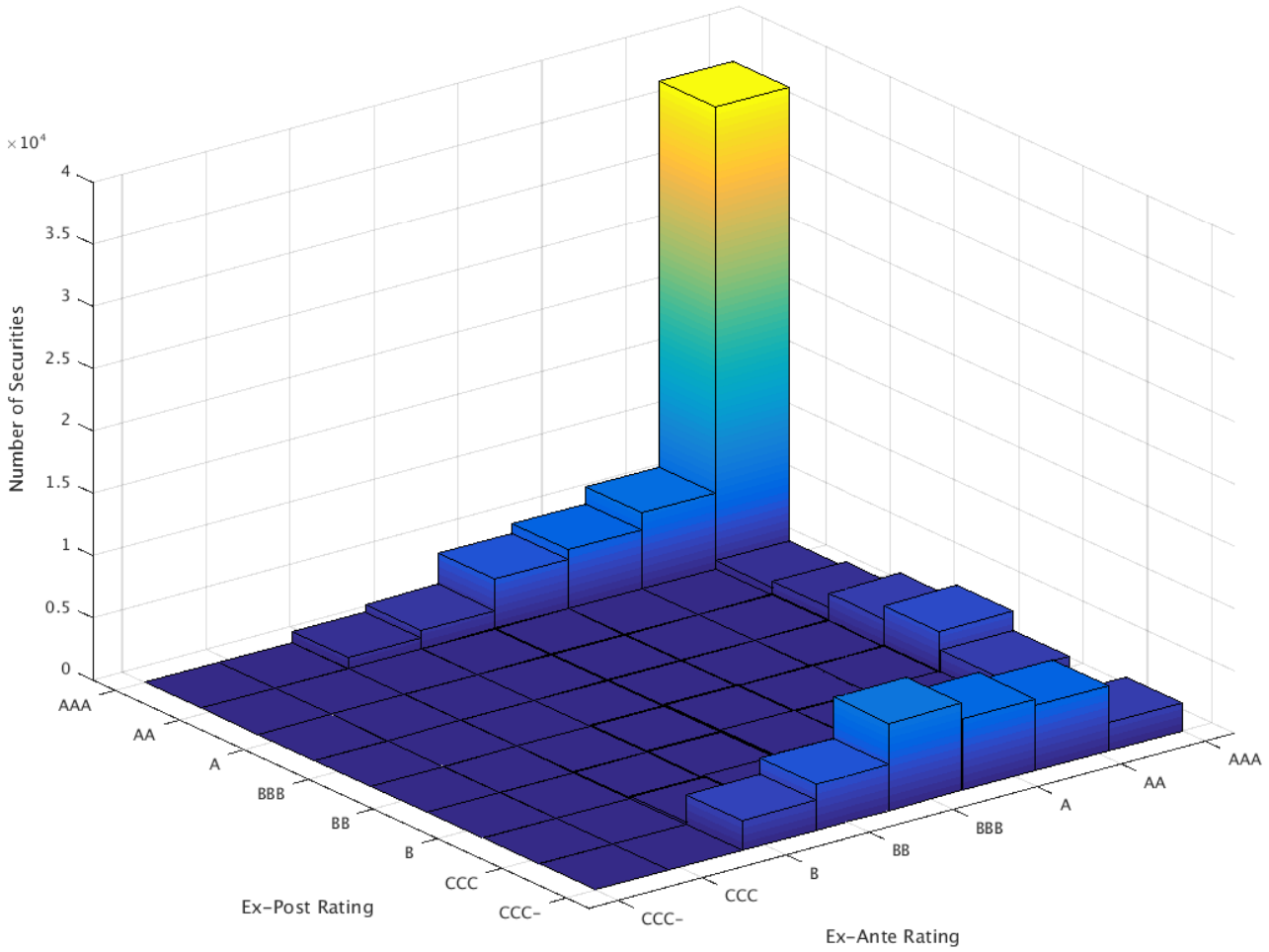
C.5 Fact 5 and 6: Additional Information

Figure TA9: **Moody's Idealized Cumulative Expected Loss Rates**

	Year									
Rating	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Aaa	0.000028%	0.000110%	0.000390%	0.000990%	0.001600%	0.002200%	0.002860%	0.003630%	0.004510%	0.005500%
Aa1	0.000314%	0.001650%	0.005500%	0.011550%	0.017050%	0.023100%	0.029700%	0.036850%	0.045100%	0.055000%
Aa2	0.000748%	0.004400%	0.014300%	0.025850%	0.037400%	0.048950%	0.061050%	0.074250%	0.090200%	0.110000%
Aa3	0.001661%	0.010450%	0.032450%	0.055500%	0.078100%	0.100650%	0.124850%	0.149600%	0.179850%	0.220000%
A1	0.003196%	0.020350%	0.064350%	0.103950%	0.143550%	0.181500%	0.223300%	0.264000%	0.315150%	0.385000%
A2	0.005979%	0.038500%	0.122100%	0.189750%	0.256850%	0.320650%	0.390500%	0.455950%	0.540100%	0.660000%
A3	0.021368%	0.082500%	0.198000%	0.297000%	0.401500%	0.500500%	0.610500%	0.715000%	0.836000%	0.990000%
Baa1	0.049500%	0.154000%	0.308000%	0.456500%	0.605000%	0.753500%	0.918500%	1.083500%	1.248500%	1.430000%
Baa2	0.093500%	0.258500%	0.456500%	0.660000%	0.869000%	1.083500%	1.325500%	1.567500%	1.782000%	1.980000%
Baa3	0.231000%	0.577500%	0.940500%	1.309000%	1.677500%	2.035000%	2.381500%	2.733500%	3.063500%	3.355000%
Ba1	0.478500%	1.111000%	1.721500%	2.310000%	2.904000%	3.437500%	3.883000%	4.339500%	4.779500%	5.170000%
Ba2	0.858000%	1.908500%	2.849000%	3.740000%	4.625500%	5.373500%	5.885000%	6.413000%	6.957500%	7.425000%
Ba3	1.545500%	3.030500%	4.328500%	5.384500%	6.523000%	7.419500%	8.041000%	8.640500%	9.190500%	9.713000%
B1	2.574000%	4.609000%	6.369000%	7.617500%	8.866000%	9.839500%	10.521500%	11.126500%	11.682000%	12.210000%
B2	3.938000%	6.418500%	8.552500%	9.971500%	11.390500%	12.457500%	13.205500%	13.832500%	14.421000%	14.960000%
B3	6.391000%	9.135500%	11.566500%	13.222000%	14.877500%	16.060000%	17.050000%	17.919000%	18.579000%	19.195000%
Caa	14.300000%	17.875000%	21.450000%	24.134000%	26.812500%	28.600000%	30.387500%	32.175000%	33.962500%	35.750000%

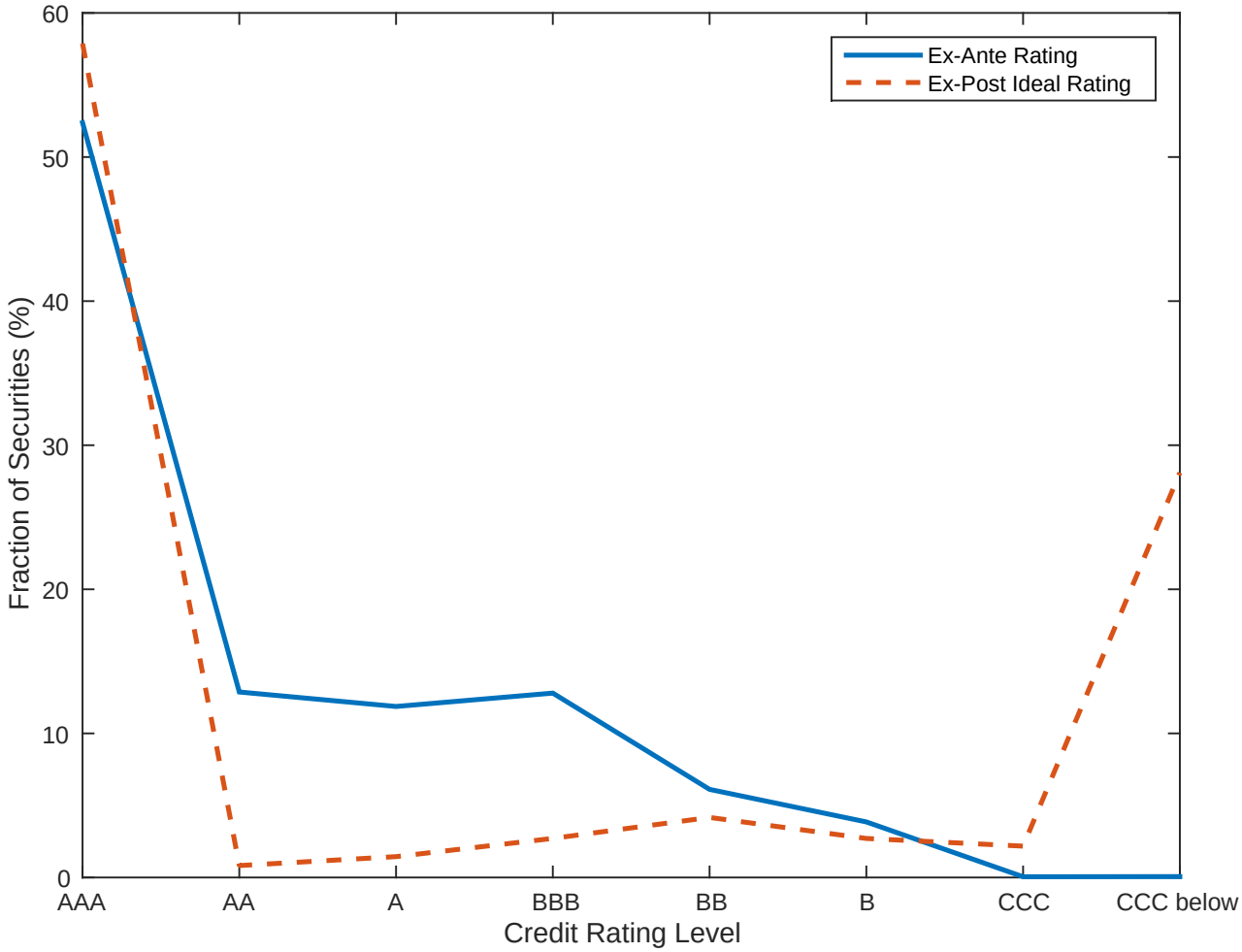
This figure presents a table that relates credit ratings with the loss rates (loss as fraction of principal) that asset backed securities would be expected to have. The table was used up to the crisis as a reference and it was produced by Moody's. Importantly, Moody's would use this table as part of the risk and valuation analysis, but not as summary statistic that would completely determine its rating. The table is available here `https://www.moodys.com/sites/products/productattachments/marvel_user_guide1.pdf`

Figure TA10: **"Misratings" Ratings Based on Moody's Ideal Ratings**



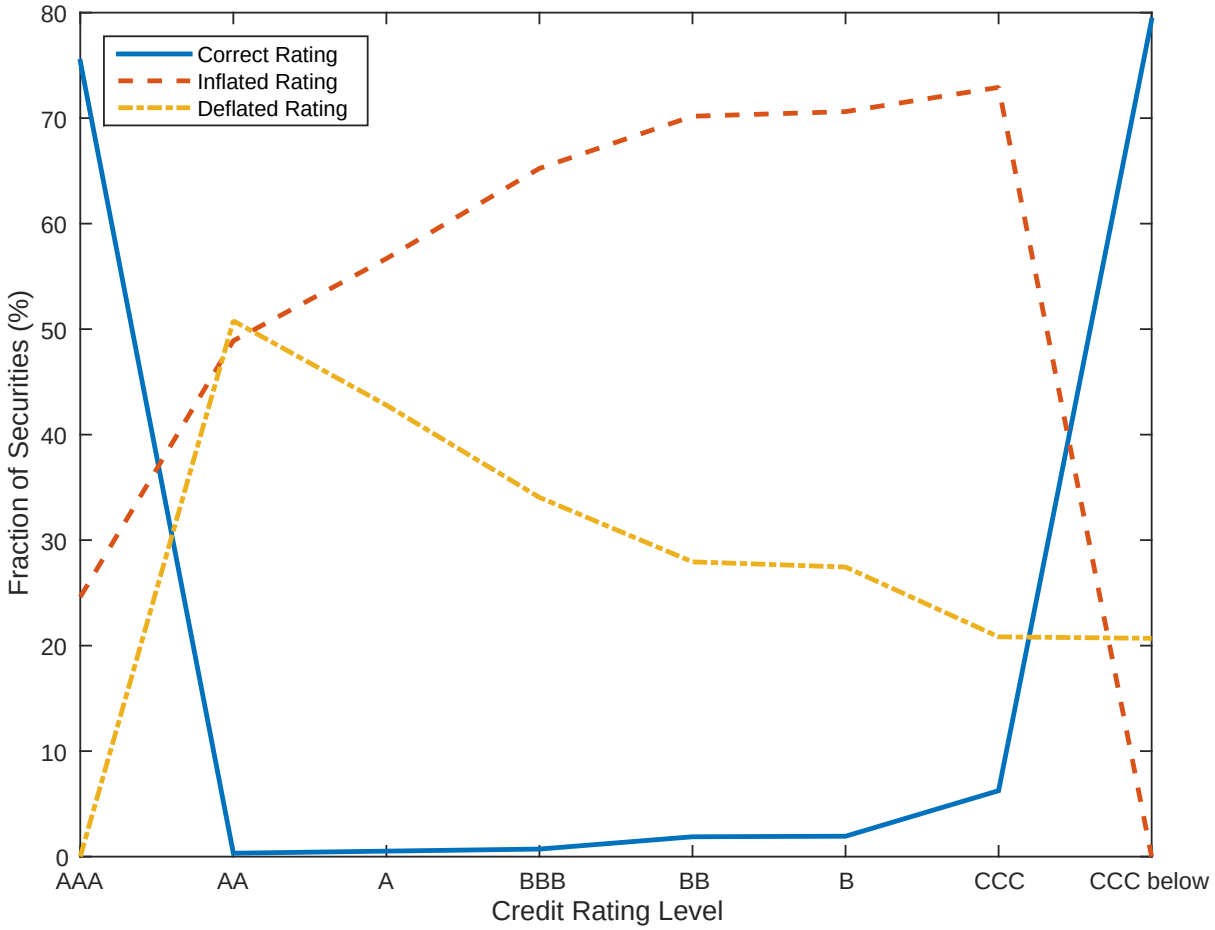
This figure classifies each security in a bin defined in two dimensions. One dimension is the ex-ante credit rating as determined by the original credit rating. The second dimension is the ex-post rating determined by Moody's table for idealized expected losses. If all securities had behaved as expected, all the mass would be represented in bars on the diagonal running southwest-northeast in the plot. The height of the bar represents the number of securities.

Figure TA11: **Ex-Ante vs Ex-Post Ideal Ratings - Unweighted Version**



In this figure, for each security, we compare the original credit rating (which we call here Ex-Ante Rating) to the rating that ex-post we would have assigned given the security's realized loss using Moody's idealized Expected Loss Table by Rating, which we present in Figure TA9 in the technical appendix. The solid line shows the fraction of securities that was assigned each rating level. The dotted line shows the fraction of securities that should have gotten each rating level based on their loss as a fraction of original principal. Unlike figure 3 in the paper, the calculations here are not weighted by dollar value of principal.

Figure TA12: **"Right" and "Wrong" Ratings Based on Moody's Ideal Ratings - Unweighted Version**



This figure compares the original rating of each security to the rating we would have assigned ex-post based on Moody's idealized Expected Loss Table by Rating. If the two ratings coincide, we say that the security was correctly rated. If the original rating is higher than what it should have been based on realized losses, we say that the security had an inflated rating. Finally, if the original rating is lower than what it should have been based on realized losses, we say that the security had a deflated rating. Unlike figure 4 in the paper, the calculations here are not weighted by dollar value of principal.

C.6 Fact 7: Additional Information

Table TA6: **House Prices and Probability of Loss**

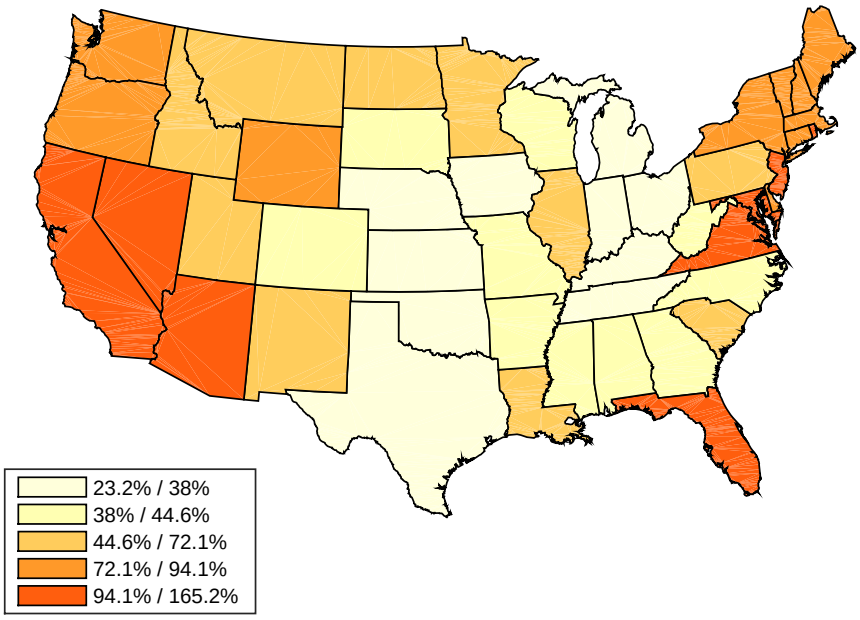
This table presents regressions to study the relation between the probability of incurring losses and changes in house prices.

	(1)	(2)	(3)	(4)	(5)
ΔHP 2000 - 2006	0.338***		-0.510***	-0.376***	-0.551***
	0.007		0.022	0.030	0.069
ΔHP 2006 - 2009		-0.0834***	-1.828***	-1.288***	-1.320***
		0.014	0.045	0.052	0.155
AA				0.318***	0.310***
				0.008	0.008
A				0.394***	0.382***
				0.010	0.010
BBB				0.45***	0.439***
				0.012	0.012
BB				0.601***	0.575***
				0.018	0.017
B				0.502***	0.486***
				0.032	0.032
CCC				0.633***	0.596***
				0.224	0.217
CC				0.317	0.252
				0.227	0.221
C or Below				0.458***	0.397***
				0.058	0.057
Subprime				-0.255***	-0.282***
				0.004	0.005
Alt-A				0.095***	0.051***
				0.004	0.004
Contstant	0.062***	0.038***	0.084***	0.217***	0.454***
	0.005	0.005	0.005	0.013	0.017
State Dummies	No	No	No	No	Yes
Weighted Dummies	No	No	No	No	Yes
Observations	93,902	93,902	93,902	71,316	71,316
R-squared	0.0257	0.0372	0.0428	0.1634	0.2086
Weighted	Yes	Yes	Yes	Yes	Yes ”

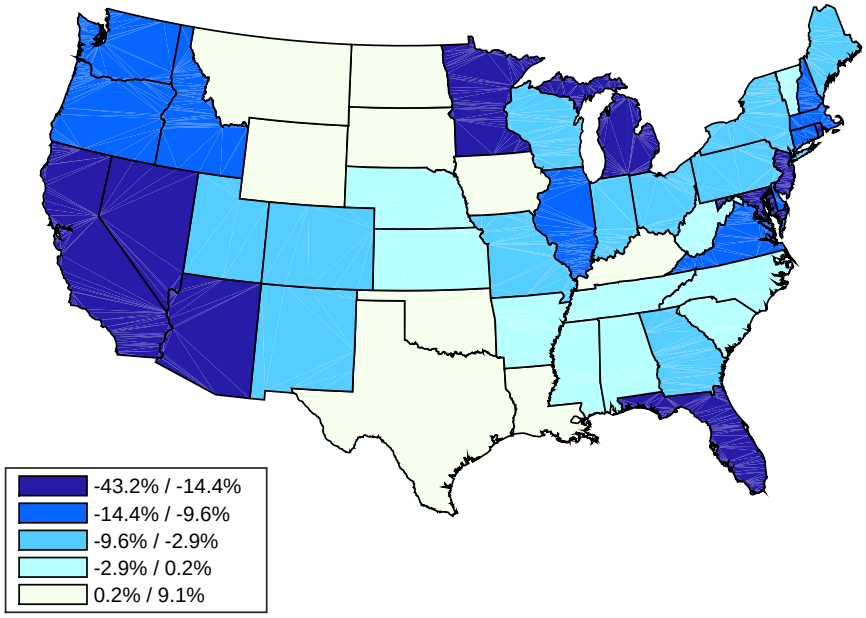
Standard errors in parentheses: $*p < 0.10, **p < 0.05, ***p < 0.01$

Figure TA13: **State-Level House Price Boom and Bust From 2000-Q1 to 2009-Q2**

Panel A. Boom: 2000-Q1 to 2006-Q4



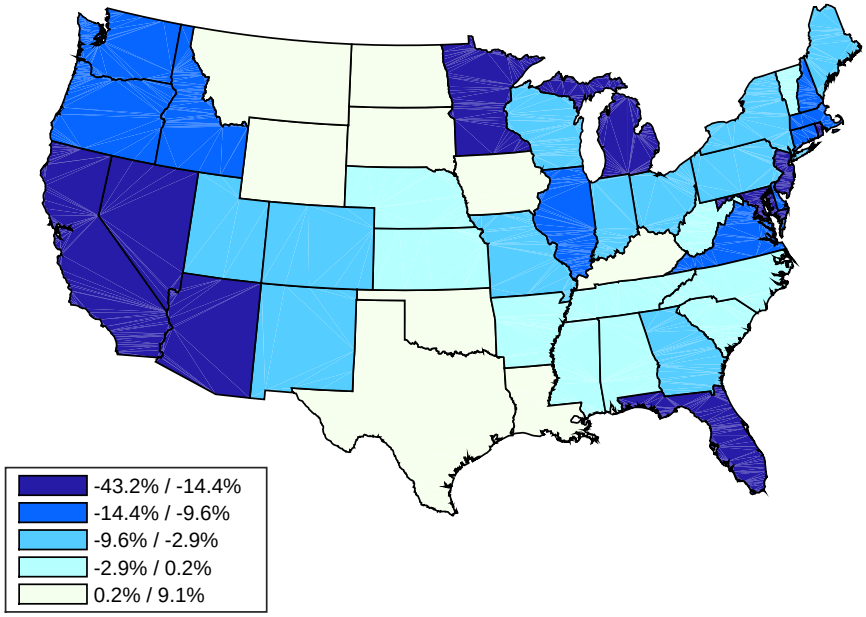
Panel B. Bust: 2006-Q4 to 2009-Q4



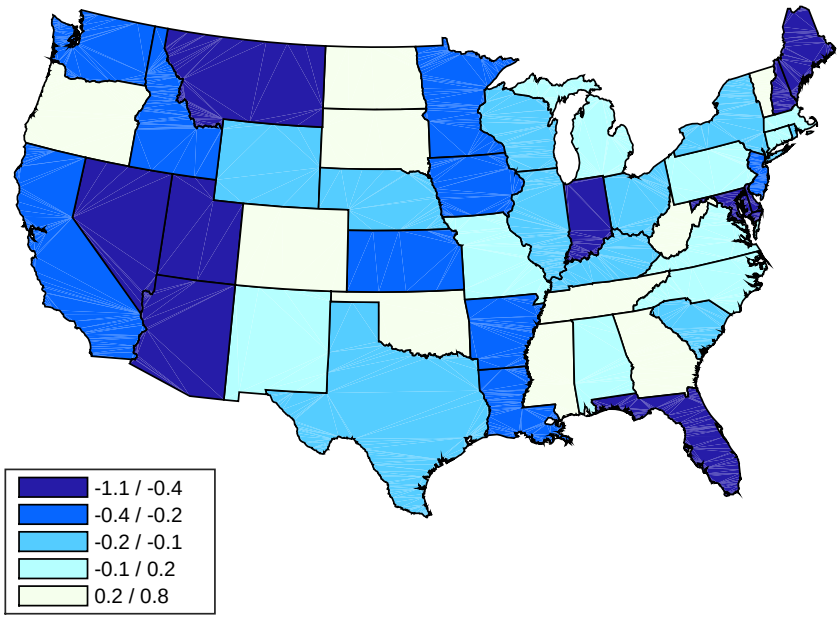
This map highlights the differences in house price increases between the first quarter of 2000 and the fourth quarter of 2006 and house price decreases between the fourth quarter of 2006 and the fourth quarter of 2009 across states. The house price data comes from the Federal Housing Agency and corresponds to the State-Level All-transaction indexes available here `http://www.fhfa.gov/DataTools/Downloads/Pages/House-Price-Index-Datasets.aspx#qexe`*. States are grouped in quintiles according to the house price change the experienced in each period. Each color on the map represents a quintile, with darkest colors representing bigger absolute changes (red for the period of price increases and blue for the period of price decreases).*

Figure TA14: **House Price Bust and State-Level Dummies on Loss Rates**

Panel A. Bust: 2006-Q4 to 2009-Q4



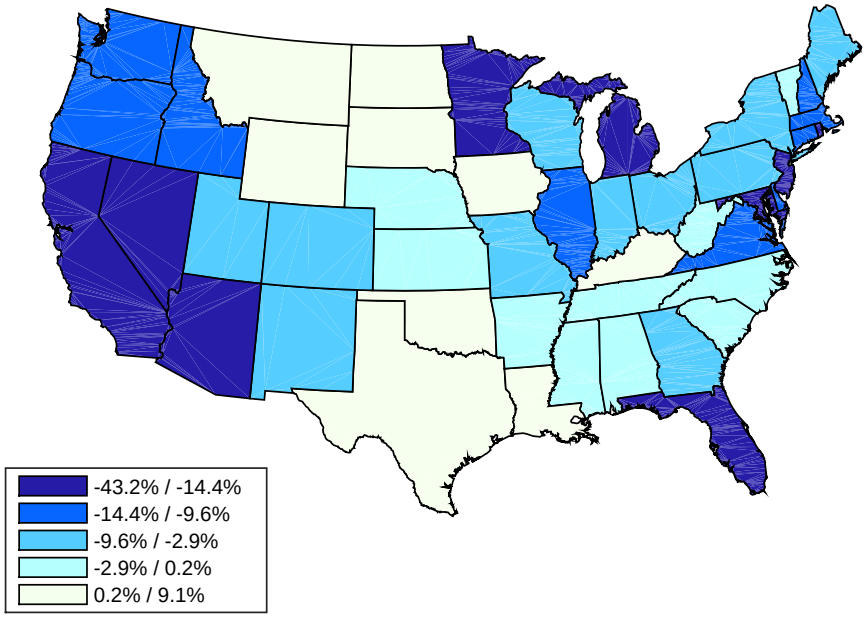
Panel B. Dummy Coefficients Regression without Controls



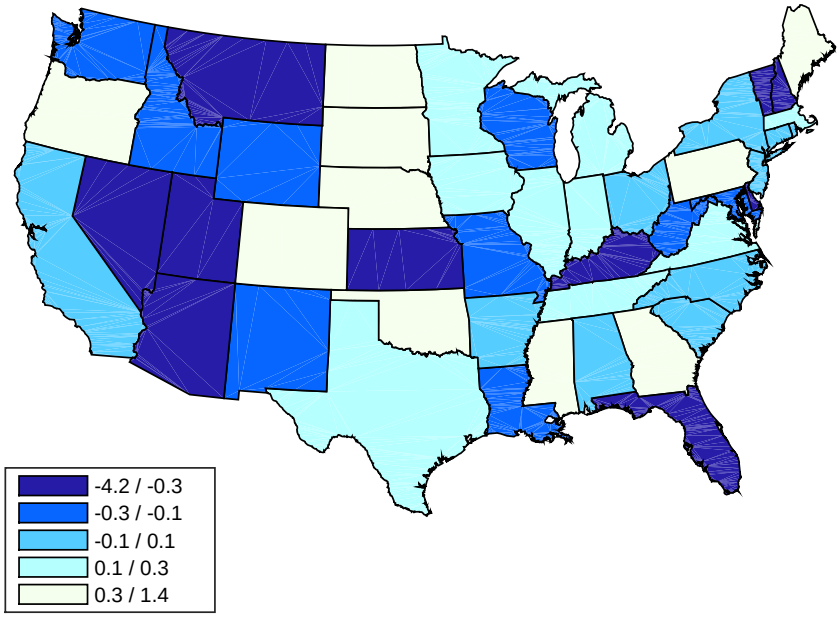
The map at the top colors states according to the quintiles of house price change between the fourth quarter of 2006 and the fourth quarter of 2009. Darker colors represent states with bigger house price declines. The map at the bottom colors states according to the coefficients on state-level dummy variables weighted by the concentration of mortgages of a given state in a given MBS from a regression of loss rates (cumulative loss as of December 2013 divided by original principal amount) on only the state dummy variables. The coefficients of the dummy variables are then colored by quintiles. Darker colors represent larger coefficients. The house price data comes from the Federal Housing Agency and corresponds to the State-Level All-transaction indexes available here `http://www.fhfa.gov/DataTools/Downloads/Pages/House-Price-Index-Datasets.aspx#qexe`.

Figure TA15: **House Price Bust and State-Level Dummies on Loss Rates**

Panel A. Bust: 2006-Q4 to 2009-Q4



Panel B. Dummy Coefficients Regression with Controls



The map at the top colors states according to the quintiles of house price change between the fourth quarter of 2006 and the fourth quarter of 2009. Darker colors represent states with bigger house price declines. The map at the bottom colors states according to the coefficients on state-level dummy variables weighted by the concentration of mortgages of a given state in a given MBS from a regression of loss rates (cumulative loss as of December 2013 divided by original principal amount) on state dummy variables, dummy variables representing credit ratings and dummy variables for Prime, Alt-A, Subprime to control for FICO score. The coefficients of the dummy variables are then colored by quintiles. Darker colors represent larger coefficients. The house price data comes from the Federal Housing Agency and corresponds to the State-Level All-transaction indexes available here `http://www.fhfa.gov/DataTools/Downloads/Pages/House-Price-Index-Datasets.aspx#qexe`.

Table TA7: **Return Premium (θ) From Issuance to 2013 by Credit Rating**

This table presents premium calculations for the RMBS in our database by credit rating using the 3-month Tbill rate as benchmark. The premium IRR solves equation 3.Here we report annualized rates. We present the computation under different assumptions about the terminal value of each security as of December 2013. The first 3 columns assume that the security is sold at 80%, 90% *and* 100% *of the outstanding principal amount in December 2013 respectively. The fourth column assumes that the loss in the terminal value is equal to the loss as a fraction of principal suffered by the security up to that point. The fifth and sixth columns assume that the loss in the terminal value is equal to the mean and the median of the losses as a fraction of principal suffered by all securities with the same rating and the same vintage (issue year).*

	Terminal Value Assumption					
Return Statistic	**80% TV**	**90% TV**	**100% TV**	**Same Loss**	**Mean Loss**	**Median Loss**
	Panel A: Principal Value - Weighted					
AAA-Rated						
Mean	0.0	0.3	0.7	0.6	0.7	0.6
Median	1.3	1.6	2.1	2.1	2.1	1.9
Std. Dev.	20.1	20.2	20.2	20.2	20.2	20.2
AA-Rated						
Mean	-1.6	-1.6	-1.6	-1.7	-1.8	-1.7
Median	-0.4	0.7	1.8	1.7	-1.1	-1.0
Std. Dev.	52.5	52.4	52.6	52.6	51.9	51.8
A-Rated						
Mean	-1.2	-1.2	-1.2	-1.2	-1.3	-1.2
Median	-0.1	0.4	1.0	1.0	-4.4	-3.6
Std. Dev.	52.5	52.4	52.6	52.6	51.9	51.8
BBB-Rated						
Mean	-1.0	-1.0	-1.0	-1.0	-1.1	-1.1
Median	-5.3	-7.5	-7.4	-8.2	-18.1	-11.3
Std. Dev.	67.6	66.9	67.1	67.0	65.5	66.1

Table TA8: **Return Premium (θ) From Issuance to 2013 by Vintage**

This table presents premium calculations for the RMBS in our database by vintage (year of issuance) using the 3-month Tbill rate as benchmark. The premium IRR solves equation 3. Here we report annualized rates. We present the computation under different assumptions about the terminal value of each security as of December 2013. The first 3 columns assume that the security is sold at 80%, 90% *and* 100% *of the outstanding principal amount as of December 2013 respectively.*

	Terminal Value Assumption					
Return Statistic	**80% TV**	**90% TV**	**100% TV**	**Same Loss**	**Mean Loss**	**Median Loss**
Vintage 2000						
Mean	0.0	0.0	0.0	0.0	0.0	0.0
Median	5.1	5.1	5.1	5.1	5.1	5.1
Std. Dev.	22.1	22.1	22.1	22.1	22.1	22.1
Vintage 2001						
Mean	0.1	0.1	0.1	0.1	0.1	0.1
Median	5.4	5.4	5.4	5.4	5.4	5.4
Std. Dev.	19.8	19.8	19.7	19.7	19.7	19.7
Vintage 2002						
Mean	0.1	0.1	0.1	0.1	0.1	0.1
Median	3.9	3.9	3.9	3.9	3.9	3.9
Std. Dev.	21.5	21.5	21.5	21.5	21.5	21.5
Vintage 2003						
Mean	0.2	0.2	0.2	0.2	0.2	0.2
Median	3.4	3.6	3.7	3.7	3.7	3.7
Std. Dev.	10.6	10.7	10.7	10.7	10.7	10.7
Vintage 2004						
Mean	0.3	0.3	0.3	0.3	0.3	0.3
Median	3.2	3.3	3.5	3.5	3.5	3.5
Std. Dev.	17.1	17.1	17.2	17.2	17.2	17.2
Vintage 2005						
Mean	0.1	0.2	0.2	0.2	0.2	0.2
Median	3.4	3.8	4.0	4.0	4.0	4.0
Std. Dev.	16.7	16.6	16.5	16.6	16.5	16.5
Vintage 2006						
Mean	-1.9	-1.8	-1.7	-1.8	-1.9	-1.8
Median	1.6	2.2	2.8	2.7	2.8	2.5
Std. Dev.	33.8	33.9	34.0	34.0	34.6	34.0
Vintage 2007						
Mean	-1.3	-1.2	-1.1	-1.1	-1.2	-1.2
Median	1.3	1.9	2.5	2.4	2.3	2.0
Std. Dev.	39.9	40.0	40.2	40.2	40.2	40.1

Table TA9: **Return Premium (θ) From Issuance to 2013 by Type of Mortgage Loan**

This table presents premium calculations for the RMBS in our database by type of mortgage loan using the 3-month Tbill rate as benchmark. The premium IRR solves equation 3. Here we report annualized rates. We present the computation under different assumptions about the terminal value of each security as of December 2013. The first 3 columns assume that the security is sold at 80%, 90% *and* 100% *of the outstanding principal amount as of December 2013 respectively.*

	Terminal Value Assumption					
Return Statistic	**80% TV**	**90% TV**	**100% TV**	**Same Loss**	**Mean Loss**	**Median Loss**
	Panel A: Principal Value - Weighted					
Subprime						
Mean	-2.2	-2.2	-2.1	-2.1	-2.4	-2.3
Median	0.0	0.6	1.5	1.5	1.4	0.9
Std. Dev.	35.0	35.2	35.3	35.4	35.8	35.3
Alt-A						
Mean	-1.5	-1.4	-1.3	-1.4	-1.3	-1.3
Median	0.8	1.3	2.0	1.9	1.9	1.7
Std. Dev.	35.4	35.6	35.7	35.7	35.7	35.6
Prime						
Mean	0.4	0.4	0.5	0.5	0.5	0.5
Median	3.2	3.5	3.8	3.8	3.8	3.7
Std. Dev.	15.2	15.4	15.2	15.3	15.3	15.3

Table TA10: **Return Premium (θ) for AAA-rated RMBS by Vintage, Loan Type and Bond Type**

This table presents premium calculations for the AAA RMBS in our database by type of mortgage loan, vintage, and by type of bond (floating rate or fixed rate) using the 3-month Tbill rate as benchmark. The premium IRR solves equation 3. Here we report only median annualized rates, and the calculations are all weighting by the original principal amount. We present the computation under different assumptions about the terminal value of each security as of December 2013. The assumptions are that the security is sold at 80%, 90% *and* 100% *of the outstanding principal amount as of December 2013 respectively.*

	Fixed Rate			**Floating Rate**			**3-Month**
Loan Type	**80% TV**	**90% TV**	**100% TV**	**80% TV**	**90% TV**	**100% TV**	**Libor**
Vintage 2000							
Subprime	4.5	4.5	4.5	1.6	1.6	1.6	
Alt-A	4.0	4.0	4.0	2.6	2.6	2.6	2.4
Prime	3.7	3.7	3.7	3.2	3.3	3.3	
Vintage 2001							
Subprime	2.9	2.9	2.9	0.3	0.4	0.4	
Alt-A	4.9	4.9	4.9	3.8	3.8	3.9	2.1
Prime	4.7	4.7	4.7	4.4	4.4	4.4	
Vintage 2002							
Subprime	2.8	2.8	2.8	-0.1	-0.1	-0.1	
Alt-A	4.6	4.7	4.7	1.1	1.2	1.2	2.0
Prime	4.4	4.4	4.4	3.0	3.0	3.0	
Vintage 2003							
Subprime	4.9	5.1	5.4	-0.7	-0.6	-0.6	
Alt-A	3.6	3.7	3.7	1.2	1.3	1.5	2.4
Prime	3.5	3.5	3.6	1.6	1.6	1.7	
Vintage 2004							
Subprime	4.4	4.6	4.7	-0.9	-0.8	-0.8	
Alt-A	4.0	4.1	4.2	0.6	0.9	1.2	2.0
Prime	3.9	4.0	4.1	2.1	2.4	2.7	
Vintage 2005							
Subprime	5.0	5.3	5.8	0.6	0.8	0.8	
Alt-A	3.9	4.4	4.8	0.9	1.5	2.0	2.1
Prime	4.2	4.5	4.8	2.5	3.0	3.5	
Vintage 2006							
Subprime	4.3	5.0	5.7	0.7	1.3	2.0	
Alt-A	3.1	3.9	4.6	-0.1	0.9	1.8	2.1
Prime	4.5	4.9	5.4	2.8	3.4	4.1	
Vintage 2007							
Subprime	4.3	5.0	5.8	-0.6	0.6	1.6	
Alt-A	2.9	3.8	4.6	-1.0	0.2	1.3	1.9
Prime	4.5	5.1	5.6	2.4	3.1	3.8	

C.7 Prices

While we examined the returns to purchasing RMBS at issuance and holding them to maturity in the previous section, one may also wish to examine the returns when purchasing them at market prices, in particular at the height of the financial crisis of 2008. While individual price series for the RMBS do not seem to exist, time series for indices are available. On January 16th 2006, Markit launched a series of asset-backed credit default swap indexes on US home equity Asset Backed Securities. The indexes are tradable synthetic derivatives, which reference 20 subprime RMBS deals/bonds. There are four series of indexes, each of which corresponds to a different vintage of securities: series 06-01 references deals issued between June 2005 and January 2006, series 06-02 references deals issued between January 2006 and June 2006, series 07-01 references deals issued between June 2006 and January 2007, and series 07-02 references deals issued between January 2007 and June 2007. The 20 deals used in each series are determined at the inception of the index and they never change. These deals are selected among a list of fifty deals of the 25 largest issuers (2 deals per issuer) and they must meet the following main criteria: the deal size must be at least $500 million, it must have tranches with all of 5 ratings (AAA, AA, A, BBB, and BBB-), it must have been rated by both S&P and Moody's, each tranche must have a weighted average life of at least 4 years with the AAA having a minimum of 5 years, the weighted average FICO credit score of the obligors on the assets backing the securities issued in the RMBS transaction must not exceed 660 as of its issuance date, and each Required Tranche must bear interest at a floating rate, with the base rate being one month LIBOR.

Each series corresponds to a set of 6 indexes by credit rating, from AAA to BBB-. In any transaction involving the index there is a protection buyer and a protection seller. The protection buyer makes two types of payments to the protection seller. One is a one-time payment upfront computed as the difference between par value and the index value multiplied by the notional amount[18] The second type of payment is a coupon or spread, payable monthly. This coupon is fixed for a given index. For example, for the AAA.06-1 index, the coupon is fixed at 18 basis points per annum, while for the BBB.07-01 is 224 basis points. The protection buyer receives payments from the protection seller in the event of interest shortfalls, principal shortfalls, and writedowns. Based on the value (or "price") of the index, one can compute excess returns between t and $t+1$ as

$$r^e = \frac{price_{t+1} - price_t}{price_t} + spread \times \frac{day\_count}{360}$$

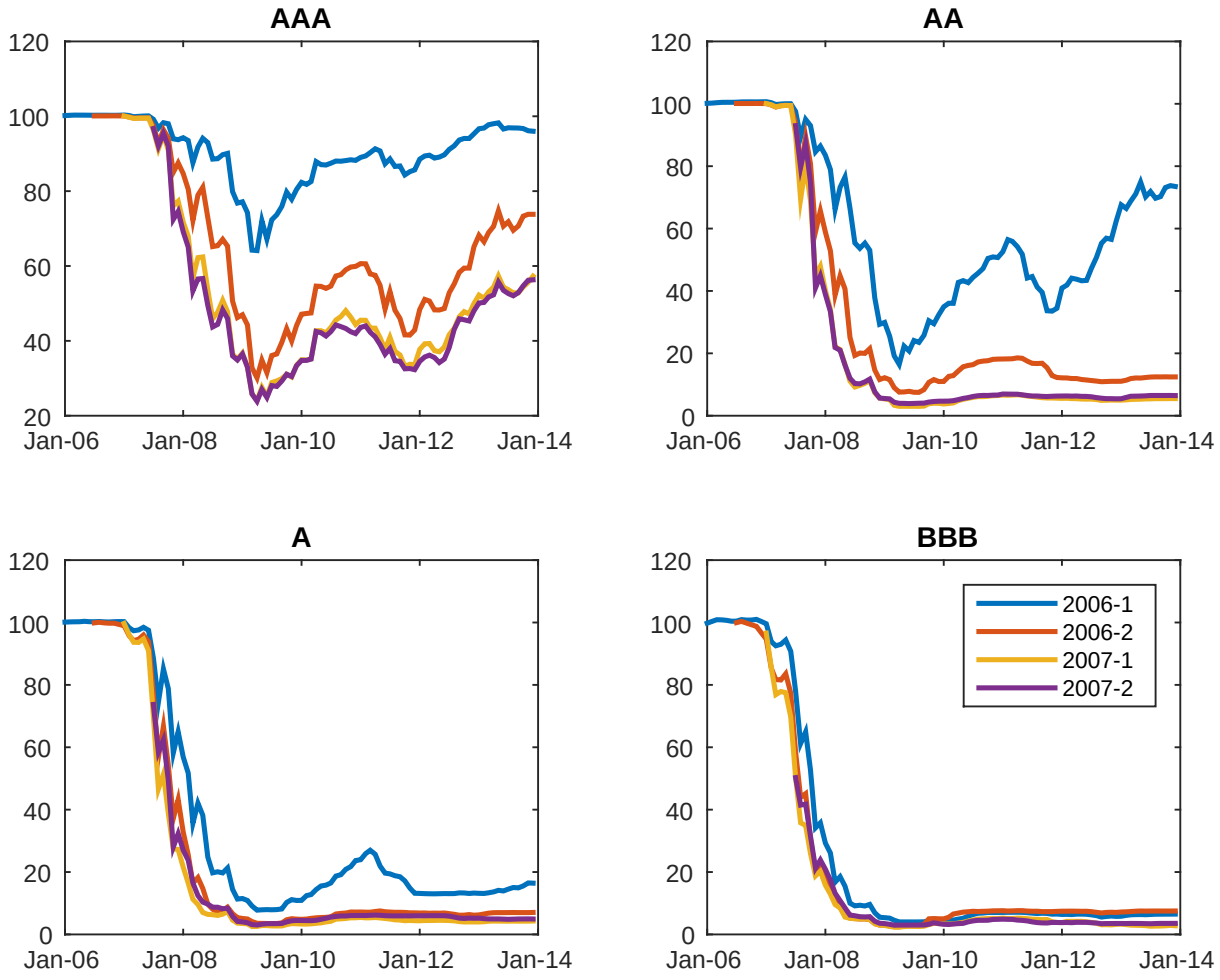
[18] the notional amount is adjusted by the so-called factor, which refers to the outstanding principal amount of the underlying bonds.

One can think of this as an excess return over some risk-free benchmark (for example Libor) by thinking about the funded transaction: the protection seller faces the risk up to 100% of the notional, if after entering the transaction he sets aside this amount at risk, he will earn some benchmark rate like the libor. The running coupon and the index appreciation will make up the rest of the return.

Figure TA16 plots the prices of indexes of the different series (vintages) by credit rating. Only the AAA tranches and the AA tranche of the 2006-01 vintage recover strongly after the crisis. The corresponding annualized returns computed with the formula above are shown in Table TA11. What these numbers as well as figure TA16 reveal is that substantial returns were earned by investors purchasing these securities in May 2009 and holding them to December 2013. On the other hand, excess returns were near zero or negative, when the purchase was made in June 2007. The excess returns on AAA rated securities was substantially negative for anyone purchasing them in, say, June 2007 and selling them in May 2009, implying losses of up to 6 percent per month, while for any long term investor, who held out until December 13, we obtain the still modest losses of 0.41 percent on a monthly basis as the worst of the AAA securities, i.e. the vintage 2007-2. Securities further down in the rating scale performed considerably worse. These results are generally in line with our findings of the payoff streams in the other sections.

[Insert Figure TA16 and Table TA11]

Figure TA16: **Subprime RMBS Price Indexes**



This figure plots the prices of ABX.HE indexes by Markit. Each line represents a vintage of subprime RMBS and the Index. Each panel shows the evolution of prices over time by credit rating. These indexes are constructed based on 20 deals.

Table TA11: **Subprime RMBS Returns for Deals Underlying ABX.HE Indexes**

This table reports monthly returns computed from the evolution of prices of the ABX.HE indexes. The calculations shows three time periods. The first period is the entire period of analysis, 2006-2013. The second period runs from January 2006 through May 2009, when the prices of AAA bonds bottomed out. The third period goes from May 2009 through December 2013.

	AAA	**AAAp**	**AA**	**A**	**BBB**	**BBB-**
Vintage 2006-1						
From Jan 06 to Dec 13	0.00	-0.37	0.09	-1.35	-2.36	-2.62
From Jan 06 to May 09	-1.08	-1.37	-4.11	-5.52	-7.07	-7.28
From May 09 To Dec 13	0.76	-0.17	3.01	1.54	0.92	0.63
Vintage 2006-2						
From June 06 to Dec 13	-0.09	-0.11	-1.77	-2.31	-2.17	-2.40
From June 06 to May 09	-3.30	-4.56	-6.55	-8.46	-9.70	-9.84
From May 09 To Dec 13	1.79	0.77	1.05	1.32	2.27	1.98
Vintage 2007-1						
From Jan 07 to Dec 13	-0.38	0.05	-2.73	-3.05	-3.62	-4.49
From Jan 07 to May 09	-4.76	-8.01	-10.86	-11.50	-12.13	-12.15
From May 09 To Dec 13	1.73	1.64	1.19	1.02	0.49	-0.80
Vintage 2007-2						
From June 07 to Dec 13	-0.41	0.24	-2.76	-2.86	-2.94	-2.83
From June 07 to May 09	-6.00	-7.94	-12.56	-12.98	-11.83	-11.31
From May 09 To Dec 13	1.68	1.85	0.91	0.94	0.39	0.35