

# Complexity in Structured Finance: Financial Wizardry or Smoke and Mirrors?\*

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## Abstract

We use data from prospectus supplements to measure the complexity of securitized products. We find that securities in more complex deals default more. The higher likelihood of default is economically meaningful: a one standard deviation increase in complexity represents a 17% increase in default on AAA securities. However, yields of more complex securities are not higher indicating that investors do not perceive them as riskier. The relation between complexity and default is not primarily due to issuers masking low quality loans as it persists after controlling for the collateral default rate. Rating agencies are more lenient in rating complex deals.

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## 1. INTRODUCTION

Mortgage-backed securities (MBS) are created by the pooling and tranching of loans into multiple securities oftentimes with various credit enhancements. Their structures are detailed in lengthy prospectuses and prospectus supplements (many of them hundreds of pages long) describing the collateral, the allocation of cashflows from the pool of loans to the securities in various states of nature, the rating of the securities, and other structural features (e.g., collateral groups, subordination, and cross-collateralization). These non-standardized contingent contracts place considerable informational demands on investors. In other words, they are complex.

The fundamental question we address in this paper is whether complexity is a byproduct of issuers' attempts to tailor new securities to investors' preferences and improve risk sharing or whether it is used as smoke and mirrors to sell risky securities at inflated prices. The promise of complex structuring is that it enables the creation of low-risk securities from collateral of variable quality (Gorton and Metrick (2013)). Indeed, markets for sophisticated structured products have historically emerged as a way to disseminate high risk collateral.<sup>1</sup> The lower the quality of the collateral, the more elaborate the structuring must be to create securities that have extremely low default probabilities such as investors require for AAA-rated securities. Under this view, while complexity may be negatively correlated with the quality of the collateral, there should not be a correlation between the default of securities in MBS deals and complexity. If complex structuring fulfills its promise, there may be welfare gains from the creation of new securities.

A less sanguine view of complexity is that it is used by more informed market participants to exploit less informed investors. For example, discussions of security complexity feature prominently in the 2011 Financial Crisis Inquiry Commission's Report as a contributing

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<sup>1</sup>For example, the modern CMBS market developed to find investors for the assets of failed savings and loans (Jacobs, Manzi, and Fabozzi (2006)). Similarly, the collateral for the earliest Collateralized Debt Obligations (CDOs), which are particularly sophisticated structured securities, was high risk debt issued by corporations and governments in emerging market countries (Lucas, Goodman, Fabozzi, and Manning (2007), p. 4). Most notably, and most importantly from a macroeconomic perspective, was the explosion in the market for complex MBS collateralized by subprime mortgages in the years preceding the financial crisis of 2008-2009.

factor to the financial crisis. If investors face constraints, including high costs, in acquiring or processing information then complexity may play a role in the pricing and performance of MBS. As sophisticated MBS were at the center of the 2007-2009 financial crisis and markets for many securitized products collapsed, it is important to empirically test whether complexity is related to default of these securities.

We start by constructing five variables that proxy for the complexity of structured products. For each deal, we collect data on (i) the number of collateral groups and (ii) the number of securities (i.e., tranches). In addition, using the prospectus supplement of a deal, we count (iii) the total number of pages in the prospectus supplement, (iv) the number of pages specifically describing the collateral, and (v) the number of pages specifically describing the division of cashflows from the pool of loans to the securities. The five variables are designed to measure the informational demands MBS deals impose on investors and the intricacies in structure across deals. While correlated, they capture different facets of the complexity of structured products.

We also construct a summary measure of complexity – an index of complexity – that synthesizes the information available in our five individual variables. The complexity index can be viewed as a way of synthesizing into one statistic the information contained in all five variables. Since there are obvious tradeoffs between using an index and the underlying economic variables, we use both in the empirical work.

We then use data from the home equity asset-backed securities (ABS) market, a subsegment of the larger MBS market that consists of most subprime MBS, together with our measures of complexity to establish the following facts. Our most important finding is that, controlling for the year the security is issued, securities of more complex deals default more *ex post* and are hence riskier. A one standard deviation increase in the complexity index is associated with a three percentage point increase in the risk of default. The relation between complexity and security performance is particularly strong for securities rated AAA at issuance. For these securities, a one standard deviation increase in complexity is associated with a 6.2 percentage point higher likelihood of default. The higher likelihood of default is

economically meaningful as it represents a 17% increase relative to the mean default level on AAA securities.<sup>2</sup> The finding is robust across a variety of specifications including controls for the lead underwriter of the deal.

Our default results do not solely reflect issuers masking low quality collateral with complexity. We arrive at this conclusion for two reasons. First, we find that the relation between complexity and collateral performance is substantially less robust than the one between complexity and security performance. More importantly, we find that controlling for collateral performance directly in our regressions does not substantially alter the magnitude of the relation between complexity and security default. This suggests that one channel by which complexity may impact security default is facilitating the diversion of collateral cash to lower-rated tranches to the disadvantage of senior tranches when the collateral is performing well. Issuers, who usually own the residual tranche (see, for example, Demiroglu and James (2012) and Begley and Purnanandam (2012)), benefit as a result.

The finding that securities in more complex deals default more is not, in and of itself, evidence that complexity disadvantages investors. If investors receive higher spreads in exchange for assuming the higher default risks, the complexity may not harm investors. However, we find that securities of more complex deals have *lower* spreads at issuance indicating that, *ex ante*, investors did not perceive them as riskier. This finding is intriguing because, in light of the higher default rates of complex deals, we anticipate observing higher, rather than lower, spreads as compensation for additional credit risk.

Furthermore, credit rating agencies (CRAs) rate more complex deals more favorably from the perspective of issuers. The favorable ratings do not, however, explain the greater default propensities since we control for the treatment of the security by the CRAs in our regressions. Finally, we find that the level of complexity in ABS deals increased steadily throughout the 2000s.

The findings that more complex securities default more, and that this greater default risk is not priced, indicate that large institutional investors, who are the primary participants in

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<sup>2</sup>The mean default rate in our AAA subsample is 37 percentage points. A 6.2 percentage point increase in the likelihood of default therefore represents a 17% (6.2/37) higher likelihood of default.

the ABS market, do not fully process the information in elaborate securities. As such, they do not demand a risk premium to hold more complex securities that will default more often. Issuers, aware of the limitations of market participants, can use complexity to price low quality securities at par with high quality securities. In other words, it literally pays issuers to be complex. If, alternatively, investors fully process information about the securities, issuers would either have to accept a lower price for more complex securities or would not be able to sell them at all.

Our findings are important for understanding the boom and bust in subprime securities. As of summer 2013, the majority of these securities defaulted, including more than a third of securities rated AAA at issuance (see Table 1). Why did investors pour so much money into assets that ultimately proved so disastrous? One explanation is that they underestimated the possibility of a widespread decline in home prices. Indeed, there is evidence that subprime executives themselves did not expect that home prices would fall substantially (Cheng, Raina, and Xiong (forthcoming)). Such beliefs likely decreased investors' willingness to allocate the resources required to fully understand the structure of these securities. Our results imply that a contributing factor to the subprime boom was the complexity of the securities. Our findings also help to explain the collapse in trading of PLMBS during the crisis (see Gorton and Metrick (2012)) as they provide evidence of asymmetric information between different types of investors in the ABS market. Theoretical literature (e.g., Bhattacharya, Reny, and Spiegel (1995), Rahi (1996), Hanson and Sunderam (2013)) shows that such asymmetric information can cause trading to collapse.

Our results are important for several additional reasons. First, the finding that more complex deals are rated more favorably shows that the CRAs do not simplify the structure of complex securities into one meaningful metric, the credit rating, which in turn drives prices. Hence, CRAs do not obviate the need for investors to understand complex securities. Without knowing more about the intricacies of how CRAs rate these securities, we cannot conclude that credit analysts were confused by the complexity of deals. Nevertheless,

our findings suggests that during the subprime boom, the CRAs exacerbated rather than mitigated problems investors had in understanding complex securities.

Second, the failure of both spreads and credit ratings to reflect the greater risks associated with complexity indicates that there may be welfare benefits from standardizing securitized products in the sense of Gale (1992). Such standardization may be particularly important if Fannie Mae and Freddie Mac play less of a role in the mortgage market going forward. Securities issued by the GSEs (agency MBS) are quite simple by our measures: their offering circulars are short, there are few securities within a deal, and they usually only have one collateral group.<sup>3</sup>

Third, our results contribute to a growing literature documenting that market participants ignore publicly available information. In the context of the stock market, this results in stock return predictability (e.g., DellaVigna and Pollet (2007, 2009), Hong, Torous, and Valkanov (2007), Hirshleifer, Lim, and Teoh (2009), and Cohen and Lou (2012)).<sup>4</sup> Importantly, that literature focuses mainly on unsophisticated retail investors and their boundedly rational decision-making. Our results show that sophisticated market participants can also be boundedly rational when the processing of intricate financial information is excessively costly. The evidence also suggests that, rather than only facing difficulties processing information about the underlying assets in a timely fashion, investors either lack the incentives for or have problems understanding the structure of securities themselves. In sum, the evidence from the ABS market makes it clear that the complexity of financial information ought to play a role in defining and understanding bounded rationality.

Our results are quite distinct from those that Furfine (2014) finds in the Commercial MBS (CMBS) market. Furfine (2014) finds that *loans* in more complex deals default more and concludes from this that issuers used complexity to distract investors from the low quality collateral in the deals. However, structured finance investors hold *securities* rather than

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<sup>3</sup>Although agency MBS investors do not face default risk, they face substantial prepayment risk and, as such, there is still scope for structuring.

<sup>4</sup>Barberis and Thaler (2003) survey work demonstrating bounded rationality in financial markets. Additional recent papers in this literature include Huberman and Regev (2001), Hou (2007), Barber and Odean (2008), Cohen and Frazzini (2008), and Menzly and Ozbas (2010). These papers are based on theoretical work by Merton (1987), Hong and Stein (1999), Sims (2003), and Hirshleifer and Teoh (2003).

the collateral directly. Without further evidence, a finding that high risk collateral goes into more complex deals is entirely consistent with the efficient view of complexity in which issuers use complexity to create high quality securities from lower quality collateral. While Furfine (2014) claims that his paper is about security design, absent any analysis of the securities, his claim is speculative.

Our paper is more narrowly related to a small but growing literature on security complexity. Carlin, Kogan, and Lowery (2013) look at the effect of complexity on trading in a laboratory setting. Célérier and Vallée (2013) study complexity in the market for French retail structured products. Carlin (2009), Ellison and Ellison (2009), Carlin and Manso (2011), and Ellison and Wolitzky (2012) provide theoretical models of complexity.

The remainder of the paper proceeds as follows. In the next section, we describe the structure of the US RMBS market and our measures of complexity. In Section 3, we describe our dataset and the complexity we observe in the ABS market. Section 4 documents how complexity relates to security performance. In Section 5, we test whether investors understand that more complex deals are more likely to underperform and whether ratings reflect the greater risk associated with complexity. In Section 6, we discuss how well theories of security design can explain our results. Section 7 concludes.

## 2. THE STRUCTURE OF MBS AND MEASURING COMPLEXITY

The US RMBS market can be divided into two main asset classes: 1) RMBS issued by the GSEs or that use securities issued by the GSEs as collateral, and 2) RMBS issued by non-government entities that are backed by mortgages or securities not guaranteed by the GSEs. The first market is commonly known as the agency market while the second is usually referred to as the private label MBS market. In this paper we focus exclusively on the PLMBS market as agency securities are simpler to understand and did not see nearly the same amount of distress as the PLMBS market during the 2007-2009 crisis and its aftermath. Within the PLMBS market, we confine our attention to an asset class known as home equity ABS. Market participants use this term to refer to securities backed by residential mortgage

loans including first lien loans, home equity loans, and home equity lines of credit. Securities from the typical home equity ABS deal are marketed to investors as subprime (e.g., “RES B/C”) or Alt-A.

Institutions are the dominant investors in this market and the securities are extremely illiquid: Bessembinder, Maxwell, and Venkataraman (2013) find that only about one fifth of non-agency structured finance securities trade in the 21 month period beginning in May 2011. The issuers and underwriters of ABS are usually large investment banks. For instance, in 2006, the peak of the ABS market, the largest three lead deal managers by issuance value were Lehman Brothers, RBS Greenwich Capital, and Goldman Sachs.

A typical ABS deal has many securities in it with a prioritization of cashflows from the underlying collateral to the top tranche (i.e., security) first, then to the second tranche, and so forth. In contrast, losses on the underlying collateral are typically applied to the lowest tranche first, then the next lowest, and so forth. Most securities within a deal are rated by multiple CRAs. The lowest tranches are usually unrated and are commonly referred to as the residual or equity piece since they behave much like equity in a firm.

Some ABS securities are used as collateral for Collateralized Debt Obligations (CDOs). As Coval, Jurek, and Stafford (2009) and Griffin, Lowery, and Saretto (2013) argue, CDOs are even more complex than ABS. The typical ABS-backed CDO usually consists of either investment grade ABS securities or mezzanine (e.g., BB or residual) ABS securities. We do not include CDOs backed by ABS in our dataset for three reasons. First, CDOs backed by RMBS are a much smaller asset class than ABS. Second, getting data on these securities is far more challenging than gathering data on ABS. Bloomberg rarely has cashflows for CDOs backed by RMBS and even less frequently has prospectus supplements for these deals. Finally, as we show, there is more than enough complexity in ABS for us to understand, explain, and exploit.

ABS deals often subdivide the overall loan pool backing a deal into multiple loan groups. In a typical deal structure, a loan group primarily supports a series of senior securities but potentially with cross-collateralization from other loan groups within the same deal. For



example, the issuer divides the loans in deal ABC into loan groups 1 and 2. The loans in group 1 collateralize securities AAA-1, AA-1, and A-1. Group 2 collateralizes securities AAA-2, AA-2, and A-2. If the deal has a cross-collateralization provision, in the event securities AAA-1, AA-1, and A-1 are at serious risk of default due to poor performance of the loans in group 1, cash flows from group 2 loans would be diverted to securities AAA-1, AA-1, A-1 provided that the securities group 2 collateralizes (AAA-2, AA-2, and A-2) are at little risk of default or the prepayment rate on group 2 is such that, for example, AAA-2 has been entirely paid off. Regardless of whether a multiple loan group deal has cross-collateralization, more junior tranches within the deal are typically supported by the entire loan pool (i.e., all loan groups).

**2.1. Measuring Complexity.** We measure complexity at the deal level. The idea is to proxy for the heterogeneity in the structure of a securitization and the amount of information investors and CRAs need to process in order to trade and rate these assets, respectively. For a given deal, we define the following variables: (i) the number of collateral groups (*nloan-groups*); (ii) the number of securities or tranches (*ntranches*); (iii) the number of pages in the prospectus supplement (*pagesprosup*); (iv) the number of pages in the prospectus specifically describing the collateral (*pagesmpool*); and (v) the number of pages in the prospectus specifically describing the division of cashflows from the collateral to the securities in the deal (i.e., the waterfall) and details of the security more generally (*pageswaterfall*). All these variables are observable at issuance of the security.

The first two variables are self-explanatory. The portions of the prospectus supplement we use to define *pagesmpool* are the part of the supplement under the heading “Description of the Mortgage Pool” or a similar heading and any annex, schedule, or appendix that has tables detailing the characteristics of the loans. Some deals include tables of statistics detailing the mortgages directly in the section of the prospectus supplement labeled “Description of the Mortgage Pool” while others include these tables in an annex, schedule, or appendix. The portion of the prospectus supplement we use to define *pageswaterfall* is the part of the supplement under the heading “Description of the Certificates” or “Description of the

Securities”. Included in the waterfall are, for example, calculation of the principal and interest overcollateralization triggers and precise details regarding the mechanics of cross-collateralization. In defining *pagesmpool* and *pageswaterfall*, we do not include subsections of the section at the beginning of the supplement section typically headed “Summary” even if they include descriptions of the collateral or the waterfall as these subsections are less clearly demarcated than the main sections of the prospectus supplement.

**2.2. A Complexity Index.** While our complexity variables are correlated with one another, each one captures a different dimension of complexity. We thus construct an index of complexity, denoted by *complexityindex*, by extracting the first principal component across our five complexity variables at each point in time. The higher the index of complexity is, the greater the complexity of a deal. Measuring complexity using an index is convenient because we can include in our estimation information contained in all five variables jointly without facing the issue of collinearity. The drawback of using an index is that we lose the ease of economic interpretation. In the empirical analysis, we present results using the underlying five complexity variables as well as the complexity index.

The complexity index places approximately equal weight on the five underlying variables. The factor loadings, obtained using standard principal components methods, imply that all variables play a sizeable role in the construction of the index. While the statistical properties of the complexity index will be discussed below, here is an illustrative example: its highest value of 10.15 obtains for a deal that had 68 tranches, 10 collateral groups, and 391 pages in the prospectus supplement. As will become apparent in the data section, in our sample, this deal has the highest number of tranches and pages in the prospectus supplement, and the second highest number of collateral groups. It was highly complex by any measure.

### 3. DATA

We collected information on all PLMBS deals available on Bloomberg that were originated between 1999 and 2007. We restrict our attention to USD-denominated ABS backed by US assets for which Bloomberg has information on cashflows since the data quality is much

higher for these securities. Our sample includes roughly half the ABS deals on Bloomberg. We manually collected all relevant information on our securities available from Bloomberg, including the prospectus supplement if it was available. All of our variables are measured at the time the security was issued except for security default and the foreclosure rate on the collateral group. Security default is a binary variable that takes a value of 1 if the security had defaulted by August 2013. The foreclosure rate on the loan group is also measured in August 2013. Our data contains variables that vary by deal, by security, and by collateral group. Most of our analysis is at the security level; in robustness exercises, we cluster our standard errors at the deal level to be adequately conservative.

Our sample starts in 1999 and ends in 2007 as the ABS market was quite small until the 2000s and there was very little issuance of ABS from 2008 onwards.<sup>5</sup> Issuance in our sample peaks in 2006 at more than half a trillion USD and, in 2007, is less than half of what it is in 2006 both in terms of dollar volume and number of deals. Issuance is less than \$100B in every year before 2002.

Most securities issued are adjustable rate and, following Ashcraft, Goldsmith-Pinkham, Hull, and Vickery (2011), we drop fixed rate securities to focus on credit risk rather than prepayment risk. Our results are qualitatively the same when we include fixed rate securities in our sample. We also drop any securities collateralized by loan pools that include some fixed rate loans or for which the share of fixed rate loans in the collateral is unknown since deals with substantial fixed rate collateral may have even more complex structuring to mitigate prepayment risk.

### 3.1. Deal-Level Variables.

3.1.1. *Complexity Variables.* Panel A of Table 1 summarizes our deal level variables. Although the modal deal has 2 loan groups, 14% of deals have 3 or more loan groups. The largest number of loan groups in a deal is the 11 groups in BSABS 2007-SD1. The average number of securities per deal is 16 and one deal, LXS 2007-3, contains 68 separate securities.

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<sup>5</sup>Although there are a few ABS deals available on Bloomberg in the 1990s, we begin our sample in 1999 so that we can adequately control for heterogeneity in the year of issuance.

We have prospectus supplements for 63% of the deals. We use the prospectus supplements to derive several key deal-level characteristics, including three of our complexity variables. The average number of pages in the prospectus supplement is 147 but there is substantial variation across deals: one has only 27 pages while another, LXS 2007-3, has almost 400 pages. Roughly 65 pages of the average prospectus supplement describe the collateral and the waterfall.

The complexity index is normalized to have a standard deviation of one for ease of interpretation. To make it easier to see the time series pattern, we normalize *complexityindex* to have a mean of 0 in 1999 by subtracting the mean of *complexityindex* in 1999.<sup>6</sup> The factor loadings on the individual complexity variables in the index are 22% *nloangroups*, 20% *ntranches*, 25% *pagesprosup*, 21% *pagesmpool*, and 11% *pageswaterfall*.

As Figure 1 illustrates, complexity increases over time. For example, in 1999 the average number of securities in a deal is 11 but, by 2006, it almost doubles to 19. Over our sample period, *pagesprosup*, *pagesmpool*, and *pageswaterfall* all grow by magnitudes similar to that of the number of securities. Deal size also doubles over our sample. The number of loan groups in each deal is roughly stable over time.

While we document increases in complexity over the sample period, we do not interpret increased complexity as evidence of substantial financial innovation in securitization over the 2000s. We have no evidence that any of the features of ABS deals that increase their complexity were invented or even diffused during the 2000s. As Foote, Gerardi, and Willen (2012) point out, markets for structured MBS had existed for a long time before the subprime boom. Riddiough and Thompson (2011) document the existence of sophisticated MBS in the US since at least the 1850s.

As Table 2 shows, the complexity variables are correlated. The highest correlation (72%) between our complexity measures is between *pagesmpool* and *pagesprosup*. Mechanically, an increase in the number of pages required to describe the collateral increases the length of the

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<sup>6</sup>The normalization is done at the security level as this is the unit of observation for our analysis, rather than at the deal level for which we show results in Table 2 and summary statistics in Table 1. Because of this, the standard deviation in Table 1 is not exactly one.

overall supplement. There is also a high correlation (50%) between the number of securities and the number of loan groups.

3.1.2. *Deal-Level Control Variables.* Aside from our deal-level complexity variables, we include an indicator for whether the deal provides for cross-collateralization across loan groups, the size of the deal (in millions of USD) (*dealsize*), the excess spread in the deal in percent (*excessspread*), and the volume of ABS issuance by the lead manager of the deal in the year the deal was issued (*leadtot*). We include deal size because Furfine (2014) uses it as a measure of complexity. We drop a small number of deals that have negative excess spread. We include the size of the lead underwriting manager following He, Qian, and Strahan (2012)'s finding that larger issuers received more favorable ratings. The lead manager is usually also the sponsor. Over most of our sample period, sponsors of the deal were not disclosed in the prospectus supplement. In 2006 deals, all PLMBS deals disclosed the sponsor, the lead manager is the sponsor about 80% of the time in the 2006 deals.

We control for the year the deal was issued since there are significant changes over time in the ABS market. In robustness exercises, we control for the quarter of issuance for issues after 2003 and the results are very similar to the benchmark. As there are relatively few deals prior to 2004, we have too few observations per quarter in 2000-2003 to control for the quarter of issuance for the full sample.

Only 34% of the deals provide for any cross-collateralization. Since more than twice that number of deals have multiple loan groups, a slight majority of deals with multiple loan groups do not provide for cross-collateralization. The average deal is for \$892 million; the smallest deal is for \$25 million and the largest deal is a 2007 deal for over \$6 billion. The average excess spread across all securities in a deal is 4.1 percentage points. The average amount of total ABS underwriting by the lead manager of the deal in the year the deal is issued is \$27 billion, with one underwriter issuing \$75 billion of ABS in a year.<sup>7</sup>

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<sup>7</sup>We do not include deal-level overcollateralization as a control variable because home equity ABS typically do not have any initial overcollateralization. Rather, they rely on excess spread to paydown bonds faster than simply through the return of principal, thereby creating overcollateralization. This turboing in essence converts interest into principal for the benefit of senior bonds. If a target overcollateralization amount is achieved by the deals stepdown date, principal and interest are diverted to the residual class, provided

**3.2. Security-Level Variables.** We control for the initial rating of the security. We include securities rated BBB through AAA and control for ratings using the ratings categories AAA, AA, A, and BBB. If there is a disagreement in the rating, we take the highest rating. For example, AAA takes a value of 1 if any of the three major CRAs rate the security AAA. Since there may be disagreement among the CRAs, we also include a dummy variable (*disagreestranche*) that takes a value of 1 if there is any disagreement among the CRAs on the rating of that tranche. The ratings disagreements are concentrated in the AA and A rated tranches: less than 2% of the AAA securities have a ratings disagreement, while 39% of the AA and 44% of the A rated securities have a disagreement. 28% of the BBB rated securities have a ratings disagreement. The results are quite similar when controlling for subnotches. Furthermore, there appeared to be no more information in the subnotches than in the broader ratings categories we use.

Default takes a value of 1 if the security defaults by August 2013 and 0 otherwise. We define default to be an event in which the security has suffered a principal loss or in which one of the ratings agencies indicates the security is in default. For Moody's, this is a rating of Caa1 or lower. For S&P, this is a rating of CCC+ or lower while for Fitch this is a rating of CCC or lower. Default on a security is any loss such that defaults occur for most securities in our sample despite a loan group-level foreclosure rate of 15%.

Panel B of Table 1 describes our security-level variables. We see that 35% of our securities are AAA-rated at issuance. By August 2013, 37% of these AAA-rated securities had defaulted. By comparison, 80% of securities that had AA ratings at issuance had defaulted while 95% of securities originally rated A or BBB were in default.

We also include the subordination level of each security. Subordination is a measure of credit enhancement that measures the percentage of the value of all the securities in the deal that are below it in the priority of payments. Thus, AAA securities have the most subordination and BBB tranches have the least subordination. The mean level of subordination

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various triggers are passed. Triggers are tests embedded in a structure to protect senior security holders if the collateral exhibits abnormally high delinquency or losses.

of a security in a deal is 12 percentage points, and the average subordination for an AAA security is 20 percentage points.

The main pricing variable in our dataset is the fixed spread the security pays above one month LIBOR. This spread is fixed for the life of the security. Actual transaction prices are extremely difficult to observe in the ABS market since, prior to May 2011, there was no requirement that transactions be reported to any centralized body.<sup>8</sup> Bloomberg has transactions prices for some of our tranches on some dates, primarily the senior tranches. For dates near security issuance, the security prices are extremely close to par so that the spread is a good measure of the return investors expected to earn from investing in ABS. The mean spread on a security is 92 basis points. AAA investors were promised a mere 26 basis points while BBB investors were promised 220 basis points on average.

**3.3. Loan Group-Level Variables.** Our data contains the shares of each state in the top 5 most common property states for that pool. For example, if 25% of the loans in the pool come from California, 10% from Florida, 5% from Ohio, 3% from Michigan, and 2% from New York, the top 5 state shares are reported as “CA 25%”, “FL 10%”, “OH 5%”, “MI 3%”, and “NY 2%”. We do not know how the loans in a group are divided among the remaining 45 states. From the top 5 state shares, we construct the shares of the most prevalent top 5 states in the ABS market (California, Florida, New York, Illinois, and Texas). On average, 30% of the loans in a pool come from California, 9% from Florida, 4% from New York, 3% from Illinois, and 2% from Texas. The results using the shares from the top 10 states were quite similar.

We have detailed information on the measured *ex ante* quality of the collateral for less than half of the securities. Nevertheless, all of our results are quantitatively and qualitatively similar when we control for these observable collateral characteristics. The average FICO

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<sup>8</sup>As of May 2011, the Financial Industry Regulatory Authority (FINRA) requires reporting of all MBS transactions but has not released the data it has collected for most classes of MBS, including PLMBS, to the public. FINRA has released the data from 2011 onwards to three groups of researchers; see Atanasov and Merrick (2013), Bessembinder, Maxwell, and Venkataraman (2013), and Hollifield, Neklyudov, and Spatt (2013). Bloomberg contains modeled prices for many securities but average transactions prices for far fewer securities.

score at origination on the loans that serve as collateral for our securities is 627 and ranges from 470 to 780. The weighted average loan-to-value (LTV) of the loans in a group has an average of 79% and a standard deviation of 7%. The average share of loans in a pool that are low or no documentation is 35% with some loan groups having no reduced documentation loans and some loan groups consisting entirely of reduced documentation loans. The weighted average maturity (WAM) of the mortgages is 351 months on average and ranges from 156 to 477 months. Bloomberg has two variables that contain summary information about the principal balances of the underlying loans. These variables are the share of loans with original principal balances under \$300,000 and the share of loans with original principal balances of \$300,000 to \$600,000.

For robustness, we consider whether our results are driven by the presence of the GSEs in the ABS market. Although none of our securities are issued by the GSEs, the GSEs bought substantial quantities of AAA ABS. Often, one loan group in a multiple loan group deal is tailored for one of the GSEs. The GSEs invested in AAA ABS backed by loan groups that consisted entirely of loans with principal balances that conform to their conforming loan limit. We can frequently identify such cases from the collateral group description Bloomberg provides. We create a variable called *conforming* that takes a value of 1 if the collateral group description contains terms such as “CONF”, “CON”, or “CONFORMING”. The variable *conforming* takes a value of 0 if the collateral group description contains terms such as “NCONF”, “NCON”, or “NONCONFORMING”. We manually code the exact collateral descriptions as conforming to prevent misclassification. If the collateral group description does not indicate whether the loans are conforming or non-conforming, *conforming* is missing.

#### 4. SECURITY PERFORMANCE AND COMPLEXITY

We define  $D_{i,t+T}$  to be a variable that equals one if security  $i$  issued at  $t$  has defaulted in our sample period, and zero otherwise. We model the probability of default using a probit

$$P(D_{i,t+T} = 1) = \Phi(\text{Complex}'_{i,j,t}\beta_1 + \text{Controls}'_{i,j,t}\beta_2). \quad (1)$$



where  $\Phi()$  is the cumulative standard normal distribution and  $Complex_{i,j,t}$  is a vector of complexity variables for security  $i$  in deal  $j$  known at issuance of the security. A set of control variables, collected in the vector  $Controls_{i,j,t}$ , is observable at issuance of security  $i$ . The benchmark set of controls includes the deal size (*dealsize*), an indicator for cross-collateralization in the deal (*crosscollat*), the amount of excess spread in the deal (*excessspread*), the issuance volume of the lead manager in the year the deal was issued (*leadtot*), dummies for the year of issuance, controls for the geography of the collateral, dummies for the rating categories, the percentage subordination of the security (*subordination*), the spread above one month LIBOR the security promises (*spread*), and a dummy variable indicating whether the CRAs disagreed on the security's rating at issuance (*disagreebranche*). We include *disagreebranche* to capture the possibility that, for example, some investors treat what we code an AA security as an A security.

Table 3 contains the results from estimating various specifications of equation (1). The table presents marginal effects from the probit estimates to facilitate understanding the economic magnitudes. As Columns 1 through 5 illustrate, all of our measures of complexity predict security default. The effects are statistically significant at the 1% level for four of our measures and statistically significant at the 5% level for two of the measures. The signs of the prospectus-based measures indicate that longer prospectus supplements, or particular portions thereof, predict more default. Although longer prospectus supplements could in principle indicate more transparency, more transparency is unlikely to be associated with more default. Rather, our results suggest that longer prospectus supplements are associated with decreased readability (or less transparency) consistent with the findings of Loughran and McDonald (forthcoming).

The effect of complexity on default is also economically important. The addition of one loan group increases the likelihood that a security will default by 3 percentage points. An increase of one standard deviation in the number of securities in a deal (6 securities) raises the likelihood that a security will default by 1.2 percentage points. An increase in the prospectus length of 37 pages (1 standard deviation) increases the risk of default by two

percentage points. An increase of 18 pages in the length of the portion of the prospectus devoted to describing the collateral raises the chance of default by 1.2 percentage points. A one standard deviation (9 page) increase in the length of the portion of the prospectus that describes the waterfall is associated with a 0.9 percentage point higher risk of default.

Columns 6 and 7 of Table 3 present the effects of complexity when we combine our complexity variables. In Column 6, we include all 5 measures of complexity simultaneously without regard to potential collinearity. Although the magnitudes of the effects decrease, not surprisingly, *nloangroups* and *pagesprosup* continue to be statistically significant predictors of default at the 5% level.

In Column 7, we present our results from combining all complexity variables using their first principal component, *complexityindex*. The standard deviation of *complexityindex* is 1 and the interpretation of its marginal effect is that a one standard deviation increase in the overall complexity of the deal raises the risk of default by 2.7 percentage points.

Not surprisingly, AAA securities default the least and AA securities default the second least. Securities initially rated A do not default statistically less frequently than BBB securities. However, several variables beyond ratings predict default. Importantly, spreads on individual securities are highly predictive of default even after controlling for their rating, implying that investors priced securities using information beyond the rating. A 100 basis point increase in the spread is associated with a three percentage point greater risk of default. Furthermore, Table 4 shows that even AAA investors priced riskier securities higher. We also see that more credit support in the form of subordination reduces the risk of default. A one percentage point increase in the level of subordination decreases the risk of default by approximately 0.7 percentage points. Larger deals also default more often.

**4.1. AAA Securities and Default.** As Table 4 shows, the relation between default and complexity is stronger for AAA securities than for all securities. For AAA securities, adding one loan group to a deal is associated with a 6.5 percentage point increase in the likelihood of default rather than the 2.7 percentage point increase we observed in our benchmark model. Issuing one more security from a deal results in a 36 basis point increase in the risk of

default for AAA securities while for all securities the increase in the chance of default from one more security is only 21 basis points. We also see stronger relations between default and *pagesprosup*, *pagesmpool*, and *pageswaterfall* for AAA securities than for all securities.

Not only are the absolute magnitudes larger for AAA securities, the percentage increases in default are larger. More than 80% of securities rated below AAA default while only 37% of AAA securities default so that a given percentage point increase in the risk of default is a much larger percent change for AAA securities. As Column 7 shows, a one unit increase in *complexityindex* raises the likelihood of default by 6.2 percentage points for securities initially rated AAA. As only 37% of our AAA securities default, a one unit increase in complexity raises the risk of default by 17% for AAA securities.

**4.2. Sensitivity Analysis.** We conduct several sensitivity analyses of our results to our model specification. Table 5 presents the key alternative specifications using the summary variable *complexityindex*; the full results for the individual complexity variables are available from the authors upon request. Column 1 of Table 5 reproduces our benchmark specification with *complexityindex* (Column 7 of Table 3).

Columns 3 of Table 5 shows that, although complexity is a stronger predictor of default for AAA securities, it is also an economically important predictor of default for securities not rated AAA but the effect is not statistically significant. For securities not rated AAA, a one standard deviation increase in complexity is associated with a 0.7 percentage point rise in the likelihood of default. We estimated the effect of complexity on securities in each rating category separately (results not shown) and found that the relation between complexity and default is similar for AA, A, and BBB securities.

In Column 4, we present the results from estimating equation (1) when we include additional summary characteristics about the loans as control variables. The specification in Column 5 adds the weighted average LTV at origination (*ltv*), the average FICO score on the loans (*fico*), the share of loans that are no or low documentation (*lownodocshare*), the share of loans with balances under \$300,000, the share of loans with balances of \$300,000 to \$600,000, and the weighted average maturity (*wam*) of the loans to the vector of controls.

All of these variables are available for only about half the securities and, as such, the specification in Column 5 cuts our sample in half. The coefficient on *complexityindex* continues to be statistically significant at the 1% level although its magnitude falls by about one third. Likely as a result of the much smaller sample, the coefficients on *dealsize* and *crosscollat* are no longer statistically significant when we include collateral characteristics as controls. In the next section, we control for collateral performance directly to ensure that complexity is not capturing dynamic differences in collateral quality.

Column 5 contains the results from estimating equation (1) excluding securities collateralized primarily by pools of entirely conforming pools, i.e., those pools for which *conforming*=1. Our motivation for the specification in Column 6 is that the GSEs had a substantial demand for PLMBS and usually only purchased securities based on conforming pools (see Ghent, Hernández-Murillo, and Owyang (2013) and Adelino, Frame, and Gerardi (2014)). Deals in which the GSEs bought a security might thus have almost mechanically had one more loan group which might in turn have increased measured complexity along other dimensions. One concern then is that our complexity variables are only picking up the influence of the GSEs. However, our results are extremely similar when we include securities collateralized primarily by pools that the collateral group description describes as conforming.

In Column 6, rather than controlling for the size of the lead underwriter, we include fixed effects for the top 15 lead underwriters by issuance. The results are similar when we include deals from the top 10 or the top 20 underwriters. The results show that deals from the same underwriter that are more complex default more even after controlling for the year of issuance. The same underwriter varies the level of complexity in the deal, perhaps depending on the investors, and such variation in complexity is related to subsequent security performance. Thus, it does not appear that the relationship between complexity and security performance is because bad underwriters consistently use more complexity than good underwriters.

In Column 7, we include dummies for the quarter of issuance rather than the year of issuance to control for the possibility that there is time variation within year in security

quality. We include only data from 2004-2007 in this set of results as there is too little issuance in some quarters in the early years of the sample.

In another sensitivity exercise, we consider whether the results are sensitive to our way of controlling for the geography of the loan group. In particular, we estimate a specification in which, rather than controlling for the top 5 state shares, we control for the geographic concentration of the loan group. We measure the concentration of the loan group using a Herfindahl-Hirschmann Index (HHI) of the top five states in each loan group. The coefficients on our complexity variables are very similar to those in our other specifications. The results are available from the authors upon request.

Finally, we conduct our analysis using discrete measures of complexity to ensure the robustness of our results to outliers. For example, rather than including the number of loan groups itself as in Column 1 of Table 3, we include two dummy variables for the number of loan groups, *nloangroups2* and *nloangroups3ormore*. Similarly, rather than using the number of tranches as in Column 2 of Table 3, we include a dummy variable that takes a value of 1 if the number of securities in the deal was above the median and 0 otherwise. We construct parallel discrete measures of complexity for the number of pages in the prospectus supplement, the number of pages required to describe the collateral, the number of pages required to describe the waterfall, and the number of disagreements in the deal. The results from using these discretized complexity measures also imply that the risk that a security will default increases with its complexity. The results using discretized complexity measures are available from the authors upon request.

**4.3. Disentangling Weak Collateral from Structuring.** We have established that complex securities default more. In this subsection, we explore possible reasons for the relation between complexity and security performance. There are at least two possible explanations for the relation. The mechanisms are not mutually exclusive. First, issuers may use complexity to mask collateral that is lower in quality in ways that investors cannot easily observe. Although investors can easily observe key summary characteristics of the collateral (e.g., the average LTV of the loans in the deal), issuers may still have better information about the

quality of the collateral. If this is the case, we would expect to observe a higher foreclosure rate on the collateral *ex post*.

Another possibility is that complexity disadvantages senior tranches regardless of the underlying collateral quality. Horwitz (2011) details one such example involving Carrington Capital Management. In essence, Carrington's actions as servicer, for example, liberally using capitalization modifications to make loans current, allowed it to release millions of dollars of excess spread to the equity tranche that it owned rather than to the deals senior tranche. More generally, Whitworth and Walsh (2006) document a myriad of triggers in equity ABS deals and resulting flip-flops all of which have the potential to reduce the degree of protection afforded to senior tranches. While these junior securities almost all defaulted eventually, they received more cashflows in the early years of the deal.

4.3.1. *Collateral Quality and Security Complexity.* In Table 6, we regress the foreclosure rate of the loan group on all observable collateral characteristics in our dataset and our deal complexity variables. The coefficient on one of Furfine's measure of complexity in the CMBS market, *dealsize* is statistically insignificant. The coefficients on *nloangroups* and *pagesprosup* are also statistically insignificant. While the coefficients on *ntranches*, *pagesmpool*, and *pageswaterfall* are statistically significant at the 5% level, a comparison of Tables 3 and 6 shows that the relation between security default and complexity is more robust than the relation between collateral default and complexity.

In Column 7 of Table 6, we include our summary measure of complexity, *complexityindex*. The coefficient on *complexityindex* indicates that a one standard deviation increase in complexity is associated with a 56 basis point increase in the foreclosure rate in a pool. The coefficient on *complexityindex* is significant at the 1% level. Because we control for the year of issuance of the deal, the relation between complexity and collateral quality that we uncover is not being driven by the fact that, over our sample period, complexity is increasing (see Figure 1) while collateral quality is decreasing. There is thus a positive association between *ex post* collateral quality and complexity. This finding is analogous to Furfine's (2014) in the CMBS market. However, taken in isolation, a finding that lower quality collateral

is associated with more complexity reveals little about whether the complexity is efficient. Rather, the promise of complex structuring was to create high quality securities from low quality collateral. More complexity may be necessary to provide greater protection for the senior tranches in deals with lower quality collateral. It is our finding of greater *security* default that makes the relation between higher foreclosure rates and complexity seem more suspect.

4.3.2. *Security Performance Controlling for Collateral Performance.* In Table 7, we control for the performance of the collateral directly by including the foreclosure rate on the collateral. Thus, we control for the quality of our collateral *after* issuance. Given that the relation between security default and complexity is stronger than the relation between collateral default and complexity, it seems likely that collateral default can explain little of the relation between security default and complexity. Table 7 confirms this hypothesis. In Table 7, we estimate equation (1) including *foreclosure rate* as a control variable. Unsurprisingly, the coefficient on *foreclosure rate* is always positive and highly statistically significant.

What is more notable is that controlling for the *ex post* collateral quality barely changes the relation between *complexity index* and security default. The marginal effect of a one unit increase in complexity falls from 2.7 percentage points to 2.6 percentage points in the specifications in which we do not control for collateral characteristics measured at issuance (Columns 1 and 2). For AAA securities, the effect of a one standard deviation increase in complexity is 6.1 percentage points when we control for the performance of the collateral (Column 3) which is only 0.1 percentage points lower than in our benchmark specification in Table 3. The marginal effect falls from 1.9 percentage points to 1.7 percentage points when we use only the observations for which we can control for collateral characteristics (Columns 4 and 5 of Table 7). As such, the main channel through which complexity relates to security performance is not the collateral.

## 5. THE PRICING AND RATING OF COMPLEXITY

5.1. **Investors.** Given that complex deals perform worse *ex post*, it is important to see how investors price complexity *ex ante* to ascertain whether they were aware that more complex securities were more likely to perform poorly. We analyze the pricing of complexity by regressing the yield spread of securities on various determinants. More specifically, let  $Y_i$  be the yield of security  $i$  at issuance in excess of one month LIBOR. Our goal is to see whether more complex securities, as measured by our complexity variables, had higher yields.

We run the following cross-sectional regression

$$Y_i = \text{Complex}'_{i,j}\gamma_1 + \text{Controls}'_{i,j}\gamma_2 + \varepsilon_i \quad (2)$$

where, as before,  $\text{Complex}_{i,j}$  is a vector of complexity variables for security  $i$  in deal  $j$  and  $\text{Controls}_{i,j}$  are control variables, observable at origination of security  $i$ , and  $j$  indexes either the deal or the group.

Table 8 presents the results from estimating equation (2). Most of the complexity variables have negative coefficients implying that investors accepted lower returns for worse performance. The coefficients are statistically insignificant and the magnitudes are small, however: a one standard deviation in *complexityindex* is associated with a reduction in spreads of only 1 basis point. Overall, the results indicate that investors did not perceive more complex securities to be of lower quality *ex ante*. The same is true if we confine our analysis to AAA securities; the results for only AAA securities are in an appendix available from the authors.

As expected, AAA investors accepted lower rates of return than AA, A, or BBB investors, and AA investors were promised lower returns than A or BBB investors. Investors perceived larger deals to be less risky as well as deals in which there was more excess spread.

We perform the same sensitivity analyses for our examination of spreads and complexity as we did for default (see Table 5 for some examples). The results are available from the authors upon request.



**5.2. Credit Rating Agencies.** It is also useful to test whether the CRAs rated securities from more complex deals to reflect their higher likelihood of default. It is possible that the CRAs, which should have analyzed all the intricate details of the deal and security structure, understood these securities would likely perform worse and required issuers to provide more support for the senior tranches to be rated AAA in more complex deals.

The nature of the ratings process in the ABS market is not for issuers to prepare a set of securities and then solicit a rating. Rather, the institutional structure of the ABS market consists of a dialogue between the issuer and the CRA prior to security issuance. In essence, the issuer asks the CRA how it requires the issuer to structure the security for the CRA to give it a particular rating. One main provision consists of how much of the deal can be rated AAA. Limiting the portion of the deal rated AAA is equivalent to requiring more subordination for each AAA security in the deal.

If the observed subordination measures are unbiased measures of required credit support, we expect that more complex deals will have more subordination to compensate for their higher risk. However, several recent papers have analyzed equilibria in which disclosed ratings are systematically biased. Skreta and Veldkamp (2009) show that if issuers engage in ratings shopping, observed ratings will be systematically biased upward as the securities get more complex.<sup>9</sup> If issuers shop for ratings and the deal gets structured according to the requirements of the most favorable CRA, observed subordination levels may not be unbiased measures of credit quality.

Even if issuers do not explicitly shop for ratings, complexity may increase ratings inflation if CRAs cater to issuers to gain their business or to institutional investors' regulatory requirements.<sup>10</sup> The model of Opp, Opp, and Harris (2013) predicts more ratings inflation as the complexity of the asset increases because of catering to regulatory requirements. Even

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<sup>9</sup>Technically, Skreta and Veldkamp's model predicts a non-monotonic relation between observed ratings and security complexity. Beyond a certain level of complexity, ratings are too noisy to be valuable signals and, as investor demand for ratings decreases, rating shopping falls. However, Skreta and Veldkamp's model does not contain a regulatory motive for ratings. Given a regulatory motive for ratings (see, e.g., Bongaerts, Cremers, and Goetzmann (2012) and Opp, Opp, and Harris (2013)), we are likely to be in the case where complexity increases shopping.

<sup>10</sup>See Griffin, Nickerson, and Tang (2013) for a discussion of the distinction between explicit rating shopping and rating catering.

without a regulatory requirement, complexity may increase the cost of accurately rating an investment and decrease the likelihood that investors will discover the ratings inflation. If CRAs compete for business, as Bolton, Freixas, and Shapiro (2012) model them, greater complexity may indeed increase the incentive to inflate ratings. Such ratings inflation may require CRAs to adjust their models, unlike rating shopping. Griffin and Tang (2012) find that CRAs did, in fact, make such adjustments during the MBS boom of the 2000s. The literature on CRAs' incentives and biased ratings, while not the focus of this paper, is nevertheless relevant in helping us understand the connection between ratings' accuracy and deal complexity.

To test whether the CRAs gave less favorable ratings to more complex deals, we estimate

$$\text{subordination}_i = \text{Complex}'_{i,j}\gamma_1 + \text{Controls}'_{i,j}\gamma_2 + u_i \quad (3)$$

where  $\text{Complex}_{i,j}$  is a vector of complexity variables for security  $i$  in deal  $j$  and  $\text{Controls}_{i,j}$ , are control variables, observable at origination of security  $i$ , and  $j$  indexes either the deal or the group. In the absence of explicit rating shopping or rating catering, we anticipate  $\gamma_1 > 0$  given the higher default risk of more complex deals. In estimating equation (3), we restrict our attention to AAA securities.

Table 9 presents the results. Although the effects of complexity on subordination are less consistent across the complexity variables than the effect of complexity on default that we present in Table 3, the coefficients are negative and statistically significant or else statistically insignificant when we include each complexity variable individually. The number of tranches is not statistically significant in our regressions.<sup>11</sup> Our summary complexity measure, *complexityindex*, is highly statistically significant. A one standard deviation increase in *complexityindex* is associated with 64 basis points less subordination. As  $\gamma_1$  is negative and statistically significant, we reject the hypothesis that credit ratings are unbiased, accurate measures of complex securities' quality.

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<sup>11</sup>Although the focus of their study is not complexity, An, Deng, Nichols, and Sanders (forthcoming) find that securities in CMBS deals with more tranches have lower levels of subordination.

Increasing the number of loan groups is particularly strongly related to lower levels of subordination. Adding one more loan group results in 82 basis points less subordination; the coefficient is statistically significant at the 1% level both when we include only the number of loan groups and when we include all our complexity measures simultaneously.

We perform several sensitivity analyses on the results from Table 9. The results are in an appendix available from the authors.

We also investigate whether the ratings inflation is in the senior AAAs (sometimes called super-senior AAAs) or is confined to the junior support AAAs. We identify the senior AAAs as follows: for each collateral group, we take the AAA security with the lowest spread to LIBOR as the senior AAA. The precise way these securities have higher priority is likely in the fine details of the waterfall. Roughly half of our AAAs are senior according to our definition. When we estimate equation (3) for only the senior AAAs, the coefficient on *complexityindex* indicates that a one standard deviation increase in complexity only lowered subordination by 16 basis points and the coefficient is not statistically significant. In contrast, when we estimate equation (3) for AAAs that are not senior, we find that a one standard deviation increase in complexity is associated with 60 basis points less subordination and the coefficient is significant at the 1% level. As such, the ratings inflation is primarily in the more junior AAAs. These results are available upon request.<sup>12</sup>

Overall, the results demonstrate that in more complex deals, the CRAs gave AAA ratings to securities with less credit support. This finding is consistent with explicit rating shopping and rating catering. Without the details of the CRAs' rating models, we cannot distinguish between shopping and catering, nor can we decisively eliminate the possibility that the CRAs were confused by the more complex deals. Nevertheless, the CRAs clearly exacerbated the problems with complexity.

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<sup>12</sup>We also estimated our default and pricing regressions with the rating categories AAA\_senior, AAA\_notsenior, AA, A, and BBB rather than AAA, AA, A, and BBB as in our benchmark specification. All of our results for default and spreads are qualitatively the same when we use these finer rating categories. The magnitude of the relation between complexity and default is slightly larger when we use AAA\_senior, AAA\_notsenior, AA, A, and BBB as the rating categories.

Although we find that complexity leads to more generous ratings, ratings inflation does not explain the default results we find in Section 4. In all of our default specifications, we control for both the level of subordination and the rating of the security. If we omit the level of subordination from the default regressions, the effect of complexity on default is even larger because it captures both the direct effect of complexity on default and the indirect level of complexity on subordination.

## 6. COMPLEXITY IN THE MBS MARKET AND SECURITY DESIGN

We have shown that more complex securities perform worse and that investors did not price more complex securities in a manner consistent with their perceiving them to be riskier. Furthermore, we have not found evidence that the CRAs understood that more complex securities were riskier. From the perspective of investors, complexity thus appears to be confusing rather than welfare-enhancing.

Can we reconcile our results with theories of security design? In this section, we consider how well different theories of security design explain the level of complexity we observe in the MBS market and the facts about complexity that we have documented. We evaluate the consistency of our results with two classic theories, “tailoring theory” and “information sensitivity theory”.

Allen and Gale’s (1988) seminal theory of complexity, which we term tailoring theory, posits that complexity arises to complete the market in the Arrow-Debreu sense. In tailoring theory, an issuer (a trust in our case) should offer many different types of securities collateralized by the same assets (a pool of mortgages in our case) that satisfy different investor appetites. In so doing, investors maximize the revenue the issuer receives from the sale of the securities because each security is held by the investor that values it most.<sup>13</sup>

The tailoring theory of complexity is consistent with the existence of loan groups structured specifically to satisfy the GSEs’ demand (see Adelino, Frame, and Gerardi (2014)). However, for the tailoring theory to explain the substantial complexity that we document, the different

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<sup>13</sup>Allen and Gale (1991) extend their completing the market argument to a market model with short sales. In general, investors cannot short ABS. Since 2006, investors can short indices of ABS via the ABX.

loan groups within deals would have to be dissimilar to one another. That is, the collateral must be customized within a deal to satisfy particular clients' requests for specific types of collateral resulting in substantively dissimilar loan groups within a deal. If the loan groups are quite similar to one another, spanning different states of the world cannot be the main reason for the different loan groups since investors within a deal are buying assets backed by effectively the same collateral.

If groups within a deal are designed to cater to different risk appetites or preferences for particular types of collateral, then the loan characteristics across groups within the same deal must be different. To understand how different the loan characteristics are, we compare them to the loan characteristics across deals. In the absence of tailoring, we expect the two measures to be roughly equal. We compute the mean absolute deviation (MAD) of several loan characteristics between groups within a deal and across deals. That is, for each loan characteristic  $c$ , we compute

$$DiffIntra^c = \frac{1}{N} \sum_{k=1}^N \left| Char_{k,j}^c - \frac{1}{N_j} \sum_{n=1}^{N_j} Char_{k,j}^c \right|$$

and

$$DiffInter^c = \frac{1}{N} \sum_{k=1}^N \left| Char_{k,j}^c - \frac{1}{N_T} \sum_{l=1}^{N_T} Char_{l,j}^c \right|$$

where  $N$  is the total number of loan groups in our data,  $N_T$  is the total number of loan groups in year  $T$ , and  $N_j$  is the total number of loan groups in deal  $j$ . If the division into loan groups is because of tailoring, we expect  $DiffIntra^c > DiffInter^c$ .

Table 10 compares the differences between loan groups within deals and the differences between loan groups across deals. We see that there is much more variation in loan characteristics across deals than within them. The largest amount of variation in loan group characteristics within deals is in the original principal balances. The intra-deal differences in principal balances are likely due to the influence of the GSEs and, even along this dimension, there is greater variation across deals than within deals. Thus, tailoring cannot explain a

substantial portion of the complexity creating by subdividing the loan pool into separate loan groups.<sup>14</sup>

Another strand of the literature, pioneered by Gorton and Pennacchi (1990) and Boot and Thakor (1993), posits that the multiple securities we observe can be explained by the need for some securities to be informationally insensitive or at least less informationally sensitive. In Gorton and Pennacchi, the exploitation of uninformed traders by informed traders creates a need for some securities to be less informationally sensitive. By creating less informationally sensitive securities, the issuer expands the potential market for its securities to those investors that are either unable or unwilling to acquire information about the quality of the assets. In Boot and Thakor, an issuer divides its cash flows into multiple claims with some securities (i.e., equity) being more information-sensitive than others; the creation of multiple securities from a single asset arises to incentivize information acquisition.

Consistent with the theory of information sensitivity, ABS deals include both informationally sensitive securities (i.e., securities with ratings below AAA) and less informationally sensitive securities (i.e., securities with AAA ratings). Unfortunately, the information sensitivity model does not provide a prediction as to how many different securities an asset should collateralize, only that there should be differences in the information sensitivity of the securities that are issued. What is difficult to understand is why it is necessary to have so many different informationally sensitive and informationally insensitive securities within the same deal. The average deal has 16 securities.

Two other aspects of complexity cannot be explained by either the tailoring theory or the information acquisition theory of security design. First, neither theory can explain why

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<sup>14</sup>Furthermore, the Allen and Gale theory of complexity is somewhat difficult to apply to the RMBS market since, unlike a corporation, the underlying assets in a trust that issues mortgage-backed securities are inherently more divisible than a corporation. Should an RMBS consist of 1000 loans or 5000 loans? Some pooling of loans can be explained by diversification benefits (DeMarzo, 2005) and the desire to overcome adverse selection created by the originator of the loans (not necessarily of the securities) having more information than investors (Riddiough (1997) and DeMarzo (2005)). Without additional theory, however, it is difficult to understand why so many securities are issued within one deal rather than issued from separate deals. It is possible that there is some high fixed cost of issuing a deal such that it is advantageous to issue very large deals with more securities and loan groups rather than put the different loan groups into separate deals. Certainly, it seems likely that there are costs to establishing a trust (e.g., legal fees) that are not present with subdividing loans within a deal. However, it is unclear what puts an upper bound on the number of loans within a pool if the fixed costs are very high.

securities from more complex deals default more. Furthermore, neither theory predicts that securities from more complex deals should receive more inflated ratings.

In summary, several facts we uncover about complexity are difficult to reconcile with traditional theories of security design including those that allow explicitly for informational asymmetry between the issuer of a security and investors. Our results suggest that issuers may have an informational advantage over investors in this market and that they use complexity to exploit this informational advantage. The most closely related work is in industrial organization models wherein firms can obfuscate prices to retain clients (see Ellison and Ellison (2009), Carlin (2009), and Ellison and Wolitzky (2012)). Carlin and Manso (2011) embed such strategic obfuscation into a model of mutual funds.

While we do not have direct evidence regarding the underwriters' intent, a useful direction for future research may be to explore whether complexity is a complement or a substitute for the types of misreporting found by Ben-David (2011), Jiang, Nelson, and Vyltací (2014), Griffin and Maturana (forthcoming), and Piskorski, Seru, and Witkin (2013).

## 7. CONCLUSION

In this paper, we propose measures of complexity for securitized assets. We apply our measures to the ABS market and document an increase in complexity in the 2000s. We then show that more complexity is robustly associated with a higher likelihood of default and that the increase in the risk of default associated with complexity is greatest for securities designed to be informationally insensitive. Lower *ex post* quality collateral is associated with greater complexity but securities from more complex deals default more even after controlling for the realized collateral quality. *Ex ante* pricing indicates that investors did not think more complex securities would default more although several aspects of MBS risk beyond credit ratings were priced. The CRAs rated more complex deals more liberally indicating that they failed to distill the complexity of these deals into the rating. Our results are consistent with the market for PLMBS being subject to strategic obfuscation during the subprime boom.

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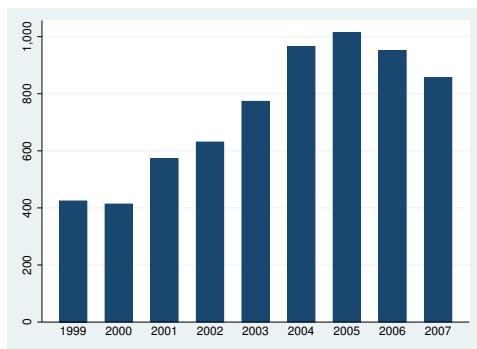
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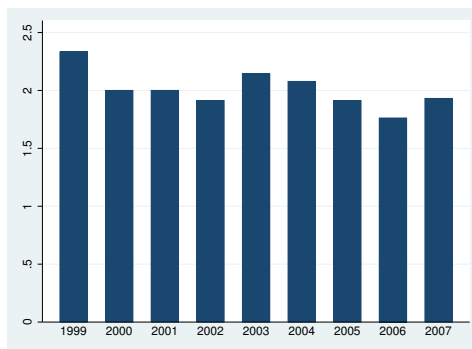
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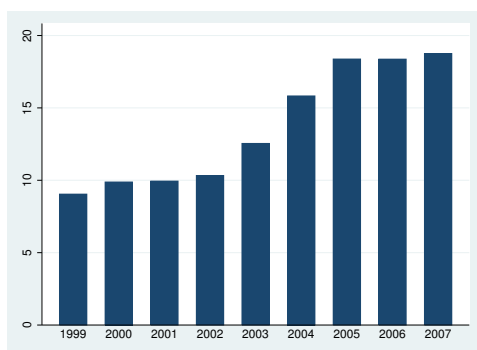
FIGURE 1. Means of Deal Size and Complexity Variables by Year, 1999-2007



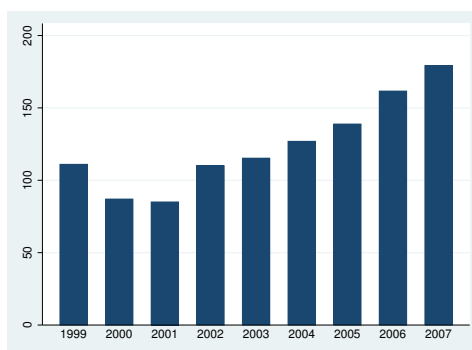
(a) Deal Size (\$M)



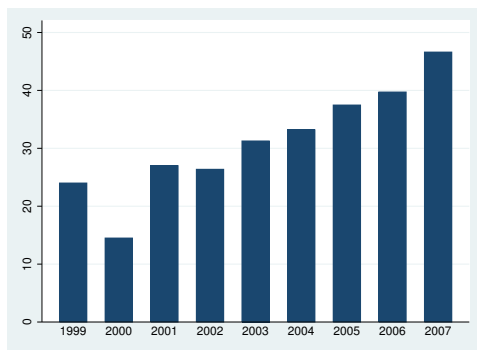
(b) No. of Loan Groups



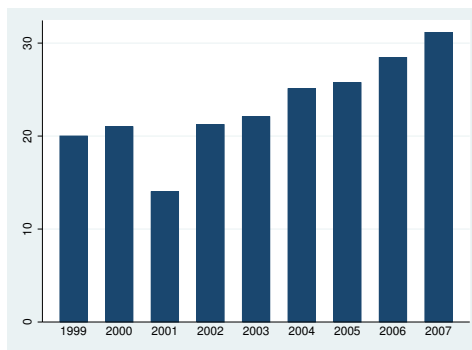
(c) No. of Securities



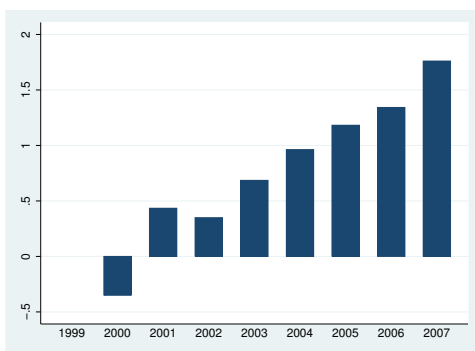
(d) No. of Pages in Prospectus Supplement



(e) No. of Pages Describing Collateral



(f) No. of Pages Describing Waterfall



(g) Complexity Index



TABLE 1. Summary Statistics

| Variable                                  | Unique Obs. | Mean   | Std. Dev. | Min.  | Max.   |
|---|-------------|--------|-----------|-------|--------|
| Panel A: Deal-Level Characteristics       |             |        |           |       |        |
| <i>nloangroups</i>                        | 2050        | 1.94   | 0.89      | 1     | 11     |
| <i>loangroups2</i>                        | 2050        | 0.59   | 0.49      | 0     | 1      |
| <i>loangroups3ormore</i>                  | 2050        | 0.14   | 0.34      | 0     | 1      |
| <i>ntranches</i>                          | 2050        | 16.34  | 5.57      | 1     | 68     |
| <i>pagesprosup</i>                        | 1297        | 147    | 37        | 27    | 391    |
| <i>pagesmpool</i>                         | 1292        | 38     | 17        | 4     | 148    |
| <i>pageswaterfall</i>                     | 1293        | 27     | 9         | 1     | 62     |
| <i>complexityfactor</i>                   | 1291        | 1.15   | 0.97      | -1.43 | 10.15  |
| <i>dealsize</i> (\$M)                     | 2050        | 892    | 596       | 25    | 6,644  |
| <i>crosscollat</i>                        | 1299        | 0.34   | 0.47      | 0     | 1      |
| <i>prospectusavail</i>                    | 2050        | 0.63   | 0.48      | 0     | 1      |
| <i>excessspread</i> (%)                   | 2015        | 4.10   | 1.80      | 0.02  | 26.20  |
| <i>leadtot</i> (\$M)                      | 2050        | 26,535 | 18,489    | 86    | 75,265 |
| Panel B: Security-Level Characteristics   |             |        |           |       |        |
| AAA                                       | 22,395      | 35%    | 48%       | 0     | 1      |
| AA  | 22,395      | 23%    | 42%       | 0     | 1      |
| A   | 22,395      | 21%    | 41%       | 0     | 1      |
| BBB                                       | 22,395      | 21%    | 41%       | 0     | 1      |
| <i>subordination</i> (%)                  | 21,426      | 12     | 8         | 0     | 98     |
| <i>spread</i> (bp)                        | 21,855      | 92     | 89        | 0     | 625    |
| <i>disagree</i> tranche                   | 22,395      | 25%    | 43%       | 0     | 1      |
| <i>default</i>                            | 22,393      | 71%    | 45%       | 0     | 1      |
| <i>AAA_default</i>                        | 7,946       | 37%    | 48%       | 0     | 1      |
| <i>AA_default</i>                         | 5,085       | 80%    | 40%       | 0     | 1      |
| <i>A_default</i>                          | 4,684       | 96%    | 21%       | 0     | 1      |
| <i>BBB_default</i>                        | 4,678       | 95%    | 21%       | 0     | 1      |
| Panel C: Group-Level Loan Characteristics |             |        |           |       |        |
| <i>conforming</i>                         | 1,263       | 0.52   | 0.50      | 0     | 1      |
| <i>foreclosurerate</i> (%)                | 3,397       | 15     | 7         | 0.04  | 100    |
| <i>fico</i>                               | 2,090       | 627    | 30        | 470   | 774    |
| <i>ltv</i> (%)                            | 3,255       | 79     | 7         | 0.1   | 102    |
| <i>lownodocshare</i> (%)                  | 2,197       | 35     | 23        | 0     | 100    |
| <i>top5geoshare</i> (%)                   | 3,444       | 58     | 12        | 28    | 100    |
| <i>Cashare</i> (%)                        | 3,445       | 30     | 16        | 0     | 100    |
| <i>Trshare</i> (%)                        | 3,445       | 2      | 3         | 0     | 33     |
| <i>Nyshare</i> (%)                        | 3,445       | 4      | 5         | 0     | 36     |
| <i>Flshare</i> (%)                        | 3,445       | 9      | 5         | 0     | 89     |
| <i>Ilshare</i> (%)                        | 3,445       | 3      | 3         | 0     | 21     |
| <i>balunder300kshare</i>                  | 3,403       | 66     | 24        | 0     | 100    |
| <i>bal300600kshare</i>                    | 3,403       | 30     | 20        | 0     | 100    |
| <i>balover600kshare</i>                   | 3,403       | 4      | 7         | 0     | 65     |
| <i>wam</i> (months)                       | 3,512       | 351    | 17        | 150   | 477    |

Notes: 1) The variable definitions are as follows. *nloangroups* is the number of loan groups in the deal; *nloangroups2* equals 1 if the number of loan groups is exactly 2, 0 otherwise; *nloangroups3ormore* equals 1 if the number of loan groups is 3 or more, 0 otherwise; *ntranches* is the number of securities in the deal; *pagesprosup* is the number of pages in the prospectus supplement; *pagesmpool* is the number of pages in the prospectus supplement describing the collateral; *pageswaterfall* is the number of pages in the prospectus supplement describing the allocation of payments from collateral to the securities; *complexityindex* is the normalized first principal component of *nloangroups*, *ntranches*, *pagesprosup*, *pagesmpool*, and *pageswaterfall*; *crosscollat* is a dummy variable that takes a value of 1 if the deal provides for some cross-collateralization across loan groups; *prospectusavail* is a dummy variable indicating whether Bloomberg has a prospectus supplement for the deal; *excessspread* is the excess coupon the collateral pays relative to what is owed on the securities; *leadtot* is the volume of ABS deals in that year by the lead manager; *subordination* is the % subordination the security has; *spread* is the coupon the security pays above one month LIBOR measured in basis points; *disagreebranche* takes a value of 1 if the ratings agencies disagree on the rating of that security; *default* equals 1 if the security has realized a principal loss or the ratings agencies have lowered their rating to that of a defaulted security; *AAAdefault*, *AAdefault*, *Adefault*, and *BBBdefault* summarize the default variable only for securities in that rating category; *conforming* takes a value of 1 if the description of the collateral group specifically refers to the loan group being conforming and takes a value of 0 if the description of the collateral group specifically states that the loan group is non-conforming; *fico* is the average FICO score of the loans at origination; *ltv* is the average loan-to-value (LTV) of the loans at origination; *lownodocshare* is the fraction of loans that are No or Low documentation; *top5geoshare* is the fraction of loans that are in the 5 most common states for that pool; *Cashare*, *Flshare*, *Nyshare*, *Ilshare*, and *Txshare* is the sum of the share of loans from the most common 5 states in that deal that are in California, Florida, New York, Illinois, and Texas, respectively; *balunder300kshare* is the fraction of loans with original principal balances of under \$300,000; *bal300600kshare* is the fraction of loans with original principal balances of \$300,000 to \$600,000; *balover600kshare* is the fraction of loans with original principal balances of \$600,000; *wam* is the original weighted average maturity of the loans in months. 2) The sample is all USD-denominated private-label ABS deals backed by US collateral issued 1999-2007 for which detailed information is available via Bloomberg.

TABLE 2. Correlations Between Complexity Variables

|                       | <i>dealsize</i> | <i>nloangroups</i> | <i>ntranches</i> | <i>pagesprosup</i> | <i>pagesmpool</i> | <i>pageswaterfall</i> |
|-----------------------|-----------------|--------------------|------------------|--------------------|-------------------|-----------------------|
| <i>dealsize</i>       | 100%            |                    |                  |                    |                   |                       |
| <i>nloangroups</i>    | 31%             | 100%               |                  |                    |                   |                       |
| <i>ntranches</i>      | 34%             | 50%                | 100%             |                    |                   |                       |
| <i>pagesprosup</i>    | 23%             | 35%                | 44%              | 100%               |                   |                       |
| <i>pagesmpool</i>     | 29%             | 41%                | 28%              | 72%                | 100%              |                       |
| <i>pageswaterfall</i> | 18%             | 27%                | 38%              | 36%                | 20%               | 100%                  |

Notes: 1) *nloangroups* is the number of loan groups in the deal, *ntranches* is the number of securities in the deal, *pagesprosup* is the number of pages in the prospectus supplement, *pagesmpool* is the number of pages in the prospectus supplement describing the collateral, and *pageswaterfall* is the number of pages in the prospectus supplement describing the allocation of payments from collateral to the securities.

TABLE 3. Complexity and Security Default

| Variable                        | (1)                  | (2)                  | (3)                  | (4)                  | (5)                  | (6)                  | (7)                  |
|---------------------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| <i>nloangroups</i>              | 0.027***<br>(0.006)  |                      |                      |                      |                      | 0.021***<br>(0.007)  |                      |
| <i>ntranches</i>                |                      | 0.0021**<br>(0.0010) |                      |                      |                      | 0.0003<br>(0.0012)   |                      |
| <i>pagesprosup</i><br>(x100)    |                      |                      | 0.053***<br>(0.012)  |                      |                      | 0.035**<br>(0.016)   |                      |
| <i>pagesmpool</i><br>(x100)     |                      |                      |                      | 0.071***<br>(0.020)  |                      | -0.0057<br>(0.028)   |                      |
| <i>pageswaterfall</i><br>(x100) |                      |                      |                      |                      | 0.098**<br>(0.038)   | 0.036<br>(0.040)     |                      |
| <i>complexityindex</i>          |                      |                      |                      |                      |                      |                      | 0.027***<br>(0.005)  |
| <i>dealsize</i><br>(x1000)      | 0.021***<br>(0.006)  | 0.027***<br>(0.007)  | 0.028***<br>(0.006)  | 0.030***<br>(0.006)  | 0.031***<br>(0.006)  | 0.022***<br>(0.006)  | 0.022***<br>(0.006)  |
| <i>crosscollat</i>              | -0.020***<br>(0.007) | -0.012*<br>(0.007)   | -0.015**<br>(0.007)  | -0.014**<br>(0.007)  | -0.010<br>(0.007)    | -0.022***<br>(0.007) | -0.020***<br>(0.007) |
| <i>excessspread</i><br>(x100)   | -0.05<br>(0.32)      | 0.39<br>(0.31)       | 0.45<br>(0.27)       | 0.51*<br>(0.27)      | 0.38<br>(0.28)       | -0.21<br>(0.33)      | -0.05<br>(0.31)      |
| <i>leadtot</i><br>(x100,000)    | 0.009<br>(0.020)     | 0.009<br>(0.021)     | 0.008<br>(0.021)     | 0.008<br>(0.021)     | 0.021<br>(0.021)     | 0.010<br>(0.021)     | 0.010<br>(0.020)     |
| <i>AAA Rated</i>                | -0.27***<br>(0.02)   | -0.26***<br>(0.02)   | -0.26***<br>(0.02)   | -0.25***<br>(0.02)   | -0.25***<br>(0.02)   | -0.26***<br>(0.02)   | -0.25***<br>(0.02)   |
| <i>AA Rated</i>                 | -0.094***<br>(0.020) | -0.090***<br>(0.020) | -0.093***<br>(0.020) | -0.085***<br>(0.019) | -0.084***<br>(0.019) | -0.088***<br>(0.019) | -0.086***<br>(0.019) |
| <i>A Rated</i>                  | 0.037**<br>(0.017)   | 0.039**<br>(0.016)   | 0.037**<br>(0.017)   | 0.044***<br>(0.016)  | 0.045***<br>(0.016)  | 0.042***<br>(0.016)  | 0.044***<br>(0.015)  |
| <i>subordination</i><br>(x100)  | -0.66***<br>(0.08)   | -0.70***<br>(0.08)   | -0.66***<br>(0.08)   | -0.67***<br>(0.08)   | -0.69***<br>(0.08)   | -0.65***<br>(0.08)   | -0.67***<br>(0.08)   |
| <i>spread</i><br>(x100)         | 0.026**<br>(0.010)   | 0.027***<br>(0.010)  | 0.026**<br>(0.010)   | 0.030***<br>(0.010)  | 0.030***<br>(0.010)  | 0.029***<br>(0.010)  | 0.030***<br>(0.010)  |
| <i>disagreebranche</i>          | 0.052***<br>(0.010)  | 0.051***<br>(0.010)  | 0.052***<br>(0.010)  | 0.052***<br>(0.010)  | 0.052***<br>(0.010)  | 0.054***<br>(0.010)  | 0.053***<br>(0.010)  |
| Observations                    | 14,531               | 14,531               | 14,503               | 14,445               | 14,445               | 14,432               | 14,432               |
| Std. Errors Clustered by Deal   | Yes                  | Yes                  | Yes                  | Yes                  | Yes                  | Yes                  | Yes                  |
| Year of Issue FEs               | Yes                  | Yes                  | Yes                  | Yes                  | Yes                  | Yes                  | Yes                  |
| Top 5 State Shares              | Yes                  | Yes                  | Yes                  | Yes                  | Yes                  | Yes                  | Yes                  |
| Pseudo- $R^2$                   | 0.52                 | 0.52                 | 0.52                 | 0.52                 | 0.52                 | 0.52                 | 0.52                 |

Notes: 1) Entries shown are marginal effects from probit estimation of default on variables shown. 2) See notes to Table 1 for variable definitions. 3) \*\*\*, \*\*, and \* denote statistical significance at the 1, 5, and 10% levels. 4) Standard errors are clustered by deal to control for correlation in security performance within deals.

TABLE 4. Complexity and Security Default: AAA Securities Only

| Variable                        | (1)                  | (2)                 | (3)                  | (4)                  | (5)                 | (6)                  | (7)                  |
|---------------------------------|----------------------|---------------------|----------------------|----------------------|---------------------|----------------------|----------------------|
| <i>nloangroups</i>              | 0.065***<br>(0.012)  |                     |                      |                      |                     | 0.055***<br>(0.015)  |                      |
| <i>ntranches</i>                |                      | 0.0036*<br>(0.0021) |                      |                      |                     | -0.00038<br>(0.0024) |                      |
| <i>pagesprosup</i><br>(x100)    |                      |                     | 0.11***<br>(0.02)    |                      |                     | 0.03<br>(0.03)       |                      |
| <i>pagesmpool</i><br>(x100)     |                      |                     |                      | 0.19***<br>(0.04)    |                     | 0.07<br>(0.06)       |                      |
| <i>pageswaterfall</i><br>(x100) |                      |                     |                      |                      | 0.19**<br>(0.09)    | 0.09<br>(0.09)       |                      |
| <i>complexityindex</i>          |                      |                     |                      |                      |                     |                      | 0.062***<br>(0.010)  |
| <i>dealsize</i><br>(x1000)      | 0.042***<br>(0.014)  | 0.058***<br>(0.014) | 0.055***<br>(0.014)  | 0.055***<br>(0.014)  | 0.062***<br>(0.014) | 0.041***<br>(0.014)  | 0.041***<br>(0.014)  |
| <i>crosscollat</i>              | -0.052***<br>(0.015) | -0.032**<br>(0.015) | -0.039***<br>(0.015) | -0.040***<br>(0.015) | -0.024*<br>(0.015)  | -0.055***<br>(0.016) | -0.051***<br>(0.016) |
| <i>excessspread</i><br>(x100)   | 0.43<br>(0.66)       | 1.8***<br>(0.64)    | 1.9***<br>(0.57)     | 2.0***<br>(0.55)     | 1.8***<br>(0.57)    | 0.25<br>(0.68)       | 0.58<br>(0.62)       |
| <i>leadtot</i><br>(x100,000)    | 0.054<br>(0.040)     | 0.049<br>(0.041)    | 0.049<br>(0.042)     | 0.051<br>(0.042)     | 0.079*<br>(0.044)   | 0.06<br>(0.042)      | 0.057<br>(0.041)     |
| <i>subordination</i><br>(x100)  | -1.1***<br>(0.2)     | -1.2***<br>(0.2)    | -1.1***<br>(0.2)     | -1.1***<br>(0.2)     | -1.1***<br>(0.2)    | -1.0***<br>(0.2)     | -1.1***<br>(0.2)     |
| <i>spread (bp)</i><br>(x100)    | 0.69***<br>(0.11)    | 0.70***<br>(0.11)   | 0.70***<br>(0.11)    | 0.72***<br>(0.11)    | 0.70***<br>(0.11)   | 0.70***<br>(0.11)    | 0.70***<br>(0.11)    |
| <i>disagreetranche</i>          | 0.026<br>(0.045)     | 0.019<br>(0.045)    | 0.024<br>(0.045)     | 0.015<br>(0.046)     | 0.018<br>(0.046)    | 0.022<br>(0.046)     | 0.017<br>(0.045)     |
| Observations                    | 4,938                | 4,938               | 4,927                | 4,902                | 4,902               | 4,897                | 4,897                |
| Std. Errors Clustered by Deal   | Yes                  | Yes                 | Yes                  | Yes                  | Yes                 | Yes                  | Yes                  |
| Year of Issue FEs               | Yes                  | Yes                 | Yes                  | Yes                  | Yes                 | Yes                  | Yes                  |
| Top 5 State Shares              | Yes                  | Yes                 | Yes                  | Yes                  | Yes                 | Yes                  | Yes                  |
| Pseudo- $R^2$                   | 0.40                 | 0.39                | 0.39                 | 0.39                 | 0.39                | 0.40                 |                      |

Notes: 1) Entries shown are marginal effects from probit estimation of default on variables shown. 2) See notes to Table 1 for variable definitions. 3) \*\*\*, \*\*, and \* denote statistical significance at the 1, 5, and 10% levels. 4) Standard errors are clustered by deal to control for correlation in security performance within deals.

TABLE 5. Complexity and Security Default: Sensitivity Analysis

| Variable                       | (1)                     | (2)                   | (3)                     | (4)                    | (5)                     | (6)                     | (7)                     |
|--------------------------------|-------------------------|-----------------------|-------------------------|------------------------|-------------------------|-------------------------|-------------------------|
| <i>complexityindex</i>         | 0.027***<br>(0.0050)    | 0.062***<br>(0.010)   | 0.0069<br>(0.0048)      | 0.019***<br>(0.0063)   | 0.025***<br>(0.0049)    | 0.025***<br>(0.0054)    | 0.019***<br>(0.0043)    |
| <i>dealsize</i><br>(x1000)     | 0.022***<br>(0.006)     | 0.041***<br>(0.014)   | 0.019***<br>(0.006)     | 0.014<br>(0.009)       | 0.021***<br>(0.006)     | 0.020***<br>(0.006)     | 0.025***<br>(0.005)     |
| <i>crosscollat</i>             | -0.020***<br>(0.007)    | -0.051***<br>(0.016)  | -0.008<br>(0.007)       | -0.013<br>(0.009)      | -0.017**<br>(0.007)     | -0.007<br>(0.010)       | -0.024***<br>(0.006)    |
| <i>excessspread</i><br>(x100)  | -0.05<br>(0.31)         | 0.58<br>(0.62)        | -0.22<br>(0.28)         | 0.46<br>(0.41)         | -0.03<br>(0.30)         | -0.36<br>(0.32)         | 0.56*<br>(0.29)         |
| <i>leadtot</i><br>(x100,000)   | 0.010<br>(0.020)        | 0.057<br>(0.041)      | -0.018<br>(0.021)       | -0.021<br>(0.026)      | 0.017<br>(0.020)        |                         | 0.024<br>(0.018)        |
| <i>AAA Rated</i>               | -0.25***<br>(0.023)     |                       |                         | -0.16***<br>(0.038)    | -0.26***<br>(0.023)     | -0.27***<br>(0.023)     | -0.24***<br>(0.028)     |
| <i>AA Rated</i>                | -0.086***<br>(0.019)    |                       | -0.098***<br>(0.013)    | -0.038<br>(0.030)      | -0.086***<br>(0.019)    | -0.10***<br>(0.020)     | -0.077***<br>(0.023)    |
| <i>A Rated</i>                 | 0.044***<br>(0.015)     |                       | -0.002<br>(0.010)       | 0.087***<br>(0.026)    | 0.041***<br>(0.015)     | 0.034**<br>(0.016)      | 0.059***<br>(0.019)     |
| <i>subordination</i><br>(x100) | -0.0067***<br>(0.00077) | -0.011***<br>(0.0018) | -0.0046***<br>(0.00100) | -0.0074***<br>(0.0011) | -0.0066***<br>(0.00076) | -0.0062***<br>(0.00074) | -0.0062***<br>(0.00076) |
| <i>spread</i><br>(x100)        | 0.030***<br>(0.010)     | 0.70***<br>(0.110)    | -0.0068<br>(0.007)      | 0.053***<br>(0.018)    | 0.028***<br>(0.010)     | 0.023**<br>(0.010)      | 0.049***<br>(0.017)     |
| <i>disagree tranche</i>        | 0.053***<br>(0.010)     | 0.017<br>(0.045)      | 0.035***<br>(0.007)     | 0.047***<br>(0.014)    | 0.051***<br>(0.010)     | 0.052***<br>(0.011)     | 0.049***<br>(0.010)     |
| Observations                   | 14,432                  | 4,897                 | 9,535                   | 7,646                  | 13,777                  | 12,988                  | 13,432                  |
| Std. Errors Clustered by Deal  | Yes                     | Yes                   | Yes                     | Yes                    | Yes                     | Yes                     | Yes                     |
| Year of Issue FEs              | Yes                     | Yes                   | Yes                     | Yes                    | Yes                     | Yes                     | No                      |
| Qtr of Issue FEs               | No                      | No                    | No                      | No                     | No                      | No                      | Yes                     |
| Top 5 State Shares             | Yes                     | Yes                   | Yes                     | Yes                    | Yes                     | Yes                     | Yes                     |
| Includes Conforming Pools      | Yes                     | Yes                   | Yes                     | Yes                    | No                      | Yes                     | Yes                     |
| Detailed Collat. Controls      | No                      | No                    | No                      | Yes                    | No                      | No                      | No                      |
| AAA Only                       | No                      | Yes                   | No                      | No                     | No                      | No                      | No                      |
| Lead Manager FEs               | No                      | No                    | No                      | No                     | No                      | Yes                     | No                      |
| Pseudo- $R^2$                  | 0.52                    | 0.40                  | 0.37                    | 0.49                   | 0.52                    | 0.53                    | 0.55                    |

Notes: 1) Entries shown are marginal effects from probit estimation of default on variables shown. 2) See notes to Table 1 for variable definitions. 3) \*\*\*, \*\*, and \* denote statistical significance at the 1, 5, and 10% levels. 4) Collateral Characteristics are *ltv*, *fico*, *lownodocshare*, *balunder300kshare*, *bal300600kshare*, and *wam*. 5) In the specification in Column 5, we exclude securities collateralized primarily by loan groups indicated as conforming in the loan group description from Bloomberg. 6) In the specification in Column 6, we include only deals from the top 15 issuers by volume and include fixed effects for each of these issuers. 7) In the specification in Column 7, we include only deals issued 2004-2007 as there are too few observations in some quarters in the earlier year to include year fixed effects.

TABLE 6. Complexity and Collateral Default

| Variable                      | (1)                | (2)                | (3)                | (4)                | (5)                 | (6)                 | (7)                |
|-------------------------------|--------------------|--------------------|--------------------|--------------------|---------------------|---------------------|--------------------|
| <i>nloangroups</i>            | -0.02<br>(0.27)    |                    |                    |                    |                     | -0.60**<br>(0.26)   |                    |
| <i>ntranches</i>              |                    | 0.09***<br>(0.03)  |                    |                    |                     | 0.11**<br>(0.04)    |                    |
| <i>pagesprosup</i>            |                    |                    | 0.005<br>(0.006)   |                    |                     | -0.019**<br>(0.009) |                    |
| <i>pagesmpool</i>             |                    |                    |                    | 0.029**<br>(0.012) |                     | 0.059***<br>(0.017) |                    |
| <i>pageswaterfall</i>         |                    |                    |                    |                    | 0.076***<br>(0.019) | 0.074***<br>(0.020) |                    |
| <i>complexityindex</i>        |                    |                    |                    |                    |                     |                     | 0.56***<br>(0.21)  |
| <i>dealsize</i><br>(x1000)    | 0.46<br>(0.36)     | 0.23<br>(0.33)     | 0.35<br>(0.34)     | 0.11<br>(0.35)     | 0.30<br>(0.34)      | 0.02<br>(0.35)      | 0.08<br>(0.36)     |
| <i>crosscollat</i>            | 0.48<br>(0.44)     | 0.35<br>(0.42)     | 0.42<br>(0.42)     | 0.33<br>(0.42)     | 0.69*<br>(0.41)     | 0.66<br>(0.44)      | 0.32<br>(0.42)     |
| <i>excessspread</i>           | 0.41***<br>(0.13)  | 0.22*<br>(0.12)    | 0.37***<br>(0.11)  | 0.37***<br>(0.10)  | 0.23**<br>(0.11)    | 0.31**<br>(0.15)    | 0.20*<br>(0.12)    |
| <i>leadtot</i><br>(x10,000)   | -0.37***<br>(0.13) | -0.36***<br>(0.13) | -0.37***<br>(0.13) | -0.38***<br>(0.13) | -0.30**<br>(0.13)   | -0.32**<br>(0.13)   | -0.36***<br>(0.12) |
| Observations                  | 1,150              | 1,150              | 1,150              | 1,143              | 1,144               | 1,141               | 1,141              |
| $R^2$                         | 0.43               | 0.44               | 0.43               | 0.44               | 0.44                | 0.46                | 0.44               |
| Year of Issue FEs             | Yes                | Yes                | Yes                | Yes                | Yes                 | Yes                 | Yes                |
| Includes Conforming Pools     | Yes                | Yes                | Yes                | Yes                | Yes                 | Yes                 | Yes                |
| Detailed Collat. Controls     | Yes                | Yes                | Yes                | Yes                | Yes                 | Yes                 | Yes                |
| Std. Errors Clustered by Deal | Yes                | Yes                | Yes                | Yes                | Yes                 | Yes                 | Yes                |

Notes: 1) Entries shown are coefficients from a regression of the foreclosure rate on the loan group, in percent, on the variables shown. 2) See notes to Table 1 for variable definitions. 3) \*\*\*, \*\*, and \* denote statistical significance at the 1, 5, and 10% levels. 4) Detailed Collat. Controls are *ltv*, *fico*, *lownodocshare*, *balunder300kshare*, *bal300600kshare*, and *wam*.

TABLE 7. Complexity and Security Default after Controlling for Collateral Default

| Variable                       | (1)                  | (2)                   | (3)                   | (4)                 | (5)                   | (6)                   |
|--------------------------------|----------------------|-----------------------|-----------------------|---------------------|-----------------------|-----------------------|
| <i>complexityindex</i>         | 0.027***<br>(0.005)  | 0.026***<br>(0.005)   | 0.061***<br>(0.010)   | 0.019***<br>(0.006) | 0.017***<br>(0.006)   | 0.052***<br>(0.014)   |
| <i>foreclosure rate</i>        |                      | 0.0028***<br>(0.0007) | 0.0058***<br>(0.0012) |                     | 0.0034***<br>(0.0008) | 0.0067***<br>(0.0017) |
| <i>deal size</i><br>(x1000)    | 0.022***<br>(0.006)  | 0.023***<br>(0.006)   | 0.041***<br>(0.014)   | 0.014*<br>(0.009)   | 0.015*<br>(0.008)     | 0.027<br>(0.022)      |
| <i>crosscollat</i>             | -0.018***<br>(0.007) | -0.021***<br>(0.007)  | -0.060***<br>(0.016)  | -0.011<br>(0.009)   | -0.013<br>(0.009)     | -0.042*<br>(0.023)    |
| <i>excess spread</i><br>(x100) | -0.05<br>(0.32)      | -0.17<br>(0.33)       | 0.20<br>(0.65)        | 0.51<br>(0.41)      | 0.41<br>(0.42)        | 1.40<br>(0.87)        |
| <i>leadtot</i><br>(x100,000)   | 0.0096<br>(0.021)    | 0.017<br>(0.020)      | 0.071*<br>(0.040)     | -0.020<br>(0.026)   | -0.010<br>(0.025)     | -0.035<br>(0.059)     |
| <i>AAA Rated</i>               | -0.26***<br>(0.02)   | -0.25***<br>(0.02)    |                       | -0.16***<br>(0.04)  | -0.16***<br>(0.04)    |                       |
| <i>AA Rated</i>                | -0.089***<br>(0.019) | -0.088***<br>(0.019)  |                       | -0.040<br>(0.030)   | -0.039<br>(0.030)     |                       |
| <i>A Rated</i>                 | 0.042***<br>(0.016)  | 0.043***<br>(0.016)   |                       | 0.087***<br>(0.027) | 0.089***<br>(0.027)   |                       |
| <i>subordination</i><br>(x100) | -0.68***<br>(0.08)   | -0.69***<br>(0.08)    | -1.14***<br>(0.18)    | -0.74***<br>(0.11)  | -0.74***<br>(0.11)    | -1.90***<br>(0.26)    |
| <i>spread</i><br>(x100)        | 0.028***<br>(0.010)  | 0.029***<br>(0.010)   | 0.700***<br>(0.110)   | 0.053***<br>(0.018) | 0.054***<br>(0.018)   | 0.540***<br>(0.130)   |
| <i>disagree tranche</i>        | 0.053***<br>(0.010)  | 0.053***<br>(0.010)   | 0.021<br>(0.045)      | 0.051***<br>(0.014) | 0.052***<br>(0.014)   | 0.054<br>(0.063)      |
| Observations                   | 14,227               | 14,227                | 4,837                 | 7,608               | 7,608                 | 2,510                 |
| Year of Issue FEs              | Yes                  | Yes                   | Yes                   | Yes                 | Yes                   | Yes                   |
| Top 5 State Shares             | Yes                  | Yes                   | Yes                   | Yes                 | Yes                   | Yes                   |
| Detailed Collat. Controls      | No                   | No                    | No                    | Yes                 | Yes                   | Yes                   |
| AAA Only                       | No                   | No                    | Yes                   | No                  | No                    | Yes                   |
| Std. Errors Clustered by Deal  | Yes                  | Yes                   | Yes                   | Yes                 | Yes                   | Yes                   |
| Pseudo- $R^2$                  | 0.52                 | 0.52                  | 0.40                  | 0.49                | 0.50                  | 0.34                  |

Notes: 1) Entries shown are marginal effects from probit estimation of default on variables shown. 2) See notes to Table 1 for variable definitions. 3) \*\*\*, \*\*, and \* denote statistical significance at the 1, 5, and 10% levels. 4) Detailed Collat. Controls are *ltv*, *fico*, *lownodocshare*, *balunder300kshare*, *bal300600kshare*, and *wam*. 5) The number of observations in Columns 1 and 2 differs from that in Table 3 because we drop observations for which we do not have a foreclosure rate.



TABLE 8. Security Spreads and Security Complexity

| Variable                      | (1)               | (2)               | (3)                | (4)                | (5)                | (6)               | (7)               |
|-------------------------------|-------------------|-------------------|--------------------|--------------------|--------------------|-------------------|-------------------|
| <i>nloangroups</i>            | -1.18<br>(0.85)   |                   |                    |                    |                    | -0.21<br>(1.11)   |                   |
| <i>ntranches</i>              |                   | -0.19<br>(0.14)   |                    |                    |                    | -0.15<br>(0.17)   |                   |
| <i>pagesprosup</i>            |                   |                   | -0.029<br>(0.023)  |                    |                    | -0.013<br>(0.034) |                   |
| <i>pagesmpool</i>             |                   |                   |                    | -0.052<br>(0.038)  |                    | -0.032<br>(0.054) |                   |
| <i>pageswaterfall</i>         |                   |                   |                    |                    | 0.039<br>(0.084)   | 0.069<br>(0.086)  |                   |
| <i>complexityindex</i>        |                   |                   |                    |                    |                    |                   | -1.21<br>(0.83)   |
| <i>dealsize</i><br>(x100)     | -0.23**<br>(0.10) | -0.23**<br>(0.10) | -0.24**<br>(0.10)  | -0.22**<br>(0.11)  | -0.26***<br>(0.10) | -0.20*<br>(0.11)  | -0.20*<br>(0.11)  |
| <i>crosscollat</i>            | 0.047<br>(1.44)   | -0.11<br>(1.41)   | -0.15<br>(1.46)    | -0.051<br>(1.43)   | -0.36<br>(1.39)    | 0.36<br>(1.45)    | 0.12<br>(1.49)    |
| <i>excessspread</i>           | -1.20**<br>(0.54) | -1.27**<br>(0.51) | -1.41***<br>(0.43) | -1.53***<br>(0.43) | -1.68***<br>(0.47) | -1.34**<br>(0.58) | -1.25**<br>(0.50) |
| <i>leadtot</i><br>(x10,000)   | -0.13<br>(0.35)   | -0.12<br>(0.35)   | -0.12<br>(0.35)    | -0.10<br>(0.35)    | -0.09<br>(0.37)    | -0.02<br>(0.37)   | -0.12<br>(0.35)   |
| <i>AAA Rated</i>              | -178***<br>(5)    | -178***<br>(5)    | -178***<br>(5)     | -179***<br>(5)     | -179***<br>(5)     | -178***<br>(5)    | -178***<br>(5)    |
| <i>AA Rated</i>               | -154***<br>(3)    | -154***<br>(3)    | -154***<br>(3)     | -154***<br>(3)     | -154***<br>(3)     | -154***<br>(3)    | -154***<br>(3)    |
| <i>A Rated</i>                | -108***<br>(1)    | -108***<br>(1)    | -108***<br>(1)     | -109***<br>(1)     | -109***<br>(1)     | -109***<br>(1)    | -109***<br>(1)    |
| <i>subordination</i>          | -0.18<br>(0.30)   | -0.16<br>(0.29)   | -0.18<br>(0.30)    | -0.15<br>(0.29)    | -0.14<br>(0.29)    | -0.17<br>(0.29)   | -0.16<br>(0.30)   |
| <i>disagree tranche</i>       | 14.4***<br>(1.5)  | 14.5***<br>(1.5)  | 14.4***<br>(1.5)   | 14.3***<br>(1.5)   | 14.2***<br>(1.5)   | 14.3***<br>(1.5)  | 14.3***<br>(1.5)  |
| Observations                  | 14,531            | 14,531            | 14,503             | 14,445             | 14,445             | 14,432            | 14,432            |
| $R^2$                         | 0.762             | 0.762             | 0.762              | 0.762              | 0.762              | 0.762             | 0.762             |
| Year of Issue FEs             | Yes               | Yes               | Yes                | Yes                | Yes                | Yes               | Yes               |
| Top 5 State Shares            | Yes               | Yes               | Yes                | Yes                | Yes                | Yes               | Yes               |
| Std. Errors Clustered by Deal | Yes               | Yes               | Yes                | Yes                | Yes                | Yes               | Yes               |

Notes: 1) Entries shown are coefficients from a regression of the spread of the security, in basis points, relative to one month LIBOR on the variables shown. 2) See notes to Table 1 for variable definitions. 3) \*\*\*, \*\*, and \* denote statistical significance at the 1, 5, and 10% levels.

TABLE 9. Subordination Levels (Credit Support) for AAA Securities and Complexity

| Variable                      | (1)                | (2)                | (3)                  | (4)                | (5)                | (6)                  | (7)                |
|-------------------------------|--------------------|--------------------|----------------------|--------------------|--------------------|----------------------|--------------------|
| <i>nloangroups</i>            | -0.82***<br>(0.18) |                    |                      |                    |                    | -1.08***<br>(0.26)   |                    |
| <i>ntranches</i>              |                    | 0.02<br>(0.05)     |                      |                    |                    | 0.13**<br>(0.05)     |                    |
| <i>pagesprosup</i>            |                    |                    | -0.019***<br>(0.005) |                    |                    | -0.024***<br>(0.006) |                    |
| <i>pagesmpool</i>             |                    |                    |                      | -0.018*<br>(0.009) |                    | 0.027**<br>(0.012)   |                    |
| <i>pageswaterfall</i>         |                    |                    |                      |                    | -0.003<br>(0.018)  | 0.012<br>(0.018)     |                    |
| <i>complexityindex</i>        |                    |                    |                      |                    |                    |                      | -0.64***<br>(0.20) |
| <i>dealsize</i><br>(x1000)    | -0.03<br>(0.24)    | -0.33<br>(0.23)    | -0.15<br>(0.23)      | -0.31<br>(0.23)    | -0.43*<br>(0.23)   | -0.33<br>(0.23)      | -0.17<br>(0.23)    |
| <i>crosscollat</i>            | -0.69**<br>(0.31)  | -1.16***<br>(0.33) | -0.90***<br>(0.32)   | -0.99***<br>(0.32) | -1.10***<br>(0.31) | -0.68**<br>(0.33)    | -0.82**<br>(0.33)  |
| <i>excessspread</i>           | 0.83***<br>(0.14)  | 0.54***<br>(0.13)  | 0.64***<br>(0.12)    | 0.61***<br>(0.12)  | 0.60***<br>(0.12)  | 0.80***<br>(0.13)    | 0.77***<br>(0.14)  |
| <i>leadtot</i><br>(x10,000)   | -0.47***<br>(0.08) | -0.48***<br>(0.08) | -0.46***<br>(0.08)   | -0.47***<br>(0.08) | -0.48***<br>(0.08) | -0.46***<br>(0.08)   | -0.47***<br>(0.08) |
| <i>disagree tranche</i>       | -1.85***<br>(0.56) | -1.86***<br>(0.55) | -1.87***<br>(0.56)   | -1.78***<br>(0.56) | -1.82***<br>(0.55) | -2.07***<br>(0.54)   | -1.76***<br>(0.57) |
| Observations                  | 5,122              | 5,122              | 5,111                | 5,085              | 5,085              | 5,080                | 5,080              |
| $R^2$                         | 0.21               | 0.20               | 0.21                 | 0.21               | 0.20               | 0.23                 | 0.21               |
| Year of Issue FEs             | Yes                | Yes                | Yes                  | Yes                | Yes                | Yes                  | Yes                |
| Top 5 State Shares            | Yes                | Yes                | Yes                  | Yes                | Yes                | Yes                  | Yes                |
| Std. Errors Clustered by Deal | Yes                | Yes                | Yes                  | Yes                | Yes                | Yes                  | Yes                |

Notes: 1) Entries shown are coefficients from a regression of the subordination of the security, in percent, on the variables shown. 2) See notes to Table 1 for variable definitions. 3) \*\*\*, \*\*, and \* denote statistical significance at the 1, 5, and 10% levels. 4) Regressions include only AAA securities.

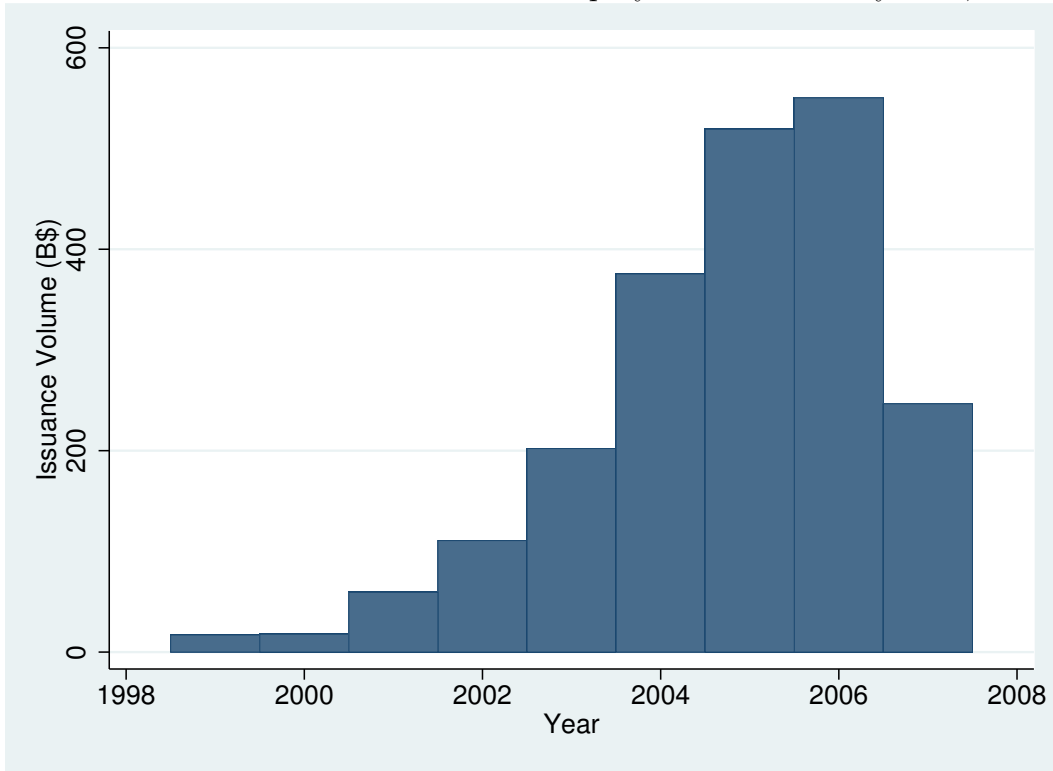
TABLE 10. Are Loan Groups Tailored?

| Loan Group Characteristic | Inter-Deal MAD | Intra-Deal MAD | T-Stat for Difference |
|---------------------------|----------------|----------------|-----------------------|
| Cashare                   | 12.4           | 7.1            | 27.4                  |
| Flshare                   | 2.9            | 1.2            | 27.8                  |
| Nyshare                   | 3.8            | 1.2            | 44.2                  |
| Ilshare                   | 3.1            | 1.2            | 46.8                  |
| Txshare                   | 2.6            | 0.9            | 47.7                  |
| fico                      | 20.6           | 7.2            | 30.7                  |
| ltv                       | 3.7            | 0.9            | 26.1                  |
| lownodocshare             | 17.2           | 3.3            | 37.1                  |
| balunder300kshare         | 19.2           | 17.9           | 4.1                   |
| bal300600kshare           | 15.5           | 14.4           | 3.7                   |
| balover600kshare          | 4.5            | 3.6            | 8.2                   |
| wam                       | 8.8            | 1.9            | 24.5                  |

Notes: 1) MAD is mean absolute deviation of loan characteristic across loan groups. 2) MADs are calculated using loan groups from deals originated in the same year. 3) See Table 1 for variable definitions.

## APPENDIX A. NOT-FOR-PUBLICATION

FIGURE A.1. US Private-Label Home Equity ABS Issuance by Year, 1999-2007



Includes all deals with detailed data available via Bloomberg terminals.

TABLE A.1. Security Spreads and Security Complexity, AAA Securities Only

| Variable                      | (1)                | (2)                | (3)                | (4)                 | (5)                | (6)                 | (7)                |
|-------------------------------|--------------------|--------------------|--------------------|---------------------|--------------------|---------------------|--------------------|
| <i>nloangroups</i>            | 0.86*<br>(0.45)    |                    |                    |                     |                    | 1.65***<br>(0.59)   |                    |
| <i>ntranches</i>              |                    | 0.040<br>(0.065)   |                    |                     |                    | -0.087<br>(0.074)   |                    |
| <i>pagesprosup</i>            |                    |                    | -0.001<br>(0.012)  |                     |                    | 0.018<br>(0.022)    |                    |
| <i>pagesmpool</i>             |                    |                    |                    | -0.035**<br>(0.016) |                    | -0.081**<br>(0.033) |                    |
| <i>pageswaterfall</i>         |                    |                    |                    |                     | 0.019<br>(0.039)   | -0.001<br>(0.042)   |                    |
| <i>complexityindex</i>        |                    |                    |                    |                     |                    |                     | 0.09<br>(0.38)     |
| <i>dealsize</i><br>(x100)     | -0.16***<br>(0.05) | -0.14***<br>(0.05) | -0.15***<br>(0.05) | -0.12**<br>(0.05)   | -0.15***<br>(0.05) | -0.14***<br>(0.05)  | -0.15***<br>(0.05) |
| <i>crosscollat</i>            | 0.85<br>(0.80)     | 1.15<br>(0.80)     | 1.28<br>(0.83)     | 1.48*<br>(0.80)     | 1.30*<br>(0.77)    | 1.03<br>(0.80)      | 1.27<br>(0.85)     |
| <i>excessspread</i>           | -1.10***<br>(0.30) | -0.90***<br>(0.26) | -0.83***<br>(0.24) | -0.81***<br>(0.23)  | -0.89***<br>(0.24) | -1.22***<br>(0.31)  | -0.88***<br>(0.26) |
| <i>leadtot</i><br>(x10,000)   | 0.32**<br>(0.16)   | 0.32*<br>(0.16)    | 0.32**<br>(0.16)   | 0.34**<br>(0.16)    | 0.34**<br>(0.16)   | 0.34**<br>(0.16)    | 0.32*<br>(0.16)    |
| <i>subordination</i>          | 0.19**<br>(0.10)   | 0.18*<br>(0.09)    | 0.17*<br>(0.10)    | 0.17*<br>(0.10)     | 0.18*<br>(0.10)    | 0.21**<br>(0.10)    | 0.18*<br>(0.10)    |
| <i>disagree tranche</i>       | 14.2***<br>(2.8)   | 14.1***<br>(2.8)   | 14.2***<br>(2.8)   | 14.2***<br>(2.7)    | 14.1***<br>(2.7)   | 14.5***<br>(2.7)    | 14.2***<br>(2.8)   |
| Observations                  | 4,938              | 4,938              | 4,927              | 4,902               | 4,902              | 4,897               | 4,897              |
| $R^2$                         | 0.22               | 0.21               | 0.21               | 0.21                | 0.21               | 0.22                | 0.21               |
| Std. Errors Clustered by Deal | Yes                | Yes                | Yes                | Yes                 | Yes                | Yes                 | Yes                |
| Year of Issue FEs             | Yes                | Yes                | Yes                | Yes                 | Yes                | Yes                 | Yes                |
| Top 5 State Shares            | Yes                | Yes                | Yes                | Yes                 | Yes                | Yes                 | Yes                |

Notes: 1) Entries shown are coefficients from a regression of the spread of the security, in basis points, relative to one month LIBOR on the variables shown. 2) See notes to Table 1 for variable definitions. 3) \*\*\*, \*\*, and \* denote statistical significance at the 1, 5, and 10% levels.

Table A.2 reports the results from selected sensitivity analyses regarding the subordination of AAA securities. In Columns 2 and 4, we report the results when we exclude securities collateralized by conforming pools. We report these particular specifications because the effect of complexity on subordination is especially strongly related to the number of loan groups. The number of loan groups in turn is partly driven by the GSEs' demand for securities based on conforming pools. Thus, it is important to understand whether complexity affects ratings only because it is associated with deals in which one or both of the GSEs bought an AAA security. As Columns 2 and 4 illustrate, our results are nearly identical when we exclude conforming pools. Finally, in Column 5, we include securities initially rated AA along with our AAA securities.

TABLE A.2. Subordination Levels (Credit Support) and Complexity: Sensitivity Analysis

| Variable                      | (1)                | (2)                | (3)                | (4)                | (5)                |
|-------------------------------|--------------------|--------------------|--------------------|--------------------|--------------------|
| <i>nloangroups</i>            | -0.82***<br>(0.18) | -0.90***<br>(0.18) |                    |                    |                    |
| <i>complexityindex</i>        |                    |                    | -0.64***<br>(0.20) | -0.71***<br>(0.19) | -0.65***<br>(0.18) |
| <i>AAA Rated</i>              |                    |                    |                    |                    | 6.63***<br>(0.10)  |
| <i>dealsize</i><br>(x1000)    | -0.03<br>(0.24)    | -0.07<br>(0.22)    | -0.17<br>(0.23)    | -0.14<br>(0.22)    | -0.09<br>(0.20)    |
| <i>crosscollat</i>            | -0.69**<br>(0.31)  | -0.74**<br>(0.31)  | -0.82**<br>(0.33)  | -0.92***<br>(0.33) | -0.65**<br>(0.29)  |
| <i>excessspread</i>           | 0.83***<br>(0.14)  | 0.89***<br>(0.14)  | 0.77***<br>(0.14)  | 0.81***<br>(0.13)  | 0.67***<br>(0.12)  |
| <i>leadtot</i><br>(x10,000)   | -0.47***<br>(0.08) | -0.46***<br>(0.08) | -0.47***<br>(0.08) | -0.47***<br>(0.08) | -0.50***<br>(0.07) |
| <i>disagreetranche</i>        | -1.85***<br>(0.56) | -1.93***<br>(0.58) | -1.76***<br>(0.57) | -1.85***<br>(0.59) | -2.53***<br>(0.18) |
| Observations                  | 5,122              | 4,483              | 5,080              | 4,453              | 8,529              |
| R-squared                     | 0.2                | 0.2                | 0.2                | 0.2                | 0.5                |
| Year of Issue FEs             | Yes                | Yes                | Yes                | Yes                | Yes                |
| Top 5 State Shares            | Yes                | Yes                | Yes                | Yes                | Yes                |
| Includes Conforming Pools     | Yes                | No                 | Yes                | No                 | Yes                |
| Std. Errors Clustered by Deal | Yes                | Yes                | Yes                | Yes                | Yes                |
| AAA Only                      | Yes                | Yes                | Yes                | Yes                | No                 |

Notes: 1) Entries shown are coefficients from a regression of the subordination of the security, in percent, on the variables shown. 2) See notes to Table 1 for variable definitions. 3) \*\*\*, \*\*, and \* denote statistical significance at the 1, 5, and 10% levels. 4) In the specifications in Columns 2 and 4, we exclude securities collateralized primarily by loan groups indicated as conforming in the loan group description from Bloomberg. 5) Regressions in Columns 1 through 4 include only AAA securities. 6) The regression in Column 5 includes AAA and AA securities.