# Complexity as a means to distract: Evidence from the securitization of commercial mortgages

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## Abstract

In the years preceding the recent financial crisis, issuances of commercial mortgage backed securities (CMBS) varied noticeably in their complexity. In particular, deals differed dramatically in their size, the homogeneity of their underlying collateral, and the tranching of their securities. Analyzing a sample of approximately 40,000 commercial mortgage loans serving as the collateral for 334 CMBS deals issued between 2001 and 2007, I examine the relationship between deal complexity and loan performance. Controlling for observable loan characteristics, subsequent movements in commercial property prices, and the identities of key institutions involved in the deal, I find that loan performance is worse for loans packaged in more complex securitizations. Because the underwriter effectively determines a deal's complexity, this finding suggests that underwriters constructed more complex deals to mask the presence of lower quality loans. Additional evidence on the composition of loan pools and the determinants of deal complexity is consistent with this interpretation.

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#### I. Introduction

The recent financial crisis has typically been associated with the extremely high default rates on loans made to subprime residential mortgage borrowers. However, similar problems affected a variety of other financial markets, with the focus of this study being on one such market: the market for commercial mortgage backed securities (CMBS). In the years immediately preceding the crisis, securitization had become the fastest growing source of financing for the commercial real estate sector. At its peak in 2007, new issues of commercial mortgage backed securities (CMBS) reached \$191.7 billion before collapsing to less than \$11 billion in 2008, \$0 in 2009, before rebounding to just over \$5 billion in 2010.<sup>1</sup> Not only did the primary market for CMBS literally disappear, losses on existing commercial mortgages grew dramatically, with delinquencies from commercial mortgage loans securitized between 2005 and 2007 being roughly twice that found in similar loans sold between 2001 and 2004.<sup>2</sup>

Given the dramatic fall in the use of securitization and the rise of delinquencies in recently securitized assets, focus began being placed on the mechanics of securitization, where financial engineering alters the promised risks and rewards given to investors buying claims on pools of risky assets (DeMarzo (2005)). Much of the previous academic focus on this issue has been on problems that arise due to information asymmetries between the originator of the loan, the underwriter of the securities, and the investors in those securities. Such asymmetries have been used to explain which loans ultimately get securitized (Agarwal et al. (2010), Black et al. (2010), Purnanandam (2010), Nadauld and Sherlund (2009)), which loans tend to become delinquent (Keys et al. (2011, 2010), and how securitization influences the workouts of loans in distress (Agarwal et al. (2011)).

This paper expands our understanding of how securitization worked in practice by emphasizing the role of complexity. Complexity has been argued to have played a role in the duration and severity of

<sup>&</sup>lt;sup>1</sup> Author's calculations derived from the Commercial Mortgage Alert CMBS database.

<sup>&</sup>lt;sup>2</sup> See Realpoint (2010).

the financial crisis (Caballero and Krishnamurthy (2008), Arora et al. (2009)), in part by influencing how financial instruments were assigned credit ratings (Coval et al. (2009)) and by affecting the efficiency of financial market trading (Carlin, Kogan, and Lowery (2012)). In contrast to this previous work, this paper emphasizes that complexity is chosen by the creator of a financial product, and that this choice might be influenced by the desire of the creator to deflect investor attention in a particular way. Within the context of the securitization of commercial mortgages, I suggest that deal complexity is, in part, chosen by underwriters looking to shift investor attention away from the details of the individual loans in the pool. Consistent with that, I document that loans serving as collateral in more complex securitizations are more likely to become nonperforming, even after controlling for observable loan characteristics, subsequent movements in commercial property prices, and the identities of key institutions involved in the deal. This finding is consistent with increased complexity being used as a mechanism to sell loans of lower than expected quality. In support of this interpretation, I demonstrate that the complexity-quality relationship is only present in loans securitized in deals that contain underwriter-underwritten loans. Further, underwriters increase the complexity of deals in which they place their own loans and form pools in ways that may help them deflect potential future investor criticism. Finally, I show that although more complex deals perform worse, the price at which performance-sensitive complex securities were sold was unrelated to complexity.

II. Commercial mortgages, the securitization timeline, and the complexity of the deal structure Commercial mortgages are loans that are secured by commercial property. Such property typically consists of office buildings, retail establishments, industrial properties, apartment buildings and other specialized real estate like hotels, medical buildings and hospitals, or storage facilities. CMBS underwriters amass a pool of such loans, at which point the pool serves as collateral for a set of securities (CMBS), whose *promised* cash flows come from interest and principal repayments on the pool

of underlying commercial mortgages. *Realized* cash flows on the CMBS, of course, will depend on the performance of the underlying loans in the pool. In some cases, loans in CMBS pools are originated by the deal's underwriter, whereas in other cases, loans have been originated by another lender, who sells the loan to the underwriting firm prior to securitization.

Commercial mortgage loans placed into CMBS pools typically forbid loan prepayments, either through outright contractual bans, high prepayment penalties, or yield maintenance or defeasance requirements.<sup>3</sup> As a result, CMBS deal structuring largely focused on default risk, which was addressed by the tranching of securities. Within a typical deal structure, underwriters create three classes of securities. The largest class of securities would be the most senior, attract a AAA bond rating, and be marketed to financial institutions and money managers as an alternative to corporate bonds. At the other end of the credit spectrum would be the below-investment grade tranche(s), commonly referred to as the B-piece. These bonds would be sold to high-yield investors who had the commercial real estate expertise to understand the risks inherent in the pool of underlying loans. In exchange for buying the riskiest tranche of the securitization structure, the B-piece investor would typically control the workout of loans that become troubled over the life of the pool.<sup>4</sup> A failure of an underwriter to find a willing Bpiece investor would typically doom the securitization, and therefore pools were assembled and tranched in a way that such investors were willing to take part. Between the institutional investors looking for fixed income securities and the commercial real estate experts who sought high yields in exchange for careful underwriting and analysis would typically be a set of mezzanine investors, who were a cross between the investors at either end of the capital structure.

<sup>&</sup>lt;sup>3</sup> Defeasance requires a borrower seeking to prepay a securitized loan to place Treasury securities into the pool in an amount that would generate the originally promised principal and interest payments.

<sup>&</sup>lt;sup>4</sup> Technically, the pooling and servicing agreement of the securitization would typically grant the "controlling class", which is the security holder in the first-loss position, the right to appoint the special servicer, the institution that controls the workout process.

With the few exceptions to be mentioned, the origination of commercial mortgages, the selection of which loans are placed into a specific pool, and the desired tranching structure are all chosen by the underwriter *before* the bonds are rated and sold to investors. After the underwriter chooses which loans are being securitized, the deal underwriter assembles a package of data that includes standardized relevant details about each collateral loan. This data contains information on the location and type of property, as well as details regarding the loan, including its size, mortgage rate, whether the rate is fixed or floating, its loan-to-value (LTV), and its debt service coverage ratio (DSCR).<sup>5</sup> The data package also contains more detailed information on the largest collateral loans, which typically total 50% of the proposed issuance, by balance. This additional information includes the major tenants of the commercial property and the expiration schedules of the property's significant leases. This package of data is shared simultaneously with potential B-piece buyers and bond rating agencies.

With respect to the B-piece buyer, the underwriter is looking for an investor that will pay the "best price" for the securities in the deal that will be the first exposed to any losses in the pool. The best price is not always the maximum bid, as bids can vary in stipulations, rights, or flexibility that could reduce a bank's profitability on a given transaction. Examples of these clauses include the offer to buy a transaction if a certain loan is removed from the pool, or the right to remove a certain number of loans deemed to have excessive risk (called "kick-outs"). These kick-out rights are one way that B-piece buyers may ultimately influence the underlying collateral pool, although during the years immediately prior to the financial crisis, such kick-outs were rare. Though occurring over the course of approximately ten days, the B-piece selection is the most heavily negotiated and arduous decision in the securitization process.

<sup>&</sup>lt;sup>5</sup> The debt-service coverage ratio measures the ratio of the income generated by the property (through rents collected, etc.) to the debt service required by the loan. Thus, higher values of DSCR, all else equal, imply a safer loan.

With respect to the rating agencies, the underwriter provides guidance to the rating agency with respect to the size and number of tranches they would like to have in the deal in addition to the package of data. This guidance reflects two features. First, underwriters want rating agencies to approve the largest tranches possible with the highest ratings, since these will sell at the highest prices. Second, underwriters design their securities to meet the expected demand from their investors.

After the B-piece buyer and the rating agencies have been selected, there is a 30 to 45 day period reserved for due diligence. Over the course of the due diligence period, the B-piece buyer will highlight loans for further diligence and invoke their "kick-out" rights for loans that are deemed to carry unacceptable risk of default.<sup>6</sup> After the due diligence period, the B-piece buyer signs off the collateral pool and the finalized pool is sent to the rating agencies for final ratings.

During the due diligence period, the bank prepares offering documents and sends them to major investment grade investors.<sup>7</sup> These investors include major pension funds, insurance companies, fixed income managers, sovereign wealth managers and may include some hedge funds. Importantly, these investors cannot affect the loans in the pool, but as mentioned below, may influence the design of the deal structure by showing interest in the deal but desiring securities with particular features. Eventually, the investment grade tranches are sold in an auction run by the CMBS trading desks. Following a deal pricing, documents are finalized with tranche prices, and the bonds are delivered to investors through a transfer of the mortgage loans to the trust at closing, approximately ten days after pricing. In total, between 60 and 120 days pass between loan aggregation and the ultimate bond sale.

As described, the underwriter finalizes the pool of commercial mortgages to be securitized before investment-grade investors have been invited to bid. At that point, therefore, the objective of the underwriter is to sell the CMBS at the highest possible collective price. In a world with complete

<sup>&</sup>lt;sup>6</sup> Alternatively, the B-piece investor may request a risk adjustment payment from the underwriter for a certain loan in exchange for keeping it in the pool.

<sup>&</sup>lt;sup>7</sup> This would typically be followed by a series of in-person meetings with investors known as the "road show."

information, the originator(s) of the loans, the underwriter of the deal, and the investors in the securities would all agree on the value of each loan, and thus, on the value of the deal's securities. Suppose by contrast that the underwriter knows more than the investors about some not-readily-observable features of the loans, but wanted to design a loan pool that encourages bond investors to primarily focus on the broad characteristics of the deal (e.g. *average* loan quality, geographic and property type diversification) rather than on the details of individual loans serving as collateral. I refer to the characteristics of the deal that potentially reduce investor attention on the individual loans as measures of deal complexity.

The simplest measure of deal complexity would be deal size. Larger deals may be more complicated for investors to understand because larger deal sizes typically incorporate more loans, more types of underlying collateral (e.g. retail, office, apartments), and more geographic variation. Because of this, when deals become larger, it becomes more difficult for investors to understand how the performance of any single loan would affect the payoff to the security they hold.

Another way to increase deal complexity would be to increase the number of tranches in the deal. Additional tranching increases deal complexity because it becomes more difficult for investors to model the expected payoffs to the various securities. This is because tranching introduces nonlinearity in the relationship between underlying loan performance and security returns. Put another way, the expected cash flow to a security is not equal to the cash flow that the security would receive if the underlying loans defaulted at their expected rates. Instead, security returns will be complicated functions of the covariance between the returns on all of the underlying mortgages serving as collateral (DeMarzo (2005), Nadauld, Sherlund, and Vorkink (2011)). Greater tranching, since it makes the nonlinearity of payoffs more extreme, makes modeling security payoffs more difficult and in particular, more sensitive to one's assumptions regarding underlying mortgage performance. Thus, in the face of a

more finely tranched deal, investors will tend to devote more focus to the terms of the deal structure and conceivably less analyzing the details of individual loans.

Another design feature that might proxy for complexity is the concentration of the underlying loan pool. As described, investors often receive relatively detailed information on the small number of loans that make up roughly 50% of the loan pool and limited, standardized information on the remaining loans in the pool. Thus, the more concentrated the loan pool, the more attention that investors will tend to place on the largest loans in the pool, potentially at the expense of looking closely at the relatively larger number of smaller loans.

A final proxy for deal complexity can be inferred from the underwriter's choice of rating agencies.<sup>8</sup> As described in the timeline, deal structures are presented to multiple rating agencies simultaneously, with the underwriter favoring the agencies that are more generous with its highest ratings. Skreta and Veldkamp (2009) formally model the underwriter-rating agency interaction and predict that as the complexity of a deal increases, rating agency opinion regarding the creditworthiness of any given security issued as part of the deal is likely to become more varied. This disagreement would lead security issuers to choose only the agency giving the highest rating. Thus, the presence of fewer agencies rating a deal may indicate a more complex transaction.

## III. The evolution of the CMBS market and the demand for complexity

In the previous section, it was argued that deal size, deal tranching, pool concentration, and rating agency involvement might proxy for the deal complexity chosen by the underwriter. The hypothesis to be tested in this paper is that the level of deal complexity was chosen by the underwriter to discourage close investor examination of the underlying loan pool. In so doing, underwriters would be

<sup>&</sup>lt;sup>8</sup> See also Ashcraft et al. (2011) and Stanton and Wallace (2010) for analysis of the role played by rating agencies in the securitization process.

more easily able to place loans more likely to default in the pool. It is important to consider, however, that another explanation of deal complexity is that it results, in part, from investor demand (Duffie and Rahi (1995), Riddiough (1997), and Gaur, Seshadri, and Subrahmanyam (2011)). To understand this alternative mechanism, consider that the market for CMBS underwent tremendous growth in the years immediately preceding the financial crisis. As shown in Figure 1, commercial mortgages held by CMBS issuers at the start of 1996 amounted to less than \$50 billion, which was less than 5% of total commercial mortgages outstanding at that time. The CMBS market expanded rapidly, both in terms of the number of dollars of outstanding securities, but also as a fraction of total commercial mortgage finance. By 2007, securitized mortgage pools were roughly 25% of all outstanding commercial mortgage finance. The market's tremendous growth was a result of an increased demand for commercial real estate debt fueled by an increase in commercial property prices that was, in part, accommodated by looser underwriting standards by commercial real estate lenders.

As a result of the market's growth, there were two notable changes that occurred to CMBS deal structure. First, relative to the size of CMBS loan pools from early in the decade, pools formed in 2007 were typically more than three times as large, with the median pool size approaching \$3 billion, nearly twice the size of deals just a few years earlier (Figure 2a). Second, CMBS deals tended to have more tranches. In particular, CMBS deals had an increasing number of AAA-rated tranches, with some being only \$10 or \$20 million in size, in order to expand the set of investors willing to purchase the bulk of the CMBS. New investors, for instance, might have sought a different level of credit support, a different priority in receiving principal repayments, or a combination of both. The larger deals also typically came with more below-investment-grade tranches. As mentioned above, the success in selling a CMBS deal relied on the underwriter's ability to find B-piece investors. Under the old, simpler deal structure, B-pieces would have become too large for traditional high-yield commercial real estate investors to obtain a controlling interest needed to be in charge of the workout process. Increasing the tranching of the

below-investment grade region of the capital structure made the first loss tranche a more manageable size, but only made sense if additional specialized investors, who were willing to buy speculative highyield investments in commercial real estate but did not want or could not manage the responsibility of interacting with troubled borrowers, could be identified.<sup>9</sup> Overall, the median CMBS pool had 19 tranches in 2001, but by 2007, this number had grown to 26 (Figure 2b).

Thus, two of the four proxies for complexity have trends that arguably have nothing to do with underwriters wanting to discourage investors from looking too closely at the details of the loan pool. At the same time, measures of loan quality tended to get worse through time. Figures 2c and 2d demonstrate that CMBS pools securitized between 2005 and 2007 have higher median LTVs and lower median DSCRs than pools securitized in 2003 and 2004. An empirical concern is that the time series correlation of complexity and observable loan quality measures will cause a spurious correlation between loan performance and complexity. This issue will be addressed in the forthcoming empirical analysis.

IV. Data

The sample of CMBS deals to be examined was identified by the CMBS database maintained by Commercial Mortgage Alert, a commercial real estate finance trade publication. From that database, 357 deals were identified that were issued between 2001 and 2007.<sup>10</sup> Each of these 357 deals was then

<sup>&</sup>lt;sup>9</sup> Evidence provided by Franzetti and Scott (2005) and Commercial Mortgage Securities Association (2008) support this description of the market's evolution. This analysis documents that in 2004, nontraditional investors in CMBS like opportunity funds, finance companies, and pension funds held 14% of CMBS outstanding. This share rose to 23% by the end of 2007 during a time that the overall size of the market grew by 50%. This implies that these nontraditional investors tripled their holdings of CMBS over a period of three years, consistent with notion that underwriters needed to market more widely to place the increasing supply of securities.

<sup>&</sup>lt;sup>10</sup> It is important to emphasize that the empirical analysis is not an examination of the determinants of loan performance per se. Rather, the purpose of the study is to determine whether loans placed in more complex deals were more likely to default when commercial real estate markets faltered during the recent financial crisis. Thus, loans that had matured or had been fully defeased in the years before the crisis are not central to the analysis, and deals issued before 2001 would have been made up almost entirely of such loans.

searched on Bloomberg, and for 334 of these 357 deals, Bloomberg contained the deal's Prospectus Supplement and the most recent monthly servicer report.

The Prospectus Supplements contain two types of information: (1) information on the securities issued and (2) information on the underlying commercial mortgages that are in the collateral pool at the time the deal was issued. With respect to the information on the securities, the data lists, among other facts, each security's face value and the credit rating as assigned at issue by the leading rating agencies. This data also provides information regarding the identity of the lead underwriter of each deal. To provide an example of the security structure information available, Table 1 reports the relevant information contained in the Prospectus Supplements for a particular deal underwritten by Lehman Brothers and UBS denoted LBUBS 2006 C1. For this particular deal, there were 34 securities issued that were backed by the cash flows arising from a common set of commercial mortgage loans. Of these, seven principal-receiving classes of securities initially received a AAA rating from Standard and Poor's. The largest security issued in this deal, Class A-4, consisted of \$1.1 billion of securities.

The Prospectus Supplement also contains standardized information on the at-issue characteristics of the loans that serve as collateral to the set of securities. Among other facts, the data lists each loan's original balance, amortization period (if any), coupon rate, loan-to-value (LTV), and debt service coverage (DSCR) ratio as well as the location and type of the underlying collateral property.

The information from the Prospectus Supplements was then merged with the information from the most recent monthly servicer report, which describes each loan's current performance status. Note that this data reflects each loan's status as of the end of the month summarized by the report. As the data were collected manually, the process extended over a period of weeks between March and April, 2010. In what follows, I will refer to a loan's status as of the first quarter of 2010. More precisely, it measures how each loan was described in the most recently available servicer report, which reflects either February or March, 2010 remittances. Note that due to the need to collect this data manually,

loan performance is only observed at this single point in time.<sup>11</sup> As a final screen, I dropped loans secured by multiple properties or loans that were part of a pari passu structure.<sup>12</sup> Overall, the loan database contains 40,172 active loans from the 334 deals. Table 2 exemplifies the loan-level data collected from the Prospectus Supplements and from the most recently available servicer report for five of the 120 loans contained in the securitization described in Table 1. Recall, the underwriting characteristics are from when the collateral pool was finalized, but the status of the loan is as of the first quarter of 2010.

## V. Deal complexity and loan performance

I am interested in understanding the relationship between the complexity of a securitization's structure and the performance of the individual loans serving as collateral. It is the subject of this section to determine whether loan performance is correlated with deal complexity after controlling for variation across time as well as for the variation in observable loan characteristics.

The dependent variable in the analysis is an indicator variable that equals 1 if as of the first quarter of 2010, a given loan is nonperforming, and is equal to 0, otherwise. Nonperforming is defined as a loan that is late, delinquent, currently in foreclosure, or has been through foreclosure as of the first quarter of 2010.<sup>13</sup>

My focus is on whether loan performance is related to the complexity of CMBS deals. The previous discussion motivates my empirical proxies measuring such complexity. I measure pool size as

<sup>&</sup>lt;sup>11</sup> Because the data collected measures loan performance at a single point in time, it is impossible to identify loans that had experienced previous late payments, distress, or any other measures of nonperformance.

<sup>&</sup>lt;sup>12</sup> Pari passu loans, where a single large loan was split into different deals, would mechanically introduce correlation across the performance of individual loan observations, since multiple loans would link to the performance of the same underlying property. Robustness checks indicate that the empirical results are not sensitive to the inclusion or omission of such loans.

<sup>&</sup>lt;sup>13</sup> Extensive robustness checking confirms that alternative multinomial and ordered analyses with various definitions of loan nonperformance lead to the same qualitative conclusions.

the log of the total dollar value of the underlying loan pool. I measure the number of tranches in the deal, but also consider additional specifications where I distinguish tranches according to whether they were initially AAA-rated, below-investment-grade rated, or rated somewhere in between. I measure pool concentration as the sum of the squares of each loan's share of the overall pool. Finally, I construct a measure of rating agency inferred complexity that takes into account that in my sample, all deals are rated by at least two agencies out of the leading three rating agencies Moody's, Standard and Poor's, and Fitch. Thus, I measure rating agency involvement with an indicator that is equal to 1 when only two agencies rate securities from a given deal.<sup>14</sup> As defined, the four complexity measures are constructed such that higher values indicate greater complexity.

Summary statistics for the variables in my regression are reported in Table 3. The first line reports that across all 40,172 loans in my sample, 10.4% are nonperforming. Of particular relevance will be the measures of deal complexity, whose summary statistics are shown in the bottom panel of Table 3. The average deal has an initial loan balance of \$1.9 billion and contains 23 tranches of securities. Roughly 90% of the deals were rated by only two rating agencies, while the average pool concentration is 0.029.

## A. Control variables

The analysis attempts to control for a variety of factors that might influence the ultimate performance of a loan. For instance, I construct an indicator variable that is equal to 1 if the loan requires interest only payments and 0 otherwise. Interest-only loans are typically viewed to be riskier, and 12.2% of the loans in my sample are of this type. The loan's original principal balance may be

<sup>&</sup>lt;sup>14</sup> A related approach would be to use rating agency disagreement as an indication of complexity (Morgan, 2002). However, as CMBS are structured products, issuers and rating agencies typically communicate before the offering and come to an understanding as to how the deal should be structured in order for certain securities to receive certain ratings. Thus, in theory, rating agency disagreement on CMBS ratings should be less common than disagreement on the rating of standard bonds. In practice, every security issued as part of the 334 deals examined in this paper received identical ratings whenever it was rated by more than one of the three agencies: Fitch, Moody's, and Standard and Poor's. Therefore, a disagreement-based ratings variable was not feasible.

related to its future performance, perhaps because larger loans may be underwritten more carefully given the larger loan's relative significance in the pool. Loans in the data average just less than \$12 million in original principal owed. I control for the obvious loan underwriting measures, LTV and DSCR.<sup>15</sup> The loans in my commercial loan sample have an average initial LTV of 67.5%. Across all the loans in the sample, the average initial DSCR is 1.64. That is, the typical collateral property generated income 64% higher than the debt service required on its first mortgage. Finally, the sample of loans has an average spread over 10 year Treasuries of 1.46%. The loan spread is a key underwriting output that one might expect to be correlated with the originator's ex ante view regarding each loan's probability of default.

Since time has elapsed between loan origination and the time that I measure loan performance, a concern arises that loans that were put into more complex deals might have been secured by property that was located in regions that ex post suffered the largest property price declines and therefore incurred higher rates of default. The analysis would then associate complexity with poor performance, but this relationship would be spurious. Thus, one might want to control for how the value of each loan's collateral property has changed between origination and the first quarter of 2010. I do this by utilizing data provided by the National Council of Real Estate Investment Fiduciaries (NCREIF). NCREIF provides an index of the quarterly price appreciation/depreciation of commercial property broken down to the level of MSA-property type, which I select based on the location and property type of each loan. For each loan in the sample, I construct the variable *Property price change* as the ratio of the level of the property-relevant NCREIF index in the first quarter of 2010 to the level of that same index at each loan's origination date.<sup>16</sup> Table 3 indicates that the average price of the commercial property securing the

<sup>&</sup>lt;sup>15</sup> Other property level metrics, like occupancy and net operating income, were not reported with regularity and so were unable to be considered for the analysis.

<sup>&</sup>lt;sup>16</sup> The NCREIF index is largely based on appraised property values and may also be limited in its coverage for smaller MSAs. For these reasons, I conducted robustness checks using an alternative price variable the MIT transactions-based index (TBI). The advantage of this index relative to the NCREIF is that it does not rely on

loans in my sample has fallen by approximately 13.5% between origination and the first quarter of 2010. Because of the variation in when and where the loans were originated, the measure shows a significant variation in the estimated property price level relative to its level at origination.

I also construct an indicator for whether or not the securities of the CMBS deal were SECregistered or issued under Rule 144A. Rule 144A allows for simplified disclosures on the part of the underwriter under the condition that the securities will only be marketed, sold, and traded among qualified institutional investors. It could be the case that better collateral is placed into Rule 144A deals because only sophisticated institutions will be buying the securities and these institutions have the ability to conduct a careful underwriting of the loan pool. On the other hand, the reduction in disclosure requirements associated with Rule 144A may provide the opportunity to place worse loans in a pool undetected. Only seven of my 334 (2.1%) CMBS deals were offered without SEC registration and were issued under Rule 144A.

As argued earlier, it is essential to control for any time series variation in loan performance, loan characteristics, and deal complexity. To do so, all the empirical specifications will include dummy variables for the quarter in which the securitization occurs. Thus, any observed correlations between complexity and loan performance are in the cross section of deals within any given quarter. Further, all the regressions include additional fixed effects for property type, state in which the collateral property is located, and lead underwriter, as well as fixed-effects for each of the 17 leading originators in the data, each of whom originated at least 1000 loans in my sample.

## **B.** Loan performance results

My focus is on relating the performance of commercial mortgage loans as of the first quarter of 2010 to the complexity of the deal into which the loans were placed. I report in Table 4 output from two

appraisals. Its limitation is that it only measures prices across property types, and does not calculate values by geographic region. With either index, the results are quantitatively and qualitatively similar.

probit regressions. Because of the difficulty in interpreting output from probit regressions, the numbers in Table 4 report the marginal effects of increasing a given variable on the probability of a loan being nonperforming, holding all other variables at their mean value. Positive coefficients, therefore, imply that an increase in the given variable correlates with a higher probability that a loan is nonperforming as of the first quarter of 2010. Standard errors have been clustered at the deal level.<sup>17</sup>

### Complexity and loan performance

The first column of Table 4 represents a benchmark analysis of the determinants of loan performance in the sample of 40,172 commercial mortgages underlying my sample's 334 CMBS deals. The first row indicates that loans in larger pools – all else equal – are more likely to be nonperforming. The marginal impact estimated implies that a one standard deviation increase in pool size correlates with a 2.0% reduction in the probability that a loan is performing. This is consistent with underwriters and ultimate investors being less careful looking at individual loans when the pool becomes large, perhaps because the performance of an individual loan is less important to the performance of the pool when the pool is larger. In this initial specification, the coefficient on the pool loan concentration is positive, but is significant only at the 11% level. The results indicate that there is not a statistically significant relationship between the number of tranches in a pool and a loan's nonperformance. The final measure of complexity is the indicator for the deal being rated by only two rating agencies. The estimates suggest that loans in such deals are 3.0% more likely to be nonperforming. This is consistent with lower quality loans being placed in deals that are more complex, as evidenced by the choice of using only two rating agencies.

The second column of Table 4 explores tranching in more detail. As described earlier, the increased complexity of the tranching was largely motivated by the need to differentiate buyers of AAA-rated securities and also to meet the capacity of the traditional buyers of the B-piece, or lowest rated

<sup>&</sup>lt;sup>17</sup> Robustness checks were performed with clustering completed at various levels.

securities in the offering. This suggests that empirically, complexity may not be captured well by the overall number of tranches, but rather by the composition of the tranches, particularly with respect to those that are either AAA-rated or are below investment grade. For this reason, I distinguish three variables that count the number of tranches that were initially AAA-rated, below-investment-grade rated, and rated somewhere in between. When the tranching variable is expanded in this way, the variable measuring the number of AAA-rated tranches enters positively and is highly statistically significant. The magnitude of the coefficient implies that a one standard deviation increase in the number of AAA-rated tranches with a 2.5% increased probability of a loan's nonperformance. Coefficients on the other tranche variables are not statistically different from zero.

Note that in this alternative specification, the coefficient on pool size declines and becomes statistically insignificant. Thus, it seems that pool size was in part, serving as a proxy for the number of highly rated tranches. The coefficient on pool loan concentration becomes marginally significant, but economically, its size is small. The point estimate suggests that a one standard deviation increase in pool concentration correlates with a 0.6% increase in loan nonperformance.

#### Other indicators of loan performance

The coefficients on the loan-specific underwriting criteria are generally unsurprising. Loans with higher loan-to-value ratios have higher future nonperformance. A one standard deviation increase in a loan's LTV correlates with a 3.2% higher probability of loan nonperformance. The coefficient on debt service coverage is negative, as expected, with the coefficient implying that a one standard deviation increase in a loan's DSCR correlates with a 2.6% decrease in loan nonperformance. Loan spreads enter positively, implying that loans with higher spreads at issue are ultimately more likely to become nonperforming. A one-percentage point increase in a loan's spread over Treasuries correlates with a 2.25% increase in the loan's probability of being nonperforming. The negative coefficient estimated on the change in the underlying collateral property's value suggests that loans on properties that have

suffered larger price declines are more likely to be nonperforming. A one standard deviation decline in property value correlates with a 2.0% increase in loan nonperformance. Finally, I estimate a positive coefficient on the indicator variable for deals where the securities were issued under Rule 144A rather than through a more standard SEC registration. This suggests that loans pooled in deals that would back securities sold only to qualified, sophisticated investors tended to perform worse.

#### VI. Interpretation and additional empirical tests

The results of Section V document a positive correlation between loan nonperformance and the complexity of the deal into which the loan was placed. If loans had been placed at random into deals, one would not expect to find such a correlation once all relevant characteristics of the loans were held constant. In this section, I explore the hypothesis that underwriters do not put together pools of loans at random, but rather, assemble pools in ways that place loans more likely to underperform in pools that are more complex.

It is natural to assume that each loan has some not-so-readily observed characteristics that would help predict future loan performance. For example, this might include the care with which the borrower's financial statements were validated or the degree to which optimistic cash flow forecasts influenced the loan decision. I will refer to good (bad) loans to be those for which these not-so-readily observed characteristics would tend to predict fewer (more) defaults after controlling for all readily observed characteristics of the loan. That is, readily observable characteristics like LTV and DSCR do not determine whether a loan is good or bad. Good and bad reflects the not-so-readily observable measures of loan quality.

Suppose that the originator of a loan, Bank O (originator), was able to tell whether a mortgage loan M was good or bad and chooses to sell it to Bank U (deal underwriter), who will be the underwriter of a future CMBS deal that will contain loan M. If Bank U finds out that mortgage M is bad at the time of

the sale, one might suppose that it should not rationally buy it at all from Bank O, or it should buy it at a lower price. If Bank U realizes that mortgage M is of poorer quality after it already purchased the loan but before it is securitized, reputation theory might suggest that it may not wish place it into a CMBS deal because of the risk of hurting its reputation with CMBS investors about the quality of its underwriting process. Not only that, but in such a case, Bank O will undermine its reputation in the eyes of Bank U, which subsequently can hurt Bank O's ability to sell loans to Bank U in future. So, arguably, neither Bank O nor Bank U would consistently sell and securitize loans that they know to be bad because of reputational concerns.

Since I argue that underwriters did selectively place bad loans in more complex deals, my presumption is that reputational concerns must not be the only motivating factor for the institutions involved in the securitization process. In particular, I allow for the possibility that Bank U, the deal underwriter, might care more about the ability to sell lower quality loans as part of a CMBS pool than it does about the potential loss of its reputation. The evidence that the creators of complex financial products did not always have the best interest of their investors in mind has strong support anecdotally (Lewis, 2010). Even if the creation of CMBS pools was not as egregious as the structured finance products described by Lewis (2010), it is reasonable to assume that underwriters may have believed that investors would be slow to discover or might never discover that loans were of lower quality than might have been implied by their observable characteristics. After all, it was only because there was a systematic decline in property prices that widespread commercial mortgage default and losses on CMBS became an issue. Thus, underwriters may have rationally thought that the benefits of selling bad loans outweighed this probability-weighted future diminished reputation.

Complicating the story is the fact that underwriters were also originators of commercial mortgage loans. If underwriters understood which loans were good and bad and had sufficiently little regard for its own reputation, it could easily use this venue to get rid of its own bad mortgages by

placing them into the CMBS deals it underwrites. This suggests a simple test as to whether or not loans originated by the underwriter perform better or worse than the observable loan characteristics would suggest. The first column of Table 5 repeats the earlier probit analysis, but includes an indicator variable that is equal to 1 if the loan's originator is the same institution that also underwrites the deal in which that loan was securitized, and is equal to 0, otherwise. This coefficient is estimated to be -0.0394 and is highly statistically significant. This means that holding all observable characteristics of loan constant, loans originated by the deal's underwriter are nearly 4% *less* likely to be nonperforming. In other words, underwriter-originated loans were of high not-easily-observed quality.

The second column of Table 5 further distinguishes loans by introducing another indicator variable that is equal to 1 if the loan is not originated by the deal underwriter, but is placed into a deal in which the underwriter has placed its own loans, and is equal to 0, otherwise. I refer to such loans as "outsider" loans, to convey the idea that underwriters pool their own loans with outsider loans. Note that by including this additional indicator variable into the analysis, the omitted category of loans ("other" loans) are those that are securitized in deals in which the underwriter has not placed any of its own loans. Note in this specification that the coefficient on the originator is the underwriter variable is negative 0.0272 and the coefficient on the outsider loan indicator is positive 0.0156. While neither of these coefficients are statistically different from the "other" loan benchmark, the estimates suggest that within deals in which underwriters place their own loans, outsider loans are more than four percent more likely to become nonperforming than those loans originated by the underwriter. This difference is statistically significant at the 1% level.

Taken together, the evidence in the first two columns of Table 5 suggests that a more complicated selection mechanism may have been taking place. The evidence is consistent with deal underwriters being able to identify good and bad loans in advance of pool formation. It suggests that underwriters take good loans that they originate and combine them with bad loans that others

originate. This particular strategy of pool formation might be done for at least two reasons. First, suppose that loans originated by underwriters can be both good and bad. It could be that the good loans are placed in deals that they underwrite while the bad loans are sold to other underwriters.<sup>18</sup> Thus, if in the future, their own deals suffer losses and investors complain, they can argue that the bad loans were from another lender. Second, underwriters may have believed that the "surprisingly" good performance of their own loans would offset the poor performance of the loans supplied by others so that pool-level cash flows would be not too different from what was expected by investors.

What remains is to understand how this pool formation interacts and potentially influences the complexity of the deal. The remaining three columns repeat the same regression analysis, with each column representing the estimation being completed on three different subsamples. Column 3 reports the analysis of loans originated by the deal underwriter, column 4 reports the analysis of outsider loans, and column 5 reports the analysis of the remaining loans. What is striking about the results in the final three columns of Table 5 is that the relationship between measures of complexity and loan performance is only present in loans securitized by the originator of the loan and in loans securitized with underwriter-originated loans. There is no relationship between loan performance and deal complexity for loans that were securitized in deals that contain no underwriter-originated loans. This refines the notion about what CMBS underwriters do when forming pools. The evidence suggests that only when underwriters plan to securitize their own loans do they form pools in ways in which poor loan performance is associated with greater deal complexity.

Additional evidence on this point is presented in Table 6. This table reports the output from linear regressions performed at the deal level. That is, each regression includes only one observation for

<sup>&</sup>lt;sup>18</sup> In results not shown, an additional category of loan was created, identifying loans originated by institutions that underwrite CMBS but securitized by a different firm. The coefficient on this indicator was +0.06, suggesting that these loans are 6% more likely to be nonperforming. This suggests that CMBS underwriters sell bad mortgages to each other but securitize their good mortgages in their own deals.

each of the 334 deals in the sample. The dependent variable in each regression is a different measure of deal complexity. The independent variables include loan characteristics that have been aggregated to the pool level as well as an indicator variable that is equal to 1 if the deal contains loans that were originated by the deal's underwriter, and is equal to 0, otherwise. Reading across columns, the results suggest that deals that contain loans originated by the deal underwriter are more complex. In particular, they are larger, have more tranches overall, and have more AAA-rated and below-investment-grade rated tranches. To try to quantify how much more complex deals become when underwriters also originate loans, I construct an overall complexity index. This index is the sum of four component measures, with the four measures being based on a pool's size, the number of AAA-rated tranches, its loan concentration, and its indicator for only having been rated by two rating agencies. The component measure for deal size would compute a z-score measure computed as the number of standard deviations above (positive) or below (negative) the deal's size is relative to the average deal size for that quarter. This methodology was repeated for each of the four complexity characteristics, and the four zscores are then summed to construct a complexity index. This complexity index ranges from approximately -6.5 to +7.8, with a standard deviation of 1.8. The final column of Table 6 implies that deals in which the underwriter has originated loans have a complexity index 1.0 higher. This suggests that underwriters increase the complexity of a deal by over half of a standard deviation when their own loans are part of the deal.

The preceding analysis has demonstrated that when underwriters wish to securitize their own loans, they place them in more complex deals alongside bad loans originated by others. Because the cash flows to the investors ultimately depend on the performance of the pool overall, it is useful to explore how the complexity of the deal correlates with overall pool performance. Table 7 reports the output from regressions where the dependent variable is the fraction of each deal's loan pool this is nonperforming as of the first quarter of 2010. This is regressed on the measures of deal complexity as

well as loan characteristics aggregated to the pool level. The first column of Table 7 illustrates that an increase in the number of AAA-tranches does correlate with lower pool loan performance. The number of "other" tranches also correlates with pool performance, but with the opposite sign and a much smaller magnitude. The second column adds an indicator variable for whether loans originated by the underwriter are included in the deal. The coefficient suggests that such deals tend to have 2.57% fewer nonperforming loans. However, the positive coefficient on the number of AAA-rated tranches remains. The final two columns of Table 7 separate the sample into deals in which the underwriter has also originated loans and all other deals. Consistent with the earlier findings at the loan level, the correlation between the number of AAA-rated tranches and overall deal performance is found only in deals that contain underwriter-originated loans. At least with respect to tranching, the evidence is consistent with more complex deals having worse ex-post performance. The magnitude of the relationship is economically large, too. The results suggest that a one standard deviation increase in the number of AAA-rated tranches correlates with a 4.4% reduction in performing loans, which is nearly half the standard deviation of pool performance across deals.

These previous results demonstrate that underwriters form more complex pools when they wish to securitize their own loans, and that they do so, in part, by increasing the number of AAA-rated tranches in the deal. Further, measures of tranching complexity correlate with ex post pool performance. If underwriters introduce complexity to discourage CMBS investors from looking too carefully at the details of the underlying loans, it would be interesting to examine whether investors understood that this was happening. One way to address this question is to ask whether investors paid less for securities issued from more complex deals. Unfortunately, the mechanism used to sell belowinvestment-grade securities described earlier implies that prices of the most credit-sensitive securities are not observable. This explains why the Commercial Mortgage Alert database contains virtually no

information on the yield spread (at issue) for CMBS carrying a below-investment-grade rating.<sup>19</sup> As a result, the most credit sensitive tranche for which reasonable pricing information is available reflects those securities originally carrying a BBB- credit rating. In particular, pricing information is available for the BBB- tranche in 279 out of the 334 deals.

Table 8 reports the output from regressions where the dependent variable is the initial yield spread (relative to the swap rate of a similar maturity) of the given BBB- tranche. The most striking finding in the first column of Table 8 is that none of the variables enter with a significant coefficient. These regressions include fixed effects for each quarter of the sample period, and in results not reported, these fixed effects explain nearly 89% of the variation in bond spreads across CMBS deals. In the second column, the indicator variable identifying deals in which the underwriter has included some of its own loans enters with a positive coefficient, yet is not statistically different from zero. The final two columns split the sample into deals in which underwriters have placed their own loans and all other loans. There is some weak evidence that for deals in which the underwriter has placed his own loans, investors in BBB- - rated securities paid less (higher spread) when there are more below-investmentgrade tranches. Based on the estimate from Table 6 that such deals have 0.44 more below-junk rated tranches, the yield spread impact of this complexity measure is only 1.1 basis points. In the remaining deals, there is evidence that loan concentration is positively correlated with higher spreads, but again, the economic magnitude is small, and the evidence in Table 6 suggests that such deals have roughly the same loan concentration as those that contain underwriter-originated loans. Therefore, relative to the within-quarter standard deviation of BBB- CMBS spreads of 29 basis points, it seems that measures of CMBS deal complexity do not help to explain the price paid by investors for these securities. Although

<sup>&</sup>lt;sup>19</sup> Calculating yields of CMBS bonds, since they are structured products, relies not only on a bond's sale price, but also a model that forecasts cash flow that will flow to a given bond under benchmark assumptions. As CMA collects its yield data from the underwriters, it may potentially reflect biases present in those models. Conversations with analysts at third-party CMBS pricing vendors confirms, however, that the CMA data, despite its potential problems, is the most reliable source of at-issue pricing for this market.

previous research suggests that investors were potentially aware of various incentives that underwriters had to sell bad loans (An, Deng, and Gabriel (2010), Demiroglu and James (2012)), the evidence suggests that the use of securitization complexity as a way to sell bad loans was not initially understood by security investors.

#### VII. Summary

If loan quality were perfectly observable, many of the problems associated with mortgage securitization that have been identified post-crisis would have been avoided. Because loan originators and deal underwriters typically have superior information regarding loan quality than investment-grade bond investors, market practices (e.g. tranching, the use of rating agencies) evolved in ways to address this asymmetry. This paper expands on the understanding of pre-crisis securitization practices by arguing that deal underwriters used complexity to distract investors from looking carefully at the details of the individual loans serving as collateral. Consistent with this, I found that all else equal, loans in more complex deals performed worse ex post. This complexity-performance relationship was only found for loans that were part of deals in which underwriter-originated loans were also securitized. Further evidence documents that deals containing underwriter-originated loans were systematically more complex, suggesting that the underwriter increased chose higher complexity purposefully. Looking at the ex post performance of loans suggests that the purpose of the complexity was to ease the ability of underwriters to package low quality loans originated by others.

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## Figure 1: Commercial mortgage investors

The top panel graphs the value of commercial mortgages held by various investor groups. The bottom panel expresses the same commercial mortgage holdings as a percent of total mortgages outstanding.



### Owners of commercial mortgages (share of total)



# Figure 2: Developments in commercial mortgage securitization

Panels A – D depict the evolution over time of CMBS pool size, pool tranching, LTV, and DSCR, respectively. Pool size is the total mortgage balance of the loans in the pool, calculated at the time the pool was created. Pool tranching counts the number of unique securities whose cash flows were backed by a common pool of loans. Pool loan-to-value is defined as the total value of the loans in a pool divided by the total value of all the underlying collateral commercial properties, calculated at the time the pool was created. Pool DSCR is the total cash flow generated by the properties securing the mortgage loans divided by the total debt service required by all loans in the pool, calculated at the time the pool was created. In all panels, the box graphed represents the inter-quartile range, with the line in the middle of the box depicting the median value. The dashes outside of the boxes measure the region of continuity of the distribution, calculated as 150% of the distance above (below) the 75<sup>th</sup> (25<sup>th</sup>) percentile unless that value exceeds the maximum (minimum) value observed in the data. Dots outside of the dashes represent outlier observations in the data.



Table 1: Sample securitization								
This table lists the set	of securities and their ch	naracteristics that were o	collateralized by the loa	ns pooled for the				
LBUBS 2006 C-1 securi	tization, one of the 334	deals being examined. C	ass distinguishes differ	ent securities. Amount				
is the original face valu	ue issued of the particula	ar class. % of Deal expres	sses the original face va	lue as a fraction of the				
total deal size. Coupon rate is the promised interest rate on the security. Initial rating refers to the rating given to								
the security at issue by	the security at issue by Standard and Poor's. All data come from the deal's Prospectus Supplement.							
Class	Amount	% of Deal	Coupon rate	Initial rating				
	(Millions of \$)							
A-1	64	2.58%	5.018	AAA				
A-2	326	13.16%	5.084	AAA				
A-3	92	3.72%	5.207	AAA				
A-AB	94	3.80%	5.139	AAA				
A-4	1143.176	46.16%	5.156	AAA				
A-M	245.597	9.92%	5.217	AAA				
A-J	221.037	8.93%	5.276	AAA				
В	15.35	0.62%	5.306	AA+				
С	27.63	1.12%	5.335	AA				
D	24.559	0.99%	5.365	AA-				
E	18.42	0.74%	5.404	A+				
F	21.49	0.87%	5.433	А				
G	21.489	0.87%	5.5	A-				
Н	24.56	0.99%	5.561	BBB+				
J	18.42	0.74%	5.561	BBB				
K	24.56	0.99%	5.561	BBB-				
L	12.279	0.50%		BB+				
М	9.21	0.37%		BB				
Ν	9.21	0.37%		BB-				
Р	6.14	0.25%		B+				
Q	6.14	0.25%		В				
S	6.14	0.25%		B-				
Т	24.56	0.99%		NR				
IUU-1	7.2	0.29%		NR				
IUU-2	2.578	0.10%		NR				
IUU-3	3.551	0.14%		NR				
IUU-4	1.866	0.08%		NR				
IUU-5	1.276	0.05%		NR				
IUU-6	0.909	0.04%		NR				
IUU-7	0.96	0.04%		NR				
IUU-8	1.016	0.04%		NR				
IUU-9	1.077	0.04%		NR				
X-CP(IO)	2250.748*		0.352	AAA				
X-CL(IO)	2455.967*		0.063	AAA				

\*Notional amount.

Table 2: Excerpt from the sample loan pool								
This table provides sample loan information from five loans in the securitization LBUBS 2006 C-1. <i>Collateral property</i> identifies the property that secures the given mortgage loan. <i>Status</i> is the loan's performance status as of the first quarter of 2010. <i>Loan size</i> is the principal balance remaining on the loan when the loan was added to the pool. <i>Coupon</i> is the promised interest rate on the loan. <i>LTV at Deal Cutoff</i> is the ratio of <i>Loan size</i> to the value of the property when the loan was added to the pool. <i>DSCR at Deal Cutoff</i> is the ratio of the cash flow generated by the property to the debt service required on the loan when the loan was added to the pool. Data comes from the Prospectus Supplement except for the loan's status, which comes from the most recently available monthly servicer report downloaded from Bloomberg.								
Collateral Property	Status Loan size Coupon LTV at Deal DSCR at Deal Cutoff Cutoff							
1301 Avenue of the Americas	Perform	420,783,734	5.37	38	2.22			
Sand Lake Plaza In Foreclosure 8,350,000 5.34 79 1.21								
Woodland Arms Apartments REO 4,350,000 5.86 68 1.2								
Sweetbriar Apartments	Del 30	2,750,000	5.67	80	1.32			
Hinesville Shopping Center	Late	2,592,500	5.81	76	1.27			

#### Table 3: Summary statistics

The table reports summary statistics of the data used in this paper. A loan is nonperforming is equal to 1 if the loan is late, delinquent, or is currently or has been in foreclosure as of the first quarter of 2010 and is equal to 0, otherwise. Indicator that loan is interest only equals 1 if the loan requires no amortization and 0 otherwise. Loan size is the outstanding amount of the loan at the time the loan was placed into the pool. LTV at deal cutoff is the loan-to-value ratio of the loan at the time the loan was placed into the pool. DSCR at deal cutoff is the loan's debt service coverage ratio at the time the loan was placed into the pool. Loan spread to 10 year Treasury is the difference between the loan's required interest rate and the yield to maturity on 10 year Treasuries at the time the loan was originated. Loan originator is deal underwriter is equal to 1 if the originator of the loan is the same as the underwriter of the deal into which the loan is placed and is equal to 0, otherwise. Property price change is the ratio of the level of the property-relevant NCREIF National Property Index in the first quarter of 2010 to the level of the same index at loan origination. Pool size is the total principal balance of the commercial mortgage loan pool, in millions of dollars. Pool loan concentration is the sum of the squared loan shares where each loan share is defined as a loan's initial balance divided by initial pool size. Number of tranches in the deal reports the number of different securities are offered that are backed by all or some of the loans in a given pool. # of AAA-rated tranches, # of below-investment-grade securities, # of other tranches report the number of securities issued as part of a CMBS issue were rated by only two out of the three major rating agencies Moody's, Standard and Poor's, and Fitch, and is equal to 0, otherwise. Rule 144A indicator is equal to 1 if the securities' offering was done under Rule 144A of the SEC and is equal to 0 when the securities sold were SEC-registered.

		Standard				
Loan sample (40,172 loans)	Mean	Deviation	Minimum	25th %tile	75th %tile	Max
Indicator that loan is nonperforming	0.104	0.305	0.000	0.000	0.000	1.000
Indicator that loan is interest only	0.122	0.327	0.000	0.000	0.000	1.000
Loan size (\$ millions)	11.900	3.500	0.090	2.580	10.300	1070.000
LTV at deal cutoff	67.464	14.113	1.000	63.000	77.000	100.000
DSCR at deal cutoff	1.641	1.942	0.310	1.250	1.530	136.000
Loan spread to 10-year Treasury	1.461	0.654	-1.080	1.060	1.760	11.430
Loan originator is deal underwriter	0.266	0.442	0.000	0.000	1.000	1.000
Property price change	0.865	0.167	0.449	0.748	0.947	1.805
		Standard				
Pool sample (334 deals)	Mean	Deviation	Minimum	25th %tile	75th %tile	Max
Fraction of deal that is nonperforming	0.110	0.117	0.000	0.039	0.135	0.926
Pool size (\$ millions)	1931.497	1170.152	50.500	1108.500	2504.600	7903.500
Pool loan concentration	0.029	0.013	0.002	0.019	0.035	0.085
Number of tranches in the deal	23.428	4.582	10.000	20.000	26.000	50.000
# of AAA-rated tranches in the deal	8.183	2.784	2.000	6.000	10.000	15.000
# of below-investment-grade tranches in the deal	7.066	1.327	2.000	7.000	7.000	16.000
# of other tranches in the deal	8.180	2.539	0.000	7.000	9.000	24.000
Only 2 rating agencies indicator	0.919	0.273	0.000	1.000	1.000	1.000
Pool LTV	68.063	4.018	55.200	66.500	71.000	80.300
Pool DSCR	1.577	0.260	1.170	1.400	1.650	3.120
Pool Spread	1.493	0.815	0.480	0.960	1.960	10.290
Rule 144A	0.021	0.143	0.000	0.000	0.000	1.000
Pool property price change	0.920	0.137	0.671	0.792	1.041	1.210
Underwriter has originated loans in deal	0.674	0.470	0.000	0.000	1.000	1.000

### Table 4: Complexity and loan performance, benchmark results

The table reports marginal impacts derived from estimated probit regressions. The dependent variable in all regressions is equal to 1 if the loan is late, delinquent, or is currently or has been in foreclosure as of the first quarter of 2010 and is equal to 0, otherwise. The numbers in the table report the marginal impact of the given variable on the probability that a given loan will be nonperforming estimated from a probit model. Log pool size is the natural logarithm of the total principal balance of the commercial mortgage loan pool, in millions of dollars. Pool loan concentration is the sum of the squared loan shares where each loan share is defined as a loan's initial balance divided by initial pool size. Number of tranches in the deal reports the number of different securities are offered that are backed by all or some of the loans in a given pool. # of AAA-rated tranches, # of below-investment-grade securities, # of other tranches report the number of securities offered in a deal that have an original rating that is AAA, rated BB or lower, or receive another rating, respectively. Only 2 agencies is equal to 1 if the securities issued as part of a CMBS issue were rated by only two out of the three major rating agencies Moody's, Standard and Poor's, and Fitch, and is equal to 0, otherwise. Indicator that loan is interest only equals 1 if the loan requires no amortization and 0 otherwise. Log loan size is the natural logarithm of the original outstanding amount of the loan. LTV at deal cutoff is the loan-to-value ratio of the loan at the time the loan was placed into the pool. DSCR at deal cutoff is the loan's debt service coverage ratio at the time the loan was placed into the pool. Loan spread to 10 year Treasury is the difference between the loan's required interest rate and the yield to maturity on 10 year Treasuries at the time the loan was originated. Rule 144A indicator is equal to 1 if the securities' offering was done under Rule 144A of the SEC and is equal to 0 when the securities sold were SEC-registered. Property price change is the ratio of the level of the property-relevant NCREIF National Property Index in the first quarter of 2010 to the level of the same index at loan origination.

Complexity measures		
Log pool size	0.0295**	0.0197
	[0.0129]	[0.0129]
Pool loan concentration	0.482	0.458*
	[0.295]	[0.273]
Number of tranches in the deal	0.000681	
	[0.00135]	
# of AAA-rated tranches in the deal		0.00907***
		[0.00225]
# of below-investment-grade tranches in the deal		0.00197
		[0.00252]
# of other tranches in the deal		-0.00279
		[0.00219]
Only 2 rating agencies indicator	0.0300***	0.0398***
	[0.0101]	[0.0113]
Control variables		
Indicator the loan is interest only	-0.0153**	-0.0147**
	[0.00678]	[0.00662]
Log loan size	0.00949***	0.00921***
	[0.00181]	[0.00178]
LTV at deal cutoff	0.00225***	0.00225***
	[0.000297]	[0.000293]
DSCR at deal cutoff	-0.0136*	-0.0142*
	[0.00719]	[0.00731]
Loan spread to 10-year Treasury	0.0225**	0.0200**
	[0.00955]	[0.00965]
Property price change	-0.120***	-0.117***
	[0.0215]	[0.0215]
Rule 144A indicator for the deal	0.0935**	0.133***
	[0.0380]	[0.0389]
Observations	40,172	40,172
Standard errors clustered by quarter of deal		
*** p<0.01, ** p<0.05, * p<0.1		

All regressions include dummy variables for the quarter in which the loan was securitized, the property type of underlying collateral, the underwriter of the deal, indicators for each of the leading 17 originators, and the state in which the property is located.

### Table 5: Complexity, loan performance, and the role of the underwriter

The table reports marginal impacts derived from estimated probit regressions. The dependent variable in all regressions is equal to 1 if the loan is late, delinquent, or is currently or has been in foreclosure as of the first quarter of 2010 and is equal to 0, otherwise. The numbers in the table report the marginal impact of the given variable on the probability that a given loan will be nonperforming estimated from a probit model. Log pool size is the natural logarithm of the total principal balance of the commercial mortgage loan pool, in millions of dollars. Pool loan concentration is the sum of the squared loan shares where each loan share is defined as a loan's initial balance divided by initial pool size. Number of tranches in the deal reports the number of different securities are offered that are backed by all or some of the loans in a given pool. # of AAA-rated tranches, # of below-investment-grade securities, # of other tranches report the number of securities offered in a deal that have an original rating that is AAA, rated BB or lower, or receive another rating, respectively. Only 2 agencies is equal to 1 if the securities issued as part of a CMBS issue were rated by only two out of the three major rating agencies Moody's, Standard and Poor's, and Fitch, and is equal to 0, otherwise. Loan originator is deal underwriter is equal to 1 if the originator of the loan is the same as the underwriter of the deal into which the loan is placed and is equal to 0, otherwise. Outsider loan is equal to 1 if the loan is not originated by the underwriter of the deal into which the loan is placed in a deal that does contain loans originated by the underwriter.

			Originator =		
	Full sample	Full sample	Underwriter	Outsider Loan	All Other Loans
Complexity measures					
Log pool size	0.0215	0.0222*	-0.00937	0.0223	0.0302
	[0.0133]	[0.0128]	[0.0129]	[0.0206]	[0.0234]
Pool loan concentration	0.487*	0.481*	0.360	0.575	0.170
	[0.271]	[0.275]	[0.331]	[0.404]	[0.570]
# of AAA-rated tranches in the deal	0.00892***	0.00862***	0.00903***	0.0123***	-0.00364
	[0.00219]	[0.00223]	[0.00205]	[0.00385]	[0.00524]
# of below-investment-grade tranches in the deal	0.00202	0.00193	0.000903	0.00357	-0.00566
	[0.00255]	[0.00251]	[0.00155]	[0.00326]	[0.0103]
# of other tranches in the deal	-0.00277	-0.00262	0.00135	-0.00383	-0.00931
	[0.00220]	[0.00220]	[0.00136]	[0.00240]	[0.00588]
Only 2 rating agencies indicator	0.0394***	0.0402***	0.0246***	0.0639***	0.0136
	[0.0115]	[0.0110]	[0.00890]	[0.0136]	[0.0186]
Loan originator is deal underwriter	-0.0394**	-0.0272			
	[0.0198]	[0.0233]			
Outsider loan		0.0156			
		[0.0138]			
Observations	40,172	40,172	10,574	16,515	12,744
Standard errors clustered by quarter of deal					
*** p<0.01, ** p<0.05, * p<0.1					

All regressions include control variables for indicating whether the loan is interest only, the log of the loan's initial size, the loan's original LTV, the loan's original DSCR, the loan's initial spread to the 10-year Treasury, the change in the property price of the property-relevant NCREIF price index, and an indicator for whether or not the deal was sold under Rule 144A. Additional dummy variables were included for the quarter in which the loan was securitized, the property type of underlying collateral, the underwriter of the deal, indicators for each of the leading 17 originators, and the state in which the property is located.

## Table 6: Underwriter origination and the determinants of complexity

The table reports the coefficients estimated from linear regressions. The dependent variable is a measure of deal complexity, identified at the top of each column. Log pool size is the natural logarithm of the total principal balance of the commercial mortgage loan pool, in millions of dollars. Pool loan concentration is the sum of the squared loan shares where each loan share is defined as a loan's initial balance divided by initial pool size. Number of tranches in the deal reports the number of different securities are offered that are backed by all or some of the loans in a given pool. # of AAA-rated tranches, # of below-investment-grade securities, # of other tranches report the number of securities offered in a deal that have an original rating that is AAA, rated BB or lower, or receive another rating, respectively. Only 2 agencies is equal to 1 if the securities issued as part of a CMBS issue were rated by only two out of the three major rating agencies Moody's, Standard and Poor's, and Fitch, and is equal to 0, otherwise. Complexity index is the sum of the normalized z-scores for each deal's size, # of AAA-rated tranches, concentration, and only 2 agencies. Underwriter has originated loans is equal to 1 if the deal contains loans originated by the deal underwriter. Pool LTV, DSCR, and Spread are the loan size weighted loan to value, debt service coverage ratio, and spread to 10-year Treasuries of the pool.

	Dependent variable							
						# of below-		
				# of AAA-rated	# of other	investment-	Only 2 rating	
		Pool loan	# of tranches in	tranches in the	tranches in	grade tranches	agencies	Complexity
	Log pool size	concentration	the deal	deal	the deal	in the deal	indicator	index
Underwriter has originated loans	0.171**	0.00118	1.808**	1.517***	-0.150	0.440*	-0.0406	1.020***
	[0.0767]	[0.00264]	[0.865]	[0.420]	[0.448]	[0.252]	[0.0315]	[0.309]
Pool LTV	0.00660	-0.000836**	-0.0407	0.0441	-0.0893*	0.00446	0.00309	-0.0239
	[0.0110]	[0.000325]	[0.0781]	[0.0575]	[0.0496]	[0.0280]	[0.00643]	[0.0517]
Pool DSCR	0.0742	-0.00344	0.0302	1.128	-0.917	-0.182	-0.0767	0.139
	[0.167]	[0.00415]	[0.936]	[0.717]	[0.593]	[0.443]	[0.111]	[0.635]
						-		
Pool Spread	-0.299***	0.00128	-0.961***	-0.395**	-0.329**	0.237***	-0.0263	-0.519***
	[0.0415]	[0.00160]	[0.262]	[0.164]	[0.136]	[0.0816]	[0.0172]	[0.141]
Constant	6.837***	0.0735**	19.87***	-0.739	13.67***	6.942***	1.068*	0.837
	[0.862]	[0.0268]	[5.962]	[4.536]	[4.059]	[2.471]	[0.551]	[4.176]
Observations	334	334	334	334	334	334	334	334
R-squared	0.660	0.328	0.522	0.683	0.290	0.131	0.134	0.325
Standard errors clustered by quarter	Standard errors clustered by quarter of deal							
*** p<0.01, ** p<0.05, * p<0.1								

All regressions include fixed effects for the year in which the deal was securitized and the underwriter of the deal.

## Table 7: Complexity and pool performance

The table reports the coefficients estimated from linear regressions. The dependent variable is the fraction of each deal's loan pool that is nonperforming as of the first quarter of 2010. Log pool size is the natural logarithm of the total principal balance of the commercial mortgage loan pool, in millions of dollars. Pool loan concentration is the sum of the squared loan shares where each loan share is defined as a loan's initial balance divided by initial pool size. # of AAA-rated tranches, # of below-investment-grade securities, # of other tranches report the number of securities offered in a deal that have an original rating that is AAA, rated BB or lower, or receive another rating, respectively. Only 2 agencies is equal to 1 if the securities issued as part of a CMBS issue were rated by only two out of the three major rating agencies Moody's, Standard and Poor's, and Fitch, and is equal to 0, otherwise. Underwriter has originated loans is equal to 1 if the deal contains loans originated by the deal underwriter. Rule 144A indicator is equal to 1 if the securities' offering was done under Rule 144A of the SEC and is equal to 0 when the securities sold were SEC-registered. Pool LTV, DSCR, Spread, Property Price Change are the loan size weighted loan to value, debt service coverage ratio, spread to 10-year Treasuries, and property price change of the pool.

	Full sample	Full sample	Underwriter has originated loans	All other deals
Log pool size	-0.0435	-0.0468*	-0.00809	-0.0407
	[0.0261]	[0.0266]	[0.0382]	[0.0360]
Pool loan concentration	1.343	1.339	0.128	2.303*
	[0.973]	[0.983]	[0.814]	[1.344]
# of AAA-rated tranches in the deal	0.0151***	0.0160***	0.0131***	0.0184
	[0.00514]	[0.00506]	[0.00393]	[0.0138]
# of below-investment-grade tranches in the deal	9.62e-05	0.000643	0.00638*	-0.0133
	[0.00416]	[0.00396]	[0.00357]	[0.0163]
# of other tranches in the deal	-0.00436*	-0.00465*	-0.00524**	-0.000784
	[0.00241]	[0.00239]	[0.00252]	[0.00459]
Only 2 rating agencies indicator	0.0229	0.0224	0.0440*	-0.000484
	[0.0184]	[0.0189]	[0.0240]	[0.0329]
Underwriter has originated loans		-0.0257**		
		[0.0104]		
Rule 144A	0.257***	0.237**		0.242
	[0.0884]	[0.0902]		[0.159]
Pool LTV	0.0101**	0.0102**	0.00638	0.0175***
	[0.00404]	[0.00403]	[0.00417]	[0.00257]
Pool DSCR	0.0265	0.0275	-0.00948	0.0462
	[0.0365]	[0.0361]	[0.0322]	[0.0435]
Pool Spread	-0.0249**	-0.0263**	-0.0229	-0.0331**
	[0.0107]	[0.0108]	[0.0162]	[0.0149]
Pool property price change	-0.190	-0.216	-0.220*	-0.198
	[0.128]	[0.129]	[0.118]	[0.485]
Constant	-0.124	-0.0593	-0.0767	-0.511
	[0.470]	[0.473]	[0.559]	[0.856]
Observations	334	334	225	109
R-squared	0.338	0.341	0.278	0.511
Robust standard errors in brackets			·	
*** p<0.01, ** p<0.05, * p<0.1				

All regressions include fixed effects for the year in which the deal was securitized and the underwriter of the deal.

### Table 8: Complexity and CMBS initial pricing

The table reports the coefficients estimated from linear regressions. The dependent variable is the initial yield spread of a BBB-rated CMBS tranche, expressed as the number of basis points above the swap rate of comparable maturity. Log pool size is the natural logarithm of the total principal balance of the commercial mortgage loan pool, in millions of dollars. Pool loan concentration is the sum of the squared loan shares where each loan share is defined as a loan's initial balance divided by initial pool size. # of AAA-rated tranches, # of below-investment-grade securities, # of other tranches report the number of securities offered in a deal that have an original rating that is AAA, rated BB or lower, or receive another rating, respectively. Only 2 agencies is equal to 1 if the securities issued as part of a CMBS issue were rated by only two out of the three major rating agencies Moody's, Standard and Poor's, and Fitch, and is equal to 0, otherwise. Underwriter has originated loans is equal to 1 if the deal contains loans originated by the deal underwriter. Rule 144A indicator is equal to 1 if the securities' offering was done under Rule 144A of the SEC and is equal to 0 when the securities sold were SEC-registered. Pool LTV, DSCR, and Spread are the loan size weighted loan to value, debt service coverage ratio, and spread to 10-year Treasuries of the pool.

			Underwriter	
	Full sample	Full sample	has originated	All other deals
			loans	
Log pool size	-3.012	-2.259	11.25	-13.34
	[11.40]	[11.65]	[21.06]	[18.01]
Pool loan concentration	262.4	263.0	245.9	393.8**
	[176.3]	[174.2]	[245.4]	[187.0]
# of AAA-rated tranches in the deal	-2.267	-2.469	-5.510	4.008
	[2.086]	[2.202]	[3.449]	[3.111]
# of below-investment-grade tranches in the deal	1.819	1.707	2.454*	-1.901
	[1.240]	[1.343]	[1.385]	[2.138]
# of other tranches in the deal	0.128	0.208	0.269	-0.497
	[0.711]	[0.707]	[1.331]	[1.076]
Only 2 rating agencies indicator	-16.70	-16.45	-13.81	14.78
	[12.58]	[12.13]	[13.67]	[14.37]
Underwriter has originated loans		5.614		
		[8.742]		
Rule 144A	18.94	22.74		18.48
	[44.48]	[44.48]		[31.89]
Pool LTV	1.348	1.325	2.346	-0.577
	[0.803]	[0.815]	[1.428]	[1.075]
Pool DSCR	13.79	12.95	35.44	-12.46
	[9.266]	[9.318]	[21.03]	[9.207]
Pool Spread	40.42	40.59	50.06	21.19
	[23.78]	[23.91]	[32.27]	[13.47]
Constant	-16.33	-26.52	-233.4	235.1
	[97.72]	[106.0]	[214.8]	[166.1]
Observations	279	279	182	97
R-squared	0.918	0.918	0.942	0.958
Standard errors in brackets				
*** p<0.01, ** p<0.05, * p<0.1				

All regressions include fixed effects for the quarter in which the deal was securitized and the underwriter of the deal.