Subordinations Levels in Structured Financing*

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Abstract

Duffie and DeMarzo (1999), DeMarzo (2005) and Riddiough (1997) discuss the design of asset-backed securities, particularly the senior-subordinated structure that is commonly used with mortgage-backed securities. The advantage for the creation of a low-risk security in a senior-subordinated structure is that it would help solve the asymmetric information problem between the financial intermediary and investors. However, these papers do not provide empirical support for the types and characteristics of assets (loans) that would help solve the asymmetric information problem.

The critical determinant for creating a low-risk security in a senior-subordinated structure is the subordination level. Subordination levels determine the amount of credit support that the senior bonds (or tranches) require from the subordinated bonds (or tranches) and are provided by the financial intermediaries and rating agencies. Thus, both the financial intermediaries and ratings agencies play an important role in the pricing and risk management of structured finance products.

In order to determine the nature of the assets that are required to create a low-risk security in a senior-subordinated structure, we perform a deal level analysis using commercial mortgage-backed securities (CMBS). We find that debt service coverage ratio (DSCR), a commonly used measure of default risk, is a very important variable in subordination design. In addition, measures of property type and prepayment protection are found to be important as well. Furthermore, we find that the property type and prepayment protection change in terms of importance over time.

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1. Introduction

The structured finance market has grown rapidly during the past two decades[1]. An attractive feature of structured finance to investors is the senior-subordinated debt structure where cash flows from underlying loan pool are allocated to various tranches of securities (bonds) according to rules. Typically, prepayments of principal are often distributed first to the senior tranches while losses due to default are allocated first to the subordinated tranches. Therefore, investors buying senior tranches expect to be well protected from credit risks while those holding subordinated tranches will get higher expected returns. This senior-subordinated structure allows the financial intermediary to create a low-risk security that can potentially overcome the asymmetric information problem between the issuer and the investor.

In this senior-subordinated structure, bond subordination levels are key variables because they determine how much credit support senior tranches have from the subordinated tranches. Subordination levels are determined, in part, by critical ex-ante measures of default. A stylized fact about subordination levels is that there exists a time series trend showing subordination levels declining systematically over time for one type of structured financing: commercial mortgage-backed securities (CMBS). While papers such as Duffie and DeMarzo (1999), DeMarzo (2005) and Riddiough (1997) discuss the advantages for the creation of a low-risk security in a senior-subordinated structure, they

[1] For example, CMBS annual issuance in US has grown from less than $1 billion in 1985 to $169 billion in 2005. CMBS outstanding at the end of 2005 reached $550 billion, which accounts for about 21 percent of $2.6 trillion commercial mortgage outstanding.

do not provide empirical support for the types and characteristics of assets (loans) that would help solve the asymmetric information problem.

In this paper, we provide empirical support for the types and characteristics of assets (loans) that allow the financial intermediary to create a low-risk security in a senior-subordinated structure. Using cross-sectional tests of subordination levels in commercial mortgage-backed securities (CMBS) deal, we examine how AAA (low-risk) and BBB (higher-risk) bond subordination levels can be explained by both credit and non-credit variables at deal level. We pay special attention to the roles of original LTV and original DSCR, while existing literature suggest neither will be a good credit risk predictor for commercial mortgages. Second, we examine whether subordination levels change over time and identify the fundamental drivers of the changes in subordination.

In section 2, we introduce structure finance and the pooling and tranching of assets. In section 3, we briefly summarize the mechanism of CMBS structure and subordination; section 4 explains our research questions and empirical approach; sections 4 and 5 describe the data and model results; concluding remarks are in the final section.

2. Structured Financing and the Pooling and Tranching of Assets

Structured financing has revolutionalized the debt and capital markets. By pooling and tranching financial promises, the structured financing process separates the securities with differing seniority corresponding to different risk and return characteristics, and de-link the credit risk of the underlying assets from the credit risk of originators. Allen and Gale (1988), Boot and Thakor (1993), and Duffie and DeMarzo (1999) provide thorough

analyses on these new innovations, and develop theoretical models of optimal security design based on capital structure and general equilibrium framework.

Consider a financial intermediary that is faced with the decision to sell individual assets or pool the assets and sell the pool. The financial intermediary has an informational advantage over the investor that is purchasing the individual asset or pool. Since the financial intermediary has superior information about the asset, there exists a "lemons problem" where the investor has difficulty distinguishing the good assets from the bad assets for sale. In an attempt to solve this asymmetric information problem, Leland and Pyle (1977), and DeMarzo and Duffie (1999) develop signaling models of the sale where the financial intermediary (issuer) signals a high value security retaining a portion of the issue. Winton (1995, 2003) extends DeMarzo and Duffie (1999) by allowing endogenous institutional liquidity needs, and accounting for the effect of monitoring costs in the optimal security design. DeMarzo (2005) shows that pooling of the individual assets prior to sale is not advantageous to an informed intermediary because pooling of the assets can destroy the asset-specific information held by the intermediary. By eliminating the intermediary's potential for aggressively to sell individual assets, this information destruction effect reduces the payoff to the intermediary.

Rather than simply pooling assets for sale, DeMarzo (2005) shows that the optimal security to issue is a debt security backed by the asset pool. If there is a beneficial risk diversification effect of pooling, the intermediary can issue a low-risk debt security from a large pool as well as a higher-risk debt security. The low-risk debt security is less sensitive to the intermediary's private information; hence, it is more liquid. DeMarzo (2005) also shows that as the size of the pool grows large, the risk diversification effect

dominates the information destruction effect. The result is that pooling and tranching is optimal for the intermediary.[2]

Another strand of literature related to this topic focused on the structure and the effectiveness of the financial intermediaries (DeLong, 1991), and monitoring process in the structure finance (Thakor, 1982, Diamond, 1984, Ramakrishnan and Thakor, 1984). In the CMBS market (as well as in other credit derivative securities markets), rating agencies has plaid important role in monitoring and certifying the credit risks associated with different tranches of the securities. It is worth to note that rating agencies provide credit rating matrices to reflect their opinion of the ability a security issue to meet its financial commitments on a timely basis. However, credit rating do not measure other risks in the CMBS markets, such as market risk, the risk of loss in market value due to the shock in the interest rates, as well as the security's potential for price appreciation. So rating agencies' role in the structured finance market is not to provide credit risk management, rather, they are functioned as financial monitor or certifier. Weinstein (1977), Gorton and Pennacchi (1990), Thompson and Vaz (1990) examine the function and effectiveness of intermediaries and rating agencies in the structure finance.

3. CMBS structure

Commercial mortgage-backed securities are an example of a structured finance product where assets are pooled and tranches. Commercial mortgages are pooled together by CMBS issuers and several tranches of securities are created and sold to investors.[3] The

[2] Other papers that examine the securitization process include Glaeser and Kallal (1997) and Riddiough (1997).
[3] While DeMarzo (2005) and other discuss the inclusion of lenders into the process, it does not add anything to our paper.

actual CMBS market is more complex than typically portrayed in the aforementioned studies and include entities with special expertise, such as lender/loan seller, loan underwriter, CMBS issuer, CMBS underwriter, master servicer, special servicer and rating agency.[4] These additional entities serve to more effectively manage risk.

The average CMBS deal has over $1 billion in underlying assets (commercial mortgage loans) and the average number of commercial mortgage loans in a deal pool is 150. The average commercial mortgage loan size is $7.4 million. A typical CMBS is formed when an issuer deposits commercial mortgage loans into a trust[5]. The issuer then creates a series of tranches (bonds) backed by the loans and create the senior-subordinated debt structure. The tranches have varying credit qualities from AAA, AA (senior tranche), to BB, B (subordinated) and to unrated (first loss)[6] given that any return of principal generated by amortization, prepayment and default is allocated to the highest-rated tranche first and then the lower-rated tranches, while any losses that arise from a loan default is charged against the principal balance of the lowest-rated tranche that is outstanding (first loss piece).[7] Any interest received from outstanding principal is paid to all tranches[8]

3.1 CMBS Subordination

[4] In order to reduce problems related to fraud and negligence in underwriting, the deals contains representations and warranties protecting investors.
[5] The loans could be bought from traditional lenders, portfolio holders or from conduit loan originators.
[6] Many CMBS deals also have an interest only (IO) tranche which absorbs excess interest payment.
[7] This type of structure is often referred to as the "reverse waterfall" structure.
[8] It is noteworthy that many CMBS deals vary from this simple structure. For more information, see Sanders (1999) and Darrell (2001). Also see Sanders (1999), Geltner and Miller (2001), Wheeler (2001) for other issues such as commercial mortgage underwriting, form of the trust, servicing, commercial loan evaluation, etc.

For each CMBS tranche, subordination level is defined as the proportion of principal outstanding of other tranches with lower rating. It reflects "credit support" of that tranche. Rating agencies play a key role in determining subordination levels at deal cutoff. Typically, the CMBS issuer proposes a debt structure, and the rating agencies work independently to examine whether the proposed structure can assure the tranches to reach certain ratings, such as AAA, AA, A, BBB etc. If not, rating agencies usually suggest the issuer to remove certain loans from the pool or change the amount of tranches in order to assign specific ratings to the tranches[9]. CMBS investors rely on the quality certification given by rating agencies and tell credit quality differences between different tranches mainly by their ratings[10].

Each rating agency has its own internal model in determining subordination levels. However, the general framework is approximately the same. Rating agencies perform three levels of analysis: 1) on the property level, based on commercial mortgage loan underwriters' cash flow report, rating agencies adjust property net operating income (NOI) based on their own judgments of whether the number in underwriting report is sustainable given the current market condition and deduct capital items such as capital reserves, tenant improvement and leasing commissions to form the so called net-cash flow (NCF). Rating agencies then calculate property value using their own capitalization rates, which could be different from the current market capitalization rate[11]. Rating agencies then calculate their "stressed" LTV and DSCR for each loan and feed their

[9] Usually two or more rating agencies are invited to CMBS rating and the proposing-revision process for subordination goes recursively. Moody's, Standard and Poor's and Fitch are currently three major CMBS rating agencies.
[10] Rating agencies also monitor each CMBS bond after its issuance, and like in corporate bond market, they upgrade and downgrade some bonds according to the change in the CMBS pool performance.
[11] For example, Moody's uses a stabilized cap rate to try to achieve a "through-the-cycle" property value.

stressed LTVs and DSCRs into a loss matrix to form the basic credit support assessments. 2) On the loan level, rating agencies look at borrower quality, amortization, cash management, cross- and over-collateralization to make adjustment to their basic credit support assessments. After doing this, rating agencies aggregate their analysis into the pool level and assign subordination to each proposed CMBS tranches[12]. 3) Finally rating agencies perform portfolio level analysis, which examines pool diversity, information quality and legal and structural issues, and makes final adjustment to subordination levels for each CMBS bond.

It is noteworthy that there is no standard for subordination design. Each rating agency is using a "learning by doing" approach as the industry develops (Riddiough 2004). A stylized fact about subordination is that subordination levels have declined systematically since 1997. Researchers argue that this decline is the result of rating agencies being overly conservative at the beginning of the CMBS market development, and when the ratings agencies develop greater familiarity with the product and the market, they apply less stringent subordination criteria (Sanders, 1999, Geltner and Miller, 2001, Wheeler, 2001 and Downing and Wallace, 2005).

4. Research Question and Empirical Approach

DeMarzo (2005) argues that if there is a beneficial risk diversification effect of pooling, the intermediary can issue a low-risk debt security from a large pool as well as a higher-risk debt security. The low-risk debt security is less sensitive to the intermediary's private

[12] Although rating agencies perform property and loan analysis mainly on individual basis, they sometimes only review a random sample (40-60%) of the loans when number of mortgages in the pool is large, the pool was originated with uniform underwriting standards and the distribution of the loan balance is not widely skewed.

information and, as a result, is more liquid. But how does the financial intermediary (in conjunction with the ratings agencies) determine subordination required to create a low-risk (AAA) security? Stated differently, what subordination level is sufficient to convince investors that the security is less sensitive to the intermediary's private information?

The first question we want to address is what characteristics the financial intermediary and rating agency finds compelling to reduce investor losses on the low-risk security. A parallel question concerning CMBS subordination design is whether cross sectional differentials in subordination reflect differences in credit risks of CMBS pools.

CMBS bond subordination should reflect bond lifetime CMBS pool expected loss. Although rating agencies try to incorporate the analysis of future market trend into the subordination design, precisely predicting CMBS deals' potential loss in a long horizon is a very challenging job. For example, increasing volume of studies has shown that it is the contemporaneous loan-to-value ratio (LTV) and debt-service-coverage ratio (DSCR) rather than original LTV and DSCR that determines commercial mortgage default risk[13] (Vandell et al, 1993, Archer et al, 2001, Ambrose and Sanders, 2003, Ciochetti et al 2003, Ciochetti et al 2002, Chen and Deng, 2003 and Deng, Quigley and Sanders, 2005). Although rating agencies have been trying other static variables very different from original LTV and DSCR[14], there have been concerns about the accuracy of using some "one-shot" static control variables in the long horizon prediction.

[13] It is argued that original LTV and DSCR might be endogenous to commercial mortgage default risk, e.g. because commercial mortgage loan origination is a negotiation process, when a lender/originator perceives that a commercial mortgage has higher risk than usual, one important instrument he would use is to adjust the amount of loan he issues, which results in a lower LTV and higher DSCR.

[14] Some rating agencies use their own stressed LTV and DSCR ratios, which may be very different from the original LTV and DSCR used here.

4.1 The Deal Subordination Regression

In order to address this concern, we propose an empirical test based on a deal level. In this deal level analysis, we examine how AAA and BBB bond subordination levels are related to deal level credit and non-credit variables. Following linear regression model is estimated based on observations measured at deal cutoff point:

$$S_i = \alpha + X_i\beta + \varepsilon_i, \qquad i = 1, \cdots n \tag{1}$$

where S_i is AAA/BBB subordination level of deal i, X_i is a vector of deal credit and non-credit variables including DSCR, over-collateralization, property type composition, prepayment constraints and loan size concentration measures. ε_i is the normally distributed disturbance.

We pay special attention to the roles of original LTV and original DSCR. Due to the reasons discussed in above, we expect these two factors to be insignificant on AAA and BBB subordination. We also include deal cutoff dummies to measure how the subordination levels and their determinants are varying over time. By estimating this model, we can infer what kind of factors explain the cross sectional variations in subordination.

4.2 The Chow Test for Structural Change

To capture the potential shift in subordination levels contracts over time due to the empirical observation that CMBS issuers and rating agencies tend to be conservative

in the early stage of CMBS market development, and are becoming less stringent with subordination design[15], we also run a model with time trend:

$$S_i = \alpha + X_i\beta + D_i\gamma + \varepsilon_i, \qquad i = 1, \cdots n \tag{2}$$

where D_i is a set of dummy variables for cut off year.

However, model 2 implies a restriction that rating agencies will use constant weights in their credit rating matrices when the market is changing over time. Given the existing literature on credit rating agencies' "learning by doing" behavior (Sanders 1999, Geltner and Miller 2001, Riddiough 2004, and Downing and Wallace 2005), such restriction is highly unrealistic. To test the "learning by doing" hypothesis, we follow the standard Chow test procedure to test potential structural change during our sampling period (Greene, 2003). Basically we perform F-tests on the constraint model and the unconstraint model. The test statistics are:

$$F(J, n_1 + n_2 - 2k) = \frac{\left(e^{*\prime}e^{*} - e^{1\prime}e^{1} - e^{2\prime}e^{2}\right)/J}{\left(e^{1\prime}e^{1} + e^{2\prime}e^{2}\right)/\left(n_1 + n_2 - 2k\right)}, \tag{3}$$

where e^{*} is the residual vector from the constraint model, e^{1} and e^{2} are residual vectors from the unconstraint models based on the pre-structural change and post-structural change sub-samples. J is the number of constraints; n_1 and n_2 are the numbers of observations in the pre-structural change and post-structural change sub-samples; and k is the number of explanatory variables in the unconstraint models.

5. Data

[15] See Sanders (1999), Geltner and Miller (2001), Riddiough (2004), and Downing and Wallace (2005) for a discussion.

We construct a dataset on CMBS deals based on information collected from CMBS.COM[16]. The raw database contains 718 CMBS deals and it covers virtually all CMBS deals made in US during the period of 1995 to early 2005. The data collection point is April 1, 2005. For each deal, we have detailed information on deal characteristics, such as cutoff date, balance, LTV, DSCR, AAA and BBB subordinations, property type composition, etc. Current (data collecting point) values of LTV, DSCR, balance, AAA and BBB subordinations are also recorded.

We focus on conduit deals and those deals with all fixed rate loans underlying the pools. Conduit deals are those deals with underlying commercial mortgage loans originated for the sole purpose of securitization[17]. Conduit deals usually have more uniform underwriting standards than other deals such as portfolio deals and single borrower deals. Our final sample contains 350 observations, which is 48.75% of the raw sample.

Table 1 shows the cut off year distribution of these 350 conduit deals. In 1995, there are only 2 deals in our sample, while in 2004, there are 62 deals. Table 1 also shows the percentage of conduit deals as of all deals in each year. It shows increasing popularity of conduit deals over time.

Table 2 reports the descriptive statistics of the 350 deals. On average, there are 150 commercial mortgage loans underlying each deal. The minimum number of loans underlying the deal is 28, and some deals have hundreds of loans underlying them. CMBS deals are huge, with an average cutoff balance of $1,110 million. The largest deal has a cutoff of $3,723 million. AAA subordination levels range from 9% to 37%, and

[16] The company was sold to Standard & Poor's first and later to Backshop.
[17] In contrast, another important type of deals, portfolio deals, have underlying loans originally held in whole loan form by lenders or other investors and then sold to CMBS issuers.

BBB subordination levels range from 0% to 17%. The average AAA subordination level is 21 percent. The weighted average LTVs at cutoff are between 43% and 77%, which reflects much lower LTVs of commercial mortgage loans than those of residential loans. The mean cut off debt-service-coverage ratio (DSCR) is 1.57. CMBS.com also report the estimated LTV at maturity of each deal, which is a proxy for balloon risk. The average estimated LTV and maturity is 57%. On average, about 2 percent of loans have over-collateralization. CMBS loans are of various property types. Usually a deal contains different property type loans. The property type composition is shown in table 2. Most CMBS loans have prepayment constraints, such as yield maintenance, lock out and defeasance. The coverage measures shown in table 2 are calculated as the weighted average mortgage term (in months) covered by lockout, yield maintenance and defeasance. Early originated commercial mortgage loans usually have lock out terms, which covers 28% of the sample months. Since 2003, defeasance has become a very popular form of prepayment constraint, which covers over 50 percent of our sample months. In fact, some investors regard defeasance as a way to get around prepayment constraint, since it allows the borrower to refinance the loan as long as treasury securities are used to replace the underlying property as collateral.

6. Results

6.1 Regression results

Table 3 reports regression results of both AAA and BBB subordination levels. Since credit risk is the most important concern of CMBS investments, and rating agencies are reported to pay special attention to DSCR, we first run the simple models that include

only DSCR and an intercept as explanatory variables (model 1)[18]. The results show that DSCR is indeed a very important variable in subordination design. It is negatively related to both AAA and BBB subordination levels, and it has substantial explanatory power of subordination levels. Variation in DSCR explains about 30 percent of variations in both AAA and BBB subordination levels.

In the more complicated model, we add a number of variables. For example, we add estimated LTV at maturity as a measure of balloon risk; we add property composition variables; we also include prepayment constraint variables. Most of the relationships seen from the estimates are conforming to expectation, e.g. the higher the percentage of retail, anchored loans, the lower the subordination levels are (multifamily loan share is omitted as a reference); while the higher the percentage of self-storage loans, the higher the subordination levels are. In addition, yield maintenance coverage is negatively related to subordination levels, because it mitigates prepayment risk. On the contrary, defeasance coverage is significant and positive possibly because defeasance gives the borrower the option to refinance and thus introduces refinance risk to CMBS investors. There are some surprises: over-collateralization has no impact on CMBS subordination levels, although we know it reduced commercial mortgage credit risk. Share of office loans is negatively related to subordination levels, which contradicts with common wisdom that office loans are riskier than multifamily loans. The share of top 5 loans is negatively related with subordination levels, which is contrary to the notion that diversification helps reduce credit risk. However, one possible explanation for this surprise is that the share of top 5 loans is correlated with shares of loans in California, which are less risky. The BBB

[18] We don't include the cutoff LTV in our model because it is highly correlated with DSCR.

subordination model generally has the same results, although property types seem to be less important.

The overall fitting of the models is quite strong. The simple linear regression models explain nearly 90 percent of variations in AAA subordination levels and nearly 80 percent of variations in BBB subordination levels.

Existing literature suggest that subordination levels contracts over time because CMBS issuers and rating agencies tend to be conservative in the early stage of CMBS market development, and are becoming less stringent with subordination design (Sanders 1999, Geltner and Miller 2001, Riddiough 2004, and Downing and Wallace 2005). Therefore, we perform additional analysis of subordination with time trend. The results are shown in table 4. In the first set of models, including a simple time trend as an explanatory variable suggests that subordination levels contract 1.5 percent every year. In the second set of models, we use year dummies rather than a simple time trend. The results are consistent with the simple time trend model – we see a monotonically decreasing subordination levels reflected in the dummy variable coefficients. Other results do not change in the time trend model comparing to the base model in table 3.

6.2 Structural Change and Chow tests

The debt market has experienced important changes during our study period of 1995 to 2005 both internally and externally. For example, the Russian bond default in 1998 caused “flight to quality” in the debt market (reflected by the widening of credit spread late 1998 and early 1999 in Figure 1 “Bond rates and credit spread”); during 2001 and 2002, the economy experienced a recession (reflected by the surge of credit spread in

2002 in Figure 1 “Bond rates and credit spread”) and the yield slope was very steep during the period (Figure 2 “Interest rates and yield slope”); and starting from 2003, the commercial mortgage market saw important changes such as the rising popularity of defeasance. Therefore, we want to examine whether there are structural changes in subordination design.

We first stratify the sample into four sub-samples, and run separate models with each sub-sample. The results are shown in table 5. Generally, the models are stable over time. For example, DSCR is consistently significant in the AAA subordination level model, and the share of industrial loans is also negatively significant during all four sub-periods. For AAA subordination, the only change comes from the prepayment constraint variables. Changing from the 1995-1998 period to the 1998-1999 period, yield maintenance becomes significant. Defeasance becomes a significant variable only starting from 2001. In BBB subordination level models, DSCR seems not to be a significant factor during the periods of 1995-1998 and 2001-2002. The share of limited service hotel loans has a significant positive impact during 1995-1998, but becomes insignificant afterwards. The stratified sample results suggest that the intercept changes substantially over time.

In addition to the stratified sample regressions, we perform the Chow tests for structural changes. The results are summarized in table 6. For AAA subordination, the first set of tests show that the hypotheses of no parameter change at 1998, 2000 and 2002 are rejected. Further tests show that changing from the 2001-2002 period to the 2003-2005 period, the parameter change only comes from the intercept. At the break point of the end of 1998, only the intercept and the yield maintenance coefficient change, and at

the break point of 2000, only the intercept and the defeasance coefficient change. These results are consistent with previous stratified sample results, and show that rating agencies probably only shifted the overall subordination levels over time rather than changed their models according to changes in the CMBS market.

The Chow tests on BBB subordination level models show that at the break points of 1998 and 2000, the models do not change at all. In addition, only the intercept changes from the 2001-2002 period to the 2003-2005 period.

7. Conclusion

Subordination plays an important role in the senior-subordinated structure of securitized transactions such as CMBS. Optimal subordination design is in the interests of CMBS investors, issuers and rating agencies because subordination levels determine how investors buying senior CMBS bonds are protected from credit risk and how much an issuer can get out of a certain commercial mortgage pool. Rating agencies essentially decide subordination levels for each CMBS deal.

We perform cross sectional tests of differentials in CMBS subordination levels. The results show that CMBS deal cutoff DSCR, property type composition and prepayment protection are significant factors for CMBS bond subordination, and they explain about 90 percent of cross sectional variations in AAA subordination levels and about 80 percent of variations in BBB subordination levels; surprisingly, cutoff LTV and DSCR themselves explain about 30% of the variations in subordination. In terms of evolution of subordination levels, we observe that subordination levels have declined over time and that the primary drivers of subordination have changed as well. In

particular, the growth of defeasance as a tool for prepayment protection has been observed.

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Table 1: Cutoff Year Distribution of the CMBS Conduit Deals in Our Sample

Year	Frequency	Percentage	Percentage of all deals in the year
1995	2	0.57	6.67
1996	10	2.86	19.61
1997	24	6.86	41.38
1998	35	10.00	47.95
1999	37	10.57	44.58
2000	30	8.57	44.78
2001	40	11.43	66.67
2002	38	10.86	63.33
2003	56	16.00	62.92
2004	62	17.71	63.27
2005	16	4.57	76.19
Total	350	100	

NOTE: All data are from CMBS.com. Data collecting date is April 1, 2005. The above 350 deals are conduit deals with all fixed rate loans underlying the deals.

Table 2: Descriptive Statistics of Our Sample Deals

Variable	Mean	Std Dev.	Minimum	Maximum
Number of assets at cutoff	150	78	28	664
Deal cutoff balance (000s)	1,110,103	514,808	77,962	3,722,686
AAA subordination	0.21	0.06	0.09	0.37
BBB subordination	0.07	0.04	0.00	0.17
Cutoff LTV	0.68	0.04	0.43	0.77
Cutoff DSCR	1.57	0.25	0.92	3.13
Estimated LTV at maturity	0.57	0.08	0.22	1.54
Over-collateralization	0.02	0.08	0.00	0.83
Share of multifamily loans (in $)	0.21	0.12	0.00	1.00
Share of retail, anchored loans	0.26	0.13	0.00	0.64
Share of retail, unanchored loans	0.07	0.08	0.00	0.65
Share of office loans	0.24	0.12	0.00	0.59
Share of industrial loans	0.08	0.05	0.00	0.32
Share of healthcare loans	0.01	0.05	0.00	0.82
Share of full service hotel loans	0.03	0.04	0.00	0.18
Share of limited service hotel loans	0.03	0.05	0.00	0.39
Share of self-storage space loans	0.02	0.03	0.00	0.27
Share of mixed use property loans	0.03	0.04	0.00	0.31
Share of mobile home loans	0.03	0.03	0.00	0.19
Share of warehouse loans	0.01	0.02	0.00	0.19
Share of other property loans	0.00	0.01	0.00	0.09
Share of amount of the largest loan	0.09	0.06	0.02	0.40
Share of amount of the 5 largest loan	0.27	0.10	0.09	0.66
Yield Maintenance coverage	0.58	0.23	0.05	0.96
Lock out coverage	0.28	0.24	0.00	0.91
Defeasance coverage	0.51	0.26	0.00	0.94
Number of deals		350		

NOTE: Cutoff LTV and cutoff DSCR are from the CMBS.com database, which are calculated as weighted average of loan LTV and DSCR of all loans in each specific CMBS pool at cutoff. Estimated LTV at maturity is also from CMBS.com, and is a proxy measure of balloon risk.

Table 3: Estimates of the CMBS Deal Subordination Models

Dependent variable: AAA/BBB subordination at cut off

	AAA subordination		BBB subordination	
	Model 1	Model 2	Model 1	Model 2
Intercept	0.436***	0.431***	0.198***	0.188***
	(0.018)	(0.018)	(0.011)	(0.014)
Cutoff DSCR	-0.145***	-0.034***	-0.081***	-0.021***
	(0.012)	(0.006)	(0.007)	(0.005)
Estimated LTV at Maturity		0.029		0.001
		(0.018)		(0.014)
Over-collateralization		0.016		0.022
		(0.02)		(0.016)
Share of retail, anchored loans		-0.072***		-0.009
		(0.016)		(0.012)
Share of retail, unanchored loans		-0.028		-0.001
		(0.022)		(0.017)
Share of office loans		-0.051**		-0.020
		(0.016)		(0.012)
Share of industrial loans		-0.214***		-0.033
		(0.032)		(0.024)
Share of healthcare loans		0.012		0.045*
		(0.028)		(0.021)
Share of full service hotel loans		0.022		0.000
		(0.037)		(0.028)
Share of limited service hotel loans		0.034		0.105***
		(0.033)		(0.025)
Share of self-storage property loans		0.109*		0.051
		(0.054)		(0.042)
Share of mixed-use property loans		-0.028		-0.012
		(0.032)		(0.025)
Share of mobile home loans		0.000		-0.034
		(0.042)		(0.032)
Share of warehouse loans		-0.151*		-0.092
		(0.066)		(0.051)
Share of other loans		0.244*		0.004
		(0.11)		(0.085)
The largest loan weights over 15%		0.001		-0.004
		(0.005)		(0.004)
Share of top 5 loans		-0.074***		-0.064***
		(0.02)		(0.015)
Yield maintenance coverage		-0.279***		-0.160***
		(0.022)		(0.017)
Lock out coverage		-0.002		-0.003
		(0.006)		(0.005)
Defeasance coverage		0.085***		0.067***
		(0.02)		(0.015)
N	350	350	350	350
Adjusted R-Square	0.3079	0.8707	0.2962	0.7622

NOTE: These are OLS estimates. Standard errors are in parentheses. *** for p<0.001; ** for p<0.01; * for p<0.05. We exclude from the regressions some deal level information such as cut of LTV, number of loans, and cut off balance because of multi-collinearity problem.

Table 4: Estimates of the CMBS Deal Subordination Models with Time Trend
Dependent variable: AAA/BBB subordination at cut off

	AAA Subordination		BBB Subordination	
	Model 1	Model 2	Model 1	Model 2
Intercept	0.413***	0.403***	0.183***	0.180***
	(0.016)	(0.017)	(0.014)	(0.015)
Cutoff DSCR	-0.031***	-0.038***	-0.020***	-0.017***
	(0.006)	(0.006)	(0.005)	(0.005)
Estimated LTV at Maturity	0.048**	0.035*	0.006	0.006
	(0.016)	(0.015)	(0.013)	(0.014)
Over-collateralization	0.015	0.019	0.022	0.025
	(0.018)	(0.017)	(0.015)	(0.015)
Share of retail, anchored loans	-0.064***	-0.065***	-0.007	-0.007
	(0.014)	(0.014)	(0.012)	(0.012)
Share of retail, unanchored loans	-0.040*	-0.048*	-0.005	-0.004
	(0.02)	(0.019)	(0.017)	(0.017)
Share of office loans	-0.035*	-0.030*	-0.016	-0.016
	(0.014)	(0.014)	(0.012)	(0.012)
Share of industrial loans	-0.189***	-0.182***	-0.026	-0.037
	(0.029)	(0.028)	(0.024)	(0.025)
Share of healthcare loans	0.021	0.015	0.048*	0.064**
	(0.025)	(0.025)	(0.021)	(0.022)
Share of full service hotel loans	-0.008	-0.010	-0.009	-0.002
	(0.034)	(0.033)	(0.028)	(0.029)
Share of limited service hotel loans	-0.052	-0.050	0.080**	0.072**
	(0.031)	(0.03)	(0.026)	(0.026)
Share of self-storage property loans	0.113*	0.119*	0.052	0.071
	(0.049)	(0.047)	(0.041)	(0.041)
Share of mixed-use property loans	0.003	0.012	-0.003	-0.003
	(0.029)	(0.028)	(0.025)	(0.025)
Share of mobile home loans	-0.035	-0.030	-0.044	-0.046
	(0.038)	(0.037)	(0.032)	(0.032)
Share of warehouse loans	-0.101	-0.032	-0.077	-0.086
	(0.06)	(0.058)	(0.05)	(0.051)
Share of other loans	0.197*	0.080	-0.010	-0.010
	(0.1)	(0.095)	(0.084)	(0.084)
The largest loan weights over 15%	-0.003	-0.006	-0.005	-0.005
	(0.005)	(0.005)	(0.004)	(0.004)
Share of top 5 loans	-0.058**	-0.046*	-0.059***	-0.061***
	(0.018)	(0.018)	(0.015)	(0.016)
Yield maintenance coverage	-0.096**	-0.117***	-0.108***	-0.092***
	(0.029)	(0.03)	(0.024)	(0.027)
Lock out coverage	-0.002	0.003	-0.003	-0.010
	(0.006)	(0.007)	(0.005)	(0.006)
Defeasance coverage	0.049**	0.063***	0.056***	0.049**
	(0.018)	(0.018)	(0.015)	(0.016)
Time trend	-0.015***		-0.004**	
	(0.002)		(0.001)	
YR 97		-0.004		-0.021**

		(0.008)		(0.007)
YR 98		-0.005		-0.013
		(0.008)		(0.007)
YR 99		-0.028***		-0.017*
		(0.008)		(0.007)
YR 00		-0.063***		-0.022*
		(0.01)		(0.009)
YR 01		-0.075***		-0.028**
		(0.011)		(0.01)
YR 02		-0.073***		-0.028*
		(0.012)		(0.011)
YR 03		-0.089***		-0.044***
		(0.013)		(0.012)
YR 04		-0.110***		-0.046***
		(0.015)		(0.014)
YR 05		-0.122***		-0.050***
		(0.017)		(0.015)
N	350	350	350	350
Adjusted R-Square	0.8944	0.9073	0.7677	0.7731

NOTE: These are OLS estimates. Standard errors are in parentheses. *** for p<0.001; ** for p<0.01; * for p<0.05. We exclude from the regressions some deal level information such as cut of LTV, number of loans, and cut off balance because of multi-collinearity problem.

Table 5: Estimates of the CMBS Deal Subordination Models Using Stratified Samples
Dependent variable: AAA/BBB subordination at cut off

	AAA Subordination				BBB Subordination			
Sample period	1995-1998	1999-2000	2001-2002	2003-2005	1995-1998	1999-2000	2001-2002	2003-2005
Intercept	0.426***	0.590***	0.394***	0.332***	0.181***	0.247***	0.184***	0.115***
	(0.032)	(0.047)	(0.028)	(0.02)	(0.031)	(0.03)	(0.03)	(0.019)
Cutoff DSCR	-0.075**	-0.081**	-0.041***	-0.020**	-0.027	-0.055**	-0.014	-0.014*
	(0.024)	(0.025)	(0.01)	(0.006)	(0.023)	(0.016)	(0.011)	(0.006)
Share of retail, anchored loans	-0.040	-0.077*	-0.122***	-0.012	0.007	-0.001	-0.066	0.024
	(0.02)	(0.033)	(0.035)	(0.018)	(0.02)	(0.021)	(0.036)	(0.017)
Share of office loans	-0.003	-0.026	-0.065*	-0.004	-0.018	0.013	-0.083*	0.010
	(0.038)	(0.038)	(0.031)	(0.016)	(0.037)	(0.024)	(0.033)	(0.016)
Share of industrial loans	-0.132*	-0.279***	-0.225***	-0.114*	0.030	-0.042	-0.034	-0.052
	(0.064)	(0.071)	(0.051)	(0.048)	(0.063)	(0.046)	(0.053)	(0.047)
Share of healthcare loans	0.006	0.131	-0.158	0.174	0.038	0.102	-0.066	0.485
	(0.024)	(0.178)	(0.21)	(0.359)	(0.024)	(0.114)	(0.219)	(0.347)
Share of limited service hotel loans	-0.001	-0.100	0.092	-0.118	0.110**	0.086	0.128	0.078
	(0.042)	(0.08)	(0.133)	(0.074)	(0.04)	(0.051)	(0.138)	(0.071)
Share of self-storage property loans	0.151	0.057	0.066	0.070	-0.011	0.004	0.118	0.002
	(0.084)	(0.144)	(0.104)	(0.074)	(0.082)	(0.092)	(0.108)	(0.072)
Share of warehouse loans	-0.205	-0.076	-0.020	-0.061	-0.545	-0.125	-0.063	-0.064
	(0.771)	(0.142)	(0.082)	(0.126)	(0.75)	(0.091)	(0.085)	(0.122)
Share of other loans	0.293	0.360	-0.030	0.170	-0.154	-0.019	0.023	0.145
	(0.17)	(0.234)	(0.231)	(0.139)	(0.166)	(0.149)	(0.24)	(0.135)
Share of top 5 loans	0.026	-0.093	-0.077*	-0.072***	-0.039	-0.083*	-0.043	-0.067***
	(0.031)	(0.049)	(0.037)	(0.018)	(0.03)	(0.031)	(0.038)	(0.018)
Yield maintenance coverage	-0.058	-0.436***	-0.221***	-0.312***	-0.130**	-0.191*	-0.138*	-0.100**
	(0.05)	(0.112)	(0.061)	(0.031)	(0.048)	(0.072)	(0.064)	(0.03)
Defeasance coverage	0.000	0.070	0.169***	0.188***	0.037	0.063	0.078	0.055*
	(0.029)	(0.065)	(0.038)	(0.023)	(0.029)	(0.041)	(0.04)	(0.023)
N	71	67	78	134	71	67	78	134

Adjusted R-Square	0.3107	0.6694	0.5705	0.5359	0.2183	0.4320	0.2055	0.1956

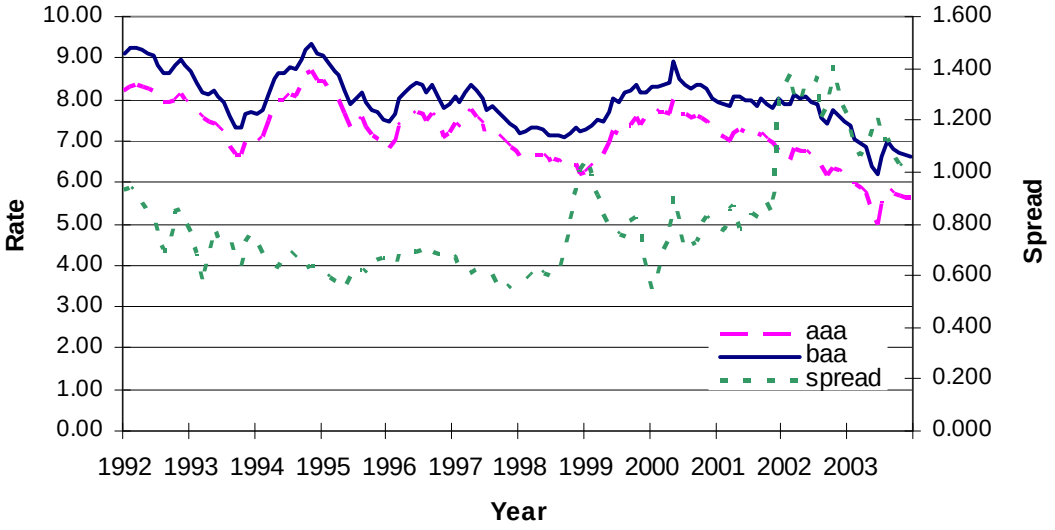
NOTE: These are OLS estimates. Standard errors are in parentheses. *** for p<0.001; ** for p<0.01; * for p<0.05.

Table 6: Chow Tests of Structural Change in Subordination Models

	Test statistics (critical value)		
Panel A: AAA subordination	No change in parameter vector	Change in intercept only	Change in intercept and another coefficient only
Break points			
1998	7.06 (1.8)	2.69 (1.8)	0.52 (1.85) (yield maintenance)
2000	7.05 (1.8)	2.14 (1.8)	0.16 (1.85) (defeasance)
2002	4.61 (1.8)	1.07 (1.8)	
Panel B: AAA subordination			
Break points			
1998	0.63 (1.8)		
2000	0.97 (1.8)		
2002	1.91 (1.8)	0.33 (1.8)	

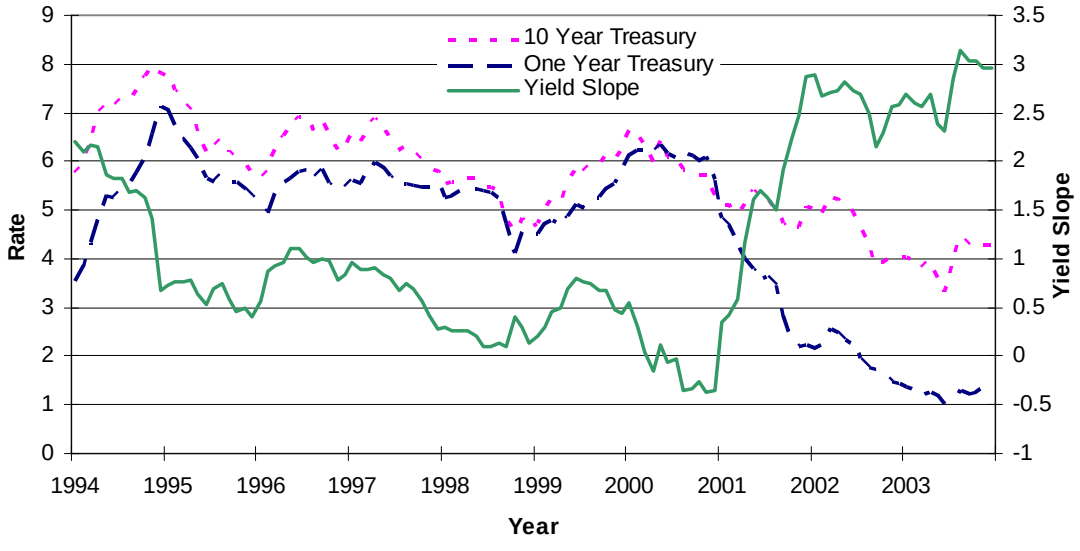
NOTE: The table shows the Chow test statistics together with critical values (in parenthesis) at 95% significance level. From these results, we see there are structural changes of the relationship between AAA subordination levels and deal information in 1998, 2000 and 2002. The intercept and coefficient of the yield maintenance coverage variable change at the end of year 1998; the intercept and coefficient of the defeasance coverage variable change at the end of year 2000; however, only the intercept in the subordination model changes at the year end of 2002. For BBB subordination, the tests reject the hypothesis that the relationships between BBB subordination and deal information change at 1998 and 2000. The only change is a simple shift in the constant term at the end of year 2002.

Figure 1: Bond Rates and Credit Spread



NOTE: Credit spread is defined as the difference between AAA corporate bond rate and BAA corporate bond rate.

Figure 2: Interest Rates and Yield Slope



NOTE: Yield slope is defined as 10 year treasury rate minus 1 year treasury rate.