Determinants of Credit Spreads in Commercial Mortgages

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ABSTRACT

We examine data on over 40,000 commercial mortgages to study the cross-sectional and time-series determinants of credit spreads. Consistent with theory, our empirical evidence indicates that mortgages on property types that tend to be riskier and have greater investment flexibility exhibit higher spreads. Spreads also tend to be higher for properties that have higher ratios of net operating income to value. The evidence, however, indicates that loan to value (LTV) ratios are negatively associated with spreads, which is inconsistent with predictions from theory. This empirical result is likely due to the endogeneity of LTV choice by lenders. We are able to partially resolve this endogeneity problem by introducing a variable accounting for average LTV ratio for each lender, and obtain a positive relation between average LTV ratio per lender and credit spreads. In addition, we provide time-series evidence that spreads decrease with the level of interest rates, and that, after a period of poor performance of the real estate market, spreads increase and LTV ratios decrease.

I. Introduction

Commercial mortgages provide perhaps the best setting for examining default spreads in the fixed income market. In most cases, commercial properties have only one outstanding loan, the loans generally are not prepayable without substantial penalties, and assets that are relatively easy to evaluate collateralize the loans. There is currently more than a trillion dollars of commercial mortgages outstanding and the market is growing, both in the United States and around the world.

This paper empirically examines the determinants of credit spreads for commercial mortgages, i.e. differences between mortgage rates and Treasury Bond rates with the same maturities. Using a data set of over 40,000 individual commercial mortgages, we examine cross-sectional differences in mortgage spreads, i.e. the extent to which mortgages with different characteristics have different spreads, as well as time-series fluctuations in average spreads.

Our cross-sectional tests are motivated by theoretical pricing models developed by Titman and Torous (1989), Kau, Keenan, Muller, and Epperson (1990), and Titman, Tompaidis, and Tsyplakov (2003). The earlier papers present models, which indicate that mortgages on properties that are more volatile and have higher payouts tend to have higher spreads. The more recent Titman, Tompaidis, and Tsyplakov (2003) model shows that mortgages on properties with more investment flexibility, i.e. properties that can be expanded or renovated, should also have higher spreads.[1]

Our empirical results are largely consistent with these theoretical predictions. In particular, properties like hotels and shopping malls, which are likely to be both riskier and have the greatest investment flexibility, have significantly higher spreads than office buildings and multi-family housing, which are likely to be less risky and have less investment flexibility. In

[1]The paper by Eom, Helwege, and Huang (2002) discusses empirical tests of different theoretical models of corporate bond pricing. We refer the reader to that paper for references of prior empirical work on the determinants of spreads of corporate bonds. In the real estate literature there is little prior empirical research on determinants of spreads for commercial mortgages. The papers by Archer, Elmer, Harrison, and Ling (2002) and Ambrose and Sanders (2002) discuss determinants of probabilities of default for commercial properties however.

addition, credit spreads are positively related to the ratio of net operating income to property value (NOI/V), which is also consistent with the models if we assume that a higher NOI/V ratio is indicative of higher payouts.

Our results pertaining to the relation between mortgage characteristics and spreads are more difficult to interpret. We find that shorter maturity mortgages and mortgages with higher loan to value ratios tend to have higher spreads. The observed relation between mortgage spreads and loan to value ratios is especially difficult to reconcile with the predictions from theory and, as we show, is at least partly due to the fact that originators require mortgages with higher down payments and perhaps also shorter maturities on properties that are likely to be risky.

Our empirical model also explains a substantial portion of the time-series variation in spreads which, we show, is considerable. Consistent with existing theory, our evidence indicates that mortgage spreads decrease with increasing Treasury Bond rates. We also find that spreads increase following periods when real estate assets perform poorly. Presumably, these are periods when the financial institutions that provide the mortgages are financially weaker, leading them to compete less aggressively. Moreover, our results indicate that not only do spreads increase during such periods, but required loan to value ratios decline as well. We also find that loan to value ratios tend to increase when the spread between BBB and AAA corporate bond rates increases.

The paper is organized as follows: In Section II we describe the data set. In Section III we discuss the regression variables, the cross-sectional regression equation and describe the cross-sectional results. In Section IV we discuss the time-series regressions and the dependence of mortgage credit spreads on macro-economic variables. Section V summarizes the paper and discusses directions for future research.

II. Data Overview

Our data set, which was provided by Standard & Poor's, includes information on more than 40,000 commercial mortgages. The mortgages originated between 1986 and 2000 with most of the originations taking place in the mid to late 1990s. The mortgages were later pooled and used as collateral for commercial mortgage backed securities (CMBS). Approximately 60% of the mortgages, which are generally referred to as conduit deals, were issued specifically for inclusion in a CMBS. The value of the commercial properties collateralizing the mortgages varies from $200,000 to $125,000,000 and the aggregate value exceeds $400 billion. The mortgages were originated by more than 130 commercial banks, investment banks and insurance companies. The data set includes detailed information on cross-sectional characteristics of individual properties and their mortgage contract specifications.

The property types in the data set include multi-family apartment complexes, unanchored retail, anchored retail, medical offices, industrial, warehouse, mobile home parks, office buildings, properties of mixed use, limited service hotels, full service hotels, and self storage. The most common type is multi-family apartment complexes, which represent 30% of the total number of properties. About half of the mortgaged properties in the data set are located in California, Texas and Florida.

Summary statistics are presented in Table I.

A. Mortgage Characteristics

The data includes the following financial information for individual mortgages: mortgage rate; loan to value ratio; origination date; whether the mortgage is balloon, amortizing, or semi-amortizing; whether the mortgage rate is fixed or adjustable; and the maturity of the mortgage.

The loan to value ratio (LTV) is measured as the loan amount divided by the appraised value of the property. Although the levels of the LTV ratio at origination vary from 20% to 97% in this data set, more than 75% of the loans have LTV ratios between 60% and 80%. Multi-family apartment complexes and anchored retail properties have the highest LTV ratios, while limited service and full service hotels have the lowest. This pattern suggests that LTV ratios are endogenously chosen to account for the riskiness of each property type.

About 93% of the mortgages in the data set are fixed rate mortgages and the rest are adjustable rate mortgages which are excluded from our analysis. Balloon mortgages represent approximately two-thirds of the mortgages with the rest being amortizing and semi-amortizing mortgages. Among the amortizing mortgages, hotels have the fastest amortization rate, while warehouses have the slowest.[2]

The majority of the mortgages have 10 year maturities and, due to prepayment penalties, are effectively not prepayable.[3] The maturities of the mortgages do not appear to differ much by property type.

B. Originator Characteristics

We have information on the originator of the mortgage for 55% of our sample. From the mortgages on which we have information on the originator, approximately 65% are originated by commercial banks and investment banks including 18% by large investment banks, while the remaining mortgages are originated by insurance companies. For the sample that includes information on the originator, twenty institutions originated about 60% of the mortgages. The number of mortgages per originator varies from 1 to 1,500, with 6 originators issuing more than 1,000 mortgages each.

[2]The loan amortization rate is defined as $1 - \frac{\text{Balloon Value}}{\text{Initial Principal Value}}$.

[3]However Ambrose and Sanders (2002) find that commercial mortgages do prepay after a lockout period in ways that suggest that property owners are in fact acting opportunistically. There is no evidence that such behavior should affect mortgage spreads however.

C. Property Characteristics

In addition to financial information, the data set includes information on individual properties at the time of mortgage origination. The information includes the appraised property value, the annual net operating income of the property, the property expenses over the previous year, the occupancy rate, the age of the property, the physical location and the property type.

The occupancy rate is defined as the percentage of square feet or units that is occupied or leased at the date of mortgage origination, or over a specified period prior to mortgage origination. Occupancy rates vary across property types with average occupancy of 100% for warehouses to average occupancy of 75% for limited and full service hotels. Occupancy information is available for only about half of our observations, and because of this, is not included in all regressions.

The age of the properties at the mortgage origination dates ranges between 0 and 150 years, with an average age of 25 years and a median age of 19 years. The average age is approximately the same across different property types.

The Net Operating Income (NOI) is defined as gross annual revenue less maintenance and other operational expenses before taxes and depreciation for the 12 month period prior to the mortgage origination date. It varies, as a percentage of appraised value, from 8.6% for warehouses to 11.5% for full and limited service hotels. The expense to revenue ratio, which we assume provides information on the investment flexibility of a property, ranges from 16.7% for warehouses to 71.4% for medical offices.

III. Cross-sectional Variation of Credit Spreads and Loan to Value Ratios

A. Regression Specification

To capture the variation in credit spreads we first estimate a cross-sectional model for fixed rate mortgages using variables that correspond to property and mortgage characteristics. The model is specified by the regression equation

$$\begin{aligned} \text{Spread} = \text{intercept} &+ \sum a_i(\text{property characteristics variables})_i \\ &+ \sum b_i(\text{mortgage characteristics variables})_i \\ &+ \sum c_i(\text{property type dummy variables})_i \\ &+ \sum d_i(\text{deal type dummy variables})_i \\ &+ \sum e_i(\text{quarterly time dummy variables})_i \\ &+ \varepsilon \end{aligned} \tag{1}$$

where the dependent variable, Spread is the difference between the mortgage rate and the rate on Treasury bonds with the same maturity as the mortgage, observed on the mortgage origination date.

The variables that describe property characteristics include the NOI/Value ratio, the property value, and the age of the property. The NOI/Value ratio proxies for the expected growth of net operating income. Specifically, properties with larger value of NOI/Value ratios are likely to have both higher payouts and lower NOI growth in the future, which in theory should increase credit spreads. In addition, this ratio, which is also related to the rate at which a property depreciates, should be related to the investment flexibility of a property. For properties that depreciate, the owner has the option to reduce maintenance when cash flows decline, and, as we mentioned previously, this flexibility should in theory lead to increases in spreads.

The value of the property captures size effects that can be associated with credit spreads for a variety of reasons. First, there may be economies of scale associated with lower transaction costs in providing a loan to a larger property. Second, larger properties may be associated with borrowers with greater reliability. Finally, bigger properties may also be more diversified and have more market power and hence be less risky.

We introduce the age of a property as a proxy for property quality. Older properties are likely to be of lower quality, and therefore provide the owner with the option to redevelop or to take steps to improve the property. As Titman, Tompaidis, and Tsyplakov (2003) emphasize, this flexibility option is likely to increase spreads. However, for a variety of reasons, lower quality properties may be riskier than high quality properties. Since we expect that the age of a property does not affect spreads linearly, we use dummy variables for different age categories: less than 5 years old, between 5 and 10 years old, between 10 and 20 years old, between 20 and 30 years old, and properties that are more than 30 years old.

The variables that describe the mortgage are the LTV ratio, the amortization rate, the mortgage maturity, and whether the originator is a large investment bank. Based on the contingent claim approach, the value of the LTV ratio should be positively related to the probability of default and the default spread, ceteris paribus. However, the LTV ratio is an endogenous choice that is determined after negotiations between the borrower and the lender. It is likely that lenders require greater downpayment (lower LTV ratio) for borrowers (or properties) that generate riskier cashflows. Therefore, it is possible that riskier properties have lower LTV ratios and hence could have higher spreads than higher LTV mortgages. We run regressions with different LTV specifications to determine how the endogeneity of the LTV choice affects our results. In particular we examine the average LTV ratio of the mortgages originated by the different lenders as well as the difference between the individual mortgage LTV ratios and the average ratio for the loan's originator. Under the hypothesis that different lenders specialize in loans with different levels of risk, the average LTV ratio for the lender proxies for the risk of the loan.

The loan amortization rate and the mortgage maturity measure how fast the loan is paid off. Similar to the LTV variable, these variables are endogenously chosen; lenders may chose higher amortization rates or shorter maturities for riskier loans. Since the effect of maturity of the mortgage on credit spreads is not likely to be linear, we use dummy variables for maturities less than 5 years, between 5 and 10 years and more than 10 years.

In order to capture the clientele effect, we introduce a dummy variable that characterizes the originator of a mortgage. This variable distinguishes whether the originator of the mortgage is a large investment bank. Investment banks such as Lehman Brothers, Merrill Lynch and Bear Sterns, among others, fall into this category. To capture the difference between types of CMBS deals we also include dummy variables that correspond to types of CMBS, such as Conduit, Franchise, Portfolio, etc.[4]

We also use dummy variables for different property types in order to differentiate between the different risk profiles for the different types of properties. We expect properties that are less volatile and require less investment and maintenance, such as multi-family apartment complexes and mobile home parks, to have lower spreads than properties with volatile cash flows and higher maintenance and investment costs such as hotels.

The dummy variables that correspond to the different quarters capture the effect of changes in the macro-economic environment on the mortgage spreads, and we study them separately in Section IV.

B. Cross-sectional Results

The results of our regressions are reported in Table II. Overall, the adjusted R-squared is above 60% indicating that the variables explain a significant portion of the cross-sectional

[4]For example, a Conduit CMBS includes mortgages that were originated with the intent of pooling them in a CMBS. A Franchise CMBS includes mortgages for properties that are franchised, for example gas stations or fast food restaurants. A Portfolio CMBS includes some properties that have been originated several years prior to the issuance of the CMBS and some properties that were originated for inclusion in a CMBS.

variation of the mortgage spreads. In the first specification (columns 1 and 2) of this table we include the LTV ratio as an independent variable. In theory, we expect mortgages with higher LTV ratios to have higher spreads. However, the estimated coefficient of the LTV variable is significantly negative, indicating that mortgages with higher LTV ratios actually have lower spreads. In the second specification (columns 3 and 4 of the table) we examine the robustness of this finding by including dummy variables representing different levels of LTV. The results of this regression indicate that the negative relation between LTV and mortgage spreads is not due to outliers, and is probably due to the endogeneity issue described earlier, i.e. that lenders require more risky borrowers to have lower LTV ratios.[5]

We examine this possibility further in the final regression specification (columns 5 and 6 of Table II). In this regression we test the possibility that different originators tend to specialize in mortgages with given risk levels and thus offer similar spreads. We do this by including a variable that measures the mortgage LTV ratio minus the average LTV ratio of the originator as well as the average LTV ratio of the originator as independent variables. We do this because we observe that individual originators tend to attract different clienteles of more or less risky borrowers. Some originators tend to offer mortgages with lower spreads, and presumably transact with less risky borrowers. Others however charge higher spreads and transact with riskier borrowers. The idea is that the LTV ratio is not likely to predict differences in spreads between the mortgages offered by any individual originator because the originators will require lower LTV ratios for the riskier properties. However, LTV ratios are likely to be positively related to spreads when we look across originators since those originators who are willing to provide riskier loans are likely to attract borrowers that require higher LTV ratios. Consistent with this hypothesis, the average LTV ratio of the originator is strongly positively related to spreads — originators that are willing to offer high LTV mortgages charge higher

[5] A similar finding of endogenous choice of LTV was reported by Archer, Elmer, Harrison, and Ling (2002) where determinants of the probability of default were studied.

spreads. However, for a given originator we still see that higher LTV mortgages have lower spreads.[6]

The estimates of the other independent variables are not substantially affected by the specification of the LTV variable. In particular, we find that the coefficient of the NOI/Property Value ratio is significantly positive indicating that a higher expected growth rate in operating income leads to narrower spreads. Specifically, an increase in the NOI/Value ratio by 1% leads to an increase in spreads of approximately 6-7 basis points. This result is consistent with both the theory that suggests that properties with higher payouts should have higher spreads as well as the theory that suggests that the flexibility to reduce investment should increase credit spreads.

The results also reveal that newer properties have lower spreads, although the relationship is not monotonic. Specifically, compared to properties more than 30 years old, the credit spreads for mortgages on buildings that are less than 5 years old are 14 b.p. lower. However, the spreads are reduced further for properties between 5 and 10 years old, and then increase for older properties. This pattern is consistent with the observation that newer buildings have both less flexibility, which reduces the spread, but require less initial maintenance and thus allow higher payouts, which increases the spread. Buildings between 5 and 10 years old have the lowest spreads because there is very little flexibility (i.e. it is unlikely that one would do a major renovation on a building that is less than 10 years old) but there are maintenance requirements that reduce the amount that the property owner can pay out. As the buildings get older the investment flexibility increases, which increases the spreads.

The coefficients of the dummy variables corresponding to the different property types indicate that multi-family apartment complexes have the smallest spreads, and full and limited service hotels the largest. The difference between the spreads of these two types is approximately 50 basis points. These results are consistent with both volatility and investment flex-

[6]The observed pattern also supports the theory that borrowing rates and spreads are ”sticky” (see Berger and Udell (1992)). Indeed, we seldom observe spreads of newly originated mortgages wider than 4%; while we observe loan to value ratios that range from above 95% to as low as 20%.

ibility being important determinants of credit spreads, since hotels are likely to be the most volatile property type as well as the type offering its owner the highest investment flexibility.

The coefficients for the variables corresponding to the dummy variables for the different ranges of mortgage maturity are both economically and statistically significant. In particular, the shortest term mortgages, with maturities less than 5 years, have the highest spreads while the longest term mortgages have the smallest spreads. On average the spreads of the mortgages with maturities shorter than 5 years are 70 b.p. above the mortgages with maturities longer than 10 years. This result is consistent with an endogenous choice of mortgage maturity, where riskier properties are given mortgages with shorter maturities and higher spreads.

The coefficient of the logarithm of property value is significant and negative, indicating that economies of scale lead to lower spreads for bigger properties. This finding is also consistent with the assumption that default risk or default costs are expected to be lower for larger borrowers. However, the magnitude of the effect is quite small; the expected discount between the largest property in the data, with a value of $125,000,000, and the smallest, with a value of $200,000, is only about 1.5 basis points.

Regarding mortgage originators, our results indicate that mortgages provided by large investment banks have spreads 3-4 basis points lower than other mortgages. While the magnitude of this effect is relatively small, the result is consistent with the intuition that lenders with a higher volume of mortgages can charge slightly lower rates because they are either more efficient, or are able to attract better quality borrowers.[7]

In results we do not report, we have checked that our analysis holds for different subsamples of the data. These include samples with only conduit CMBS, multi-family apartment complexes, office buildings, and a sample of mortgages originated between 1993 and 2000, when our data is more reliable. Our main results hold on all of the various subsamples.

[7]The t-statistic of the coefficient may be overstated due to the large number of mortgages issued by the individual investment banks relative to other originators.

C. Cross-sectional Determinants of Loan to Value Ratios

In addition to studying the determinants of spreads, and in light of the interplay between spreads and LTV ratios, we have performed a cross-sectional regression to understand the determinants of LTV ratios. The specification of the regression is given by

$$\begin{aligned} \text{LTV Ratio} = \text{intercept} &+ \sum a_i(\text{property characteristics variables})_i \\ &+ \sum b_i(\text{mortgage characteristics variables})_i \\ &+ \sum c_i(\text{property type dummy variables})_i \\ &+ \sum d_i(\text{deal type dummy variables})_i \\ &+ \sum e_i(\text{quarterly time dummy variables})_i \\ &+ \varepsilon \end{aligned} \tag{2}$$

where the independent variables are the same as in the regression equation 1.

From the results, reported in Table III, we note that the NOI/Value ratio appears to be the most important determinant of LTV ratios, with an increase of 5% in the NOI/Value ratio resulting in an increase of 16% in the LTV ratio. This relationship indicates that properties with higher NOI are able to secure larger mortgages, possibly due to their achieving better debt service coverage ratios for any given LTV ratio. Age is also a determinant of LTV ratios: properties that are less than 5 years old have, on average, have LTV ratios that are 4.2% above LTV ratios for properties that are over 30 years old. Mortgages on mixed use properties and multi-family apartment complexes have higher LTV ratios, and medical offices, limited service hotels and full service hotels have lower LTV ratios.[8]

The maturity of the mortgage appears to have little influence on the LTV ratio, while the value of the property, although statistically significant, only affects LTV ratios by a small amount. For example, the expected difference in LTV ratios between a $125,000,000 property

[8]From Table I, we note that the property types with the lowest LTV ratios also have the highest expense to revenue ratios.

and a $200,000 property is 0.2%. Finally, mortgages that amortize faster have lower LTV ratios, an indication of endogenous selection of the amortization rate by lenders.

IV. Time Series Effects

As we mentioned in the last subsection, our cross-sectional regressions include quarterly dummy variables that capture macro-economic fluctuations that can affect default spreads. In this section we examine these fluctuations in more detail by regressing the coefficient estimates of the dummy variables from our cross-sectional regression on a variety of macro-economic variables. This two-stage procedure is necessary in order to correctly calculate the t-statistics for the coefficients of the macro-economic variables.

The macro-economic variables we examine include the level of interest rates, the spread between AAA and BBB corporate bond rates, the performance of real estate assets in the previous year, and the cumulative write offs of loans on commercial property and of all loans in the previous year. These independent variables are regressed on the coefficients of the quarterly time dummy variables estimated in the regressions described in Tables II, III, as shown below

$$\begin{aligned}\text{Spread Quarter Dummy} = \text{C} &+ a \times \text{10 year Treasury rate} \\ &+ b \times \text{Spread between AAA and BBB} \\ &+ c \times \text{One year Cumulative Write offs for Commercial Property Loans} \\ &+ d \times \text{One year Cumulative Write offs for All Loans} \\ &+ e \times \text{NCREIF Return over the Previous Four Quarters} \\ &+ \varepsilon \end{aligned} \tag{3}$$

$$\begin{aligned}\text{LTV Quarter Dummy} = {} & \text{C} + a \times \text{10 year Treasury rate} \\ & + b \times \text{Spread between AAA and BBB} \\ & + c \times \text{One year Cumulative Write offs for Commercial Property Loans} \\ & + d \times \text{One year Cumulative Write offs for All Loans} \\ & + e \times \text{NCREIF Return over the Previous Four Quarters} \\ & + \varepsilon \end{aligned} \tag{4}$$

The dependent variables in the above regression represent average deviation from the predicted default spread or LTV ratio in a given quarter. Interest rate, measured by the 10 year Treasury rate, should theoretically lead to a decrease in spreads (see Titman and Torous (1989), and Titman, Tompaidis, and Tsyplakov (2003)). The spread between AAA and BBB rates can be viewed as either a proxy for the liquidity of the credit markets, or, alternatively, the risk of the overall economy. The NCREIF index return, as well as the cumulative write offs of commercial property loans measure both the riskiness of the real estate market as well as the financial health of mortgage originators. The cumulative write offs for all loans measure the riskiness of the overall market. Summary statistics for these variables are presented in Table IV.

The time series regression results, corrected for first-order autocorrelation of the residuals, are presented in Tables V and VI. Our regression estimates indicate that these independent variables explain about half of the observed variation in credit spreads and LTV ratios.

Table V reveals that an increase in interest rates results in a decrease in spreads. Specifically, the estimates suggest that a 100 basis point increase in Treasure rates results in about a 45 basis point decrease in spreads. This change in spreads is too large to be fully attributed to the theoretical effect described in Titman and Torous (1989) and Titman, Tompaidis, and

Tsyplakov (2003), and probably also reflects the decline in LTV ratios that also correspond to increases in Treasury rates. Table VI reveals that a 100 basis point increase in Treasure rates results in a 1.5% decrease in LTV ratios. The decrease in LTV ratios can be probably attributed to interest coverage requirements which are more likely to be binding constraints when interest rates are high.

Our results also indicate that the AAA-BBB spread does not influence mortgage spreads. This is somewhat surprising since the commercial mortgage rates are similar to BBB corporate rates. One possibility is that LTV ratios are reduced when the AAA-BBB spread widens. However, we find that an increase in this spread actually results in higher LTV ratios. This result could be driven by the fact that commercial real estate is easier to value and has higher recovery rates in the event of financial distress than most corporate assets, making it more attractive as collateral in periods when the AAA-BBB spread is high and the economy is very uncertain. Another possibility is that when uncertainty is high borrowers are able to obtain financing for only the least risky properties.

The coefficients of the remaining variables indicate that following poor financial performance of either the real estate market, or the overall credit market, spreads increase and collateral levels go up, i.e. LTV ratios go down. This behavior is consistent with either an increased risk for the real estate and credit markets, or, with decreased competition for the provision of financial capital to the real estate markets following poor financial performance.

V. Summary and Conclusions

The theoretical relation between credit spreads on fixed income instruments and the characteristics of both the contracts and the collateral is now pretty well understood. However, in order to apply and improve existing models, we need to have a better understanding of what determines these credit spreads empirically.

Our analysis of commercial mortgages provides evidence that is largely consistent with the theoretical predictions. In particular, property with characteristics that should in theory be associated with higher spreads, e.g. proxies for risk, payouts and flexibility, are in fact associated with higher spreads. However, we also uncover some challenges that should be examined further in future research. In particular, the evidence relating to loan characteristics and spreads is difficult to interpret because of an endogeneity problem. Our evidence indicates that riskier properties generally require higher down payments and shorter mortgage maturities.

Our time-series evidence suggests that the characteristics of the originators can affect the competitiveness of the mortgage market and this can in turn affect default spreads as well as required loan to value ratios. We find that the past performance of real estate markets, which is likely to affect the ability of financial institutions to originate new loans, has a strong effect on the time-series variation of default spreads as well as mortgage collateral requirements. Our analysis of the time-series pattern of loan to value ratios suggests that endogeneity issues may also affect observed fluctuations in credit spreads.

Our findings suggest a number of avenues for future research. In addition to further work on the above mentioned endogeneity issues we plan to investigate whether the increase in spreads and decrease in LTV ratios following poor financial performance is solely due to an increased level of risk for real estate investments, or whether the credit available for such investments shrinks after poor performance, leading to less competitive markets. While the relation between the financial health of financial institutions and credit spreads is outside the purview of existing fixed income pricing models it is an area that should be considered for future research.

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Table I
Summary Statistics: Mortgage and Property

Average property characteristics and mortgage characteristics for different property types. The averages are listed by property type as well as over the entire sample. Property value is measured in millions of dollars. NOI/V is the net operating income to value ratio, Exp/Rev is the expense to revenue ratio, LTV is the loan to value ratio, Spread is the difference between the mortgage rate and the corresponding Treasury rate measured in basis points, Amort is the amortization rate measured as 1 - Balloon/Principal, Occ is the occupancy rate of the property at mortgage origination, Age is the age of the property at mortgage origination, Maturity is the maturity of the mortgage measured in years, and Perc is the percentage of mortgages for each property type.

Property Type	Value	NOI/V	Exp/Rev	LTV	Spread	Amort	Occ	Age	Maturity	Perc
Multi-family	5.6	9.5%	45.4%	71.9%	213	20%	95%	28.6	11.0	29.9%
Retail Unanchored	3.4	9.5%	25.9%	68.6%	231	22%	96%	23.7	11.1	25.3%
Retail Anchored	15.4	9.3%	27.5%	70.5%	210	18%	96%	21.1	10.9	8.4%
Medical office	8.9	10.9%	71.4%	64.8%	252	23%	92%	27.5	10.6	1.7%
Industrial	6.6	9.6%	23.2%	67.1%	220	21%	97%	22.9	11.2	6.5%
Warehouse	8.3	8.6%	16.7%	55.8%	237	14%	100%	24.3	11.9	0.7%
Mobile Home	5.0	8.8%	42.8%	67.5%	204	17%	95%	26.4	10.5	2.7%
Office	14.3	9.5%	35.4%	66.6%	220	17%	96%	24.2	10.7	10.4%
Mixed Use	15.9	9.5%	35.1%	64.8%	240	24%	95%	24.5	10.6	6.4%
Limited Service Hotel	10.0	11.7%	63.1%	64.5%	256	34%	75%	23.5	11.0	4.3%
Full Service Hotel	44.8	11.5%	68.1%	62.8%	262	21%	75%	28.2	10.7	1.1%
Self Storage	3.9	9.6%	36.6%	64.9%	250	21%	90%	25.3	10.8	2.5%
All Types	7.9	10.1%	39.3%	69.4%	222	20%	94%	25.8	10.9	100%

Table II
Cross Sectional Regression: Spreads

Three cross-sectional regressions, with different specifications for the loan to value ratio (LTV). The dependent variable is the spread between the mortgage rate and the corresponding Treasury rate measured in percentage points. In addition to the variables reported in the table, the explanatory variables also include dummy variables for the CMBS deal type and quarterly time dummy variables.

Number of Observations = 41724						
R-squared	61.2%		60.9%		61.8%	
Adjusted R-squared	61.1%		60.8%		61.7%	
Variable	Coefficient	t-stat	Coefficient	t-stat	Coefficient	t-stat
C	2.504	56.5	1.871	25.3	1.364	23.4
Ln(PropertyValue,MM)	-0.002	-5.6	-0.002	-5.3	-0.002	-5.6
LTV	-0.736	-11.8				
LTV Minus Average LTV of Originator					-0.874	-14.9
Average LTV per Originator					0.943	10.0
$LTV \leq 0.4$			0.410	7.7		
$0.4 < LTV \leq 0.5$			0.334	7.9		
$0.5 < LTV \leq 0.6$			0.282	8.0		
$0.6 < LTV \leq 0.7$			0.262	8.4		
$0.7 < LTV \leq 0.8$			0.172	5.8		
$0.8 < LTV \leq 0.9$			0.093	2.9		
NOI/Value	7.353	12.6	6.142	9.2	7.235	12.7
Loan Amortization Rate	0.248	18.3	0.255	18.8	0.259	19.5
Mortgage Maturity Dummies						
maturity $<$ 5 years	0.640	15.0	0.642	15.1	0.640	15.3
5 years $<$ maturity $\leq$ 10 years	0.325	39.3	0.326	39.8	0.332	40.2
Property Age Dummies						
Property Age $\leq$ 5 years	-0.140	-14.0	-0.145	-14.2	-0.143	-14.5
5 years $<$ Property Age $\leq$ 10 years	-0.180	-14.7	-0.187	-14.9	-0.174	-14.3
10 years $<$ Property Age $\leq$ 20 years	-0.140	-14.8	-0.145	-15.0	-0.140	-14.9
20 years $<$ Property Age $\leq$ 30 years	-0.108	-10.6	-0.112	-10.8	-0.113	-11.1
Property Type Dummies						
Multi family	-0.305	-17.9	-0.302	-16.8	-0.315	-18.6
Retail Unanchored	-0.030	-1.9	-0.026	-1.6	-0.050	-3.1
Retail Anchored	-0.191	-11.0	-0.192	-10.7	-0.205	-11.9
Medical Office	0.075	2.5	0.102	3.2	0.055	1.9
Industrial	-0.163	-8.2	-0.161	-8.0	-0.166	-8.5
Warehouse	-0.229	-5.2	-0.225	-5.2	-0.208	-4.9
Mobile Home	-0.283	-12.5	-0.277	-12.0	-0.299	-13.2
Office	-0.123	-6.6	-0.122	-6.5	-0.136	-7.4
Limited Service Hotel	0.207	8.7	0.221	9.0	0.183	7.7
Full Service	0.212	5.1	0.226	5.4	0.194	4.7
Self Storage	0.011	0.5	0.021	0.9	-0.016	-0.7
Investment Bank Originator	-0.027	-4.0	-0.028	-4.3	-0.040	-6.1

Table III
Cross Sectional Regression: Loan to Value Ratio

Cross-sectional regression with dependent variable the loan to value ratio. In addition to the variables reported in the table, the independent variables also include dummy variables for the CMBS deal type and quarterly time dummy variables.

Number of Observations = 41724		
R-squared	34.5%	
Adjusted R-squared	34.3%	
Variable	Coefficient	t-stat
C	48.4%	20.0
Ln(PropertyValue,MM)	-0.0003	-8.1
NOI/Value	3.215	10.4
Loan Amortization Rate	-0.049	-19.0
Mortgage Maturity Dummies (vs Maturity>10 years)		
maturity $<$ 5 years	0.4%	0.6
5 years $<$ maturity $\leq$ 10 years	0.5%	2.8
Property Age Dummies (vs Age $>$ 30 years)		
Property Age $\leq$ 5 years	4.2%	21.0
5 years $<$ Property Age $\leq$ 10 years	3.5%	14.0
10 years $<$ Property Age $\leq$ 20 years	2.8%	14.3
20 years $<$ Property Age $\leq$ 30 years	1.9%	9.1
Property Type Dummies (vs. Mixed Use Type)		
Multi Family	-2.8%	-7.0
Retail Unanchored	-5.5%	-15.0
Retail Anchored	-3.7%	-9.5
Medical Office	-12.4%	-14.0
Industrial	-6.2%	-15.2
Warehouse	-6.3%	-6.6
Mobile Home	-5.3%	-11.0
Office	-6.0%	-15.7
Limited Service Hotel	-12.8%	-23.0
Full Service	-13.1%	-19.3
Self Storage	-10.1%	-19.0
Investment Bank Originator	0.8%	5.8

Table IV
Summary Statistics: Macroeconomic Variables

Summary statistics for the quarterly macro-economic variables. The variables are the yield of the ten year Treasury bond, the spread between BBB and AAA corporate bonds, the write offs for commercial property loans cumulative over the previous year and expressed as a percentage of total value of all commercial property loans, the write offs for all loans cumulative over the previous year and expressed as a percentage of the total value of all loans, and the NCREIF index return over the previous year.

Variable	Mean	St. Deviation	Skewness	Kurtosis
Yield for 10Y treasury	7.07%	1.21%	0.11	-1.06
Spread between BBB and AAA	0.87%	0.25%	0.75	-0.49
1 Year Cum. Prior Write Offs for Comm. Property Loans	0.82%	0.69%	0.51	-0.82
1 Year Cum. Prior Write Offs for All Loans	0.89%	0.40%	0.55	-0.82
NCREIF return for the last 4Qs	6.7%	5.8%	-0.82	0.09

Table V
Time Series Regression: Macro-economic Effects on Spreads

Four different regression specifications with the coefficients of the quarterly time dummy variable from Table II as the dependent variable. The independent variables are the quarterly values for the ten year Treasury rate, the spread between the BBB and AAA corporate bonds, the NCREIF index return over the previous year, the write offs for commercial property loans cumulative over the previous year, and the write offs for all loans cumulative over the previous year.

Adjusted R-squared	46.7%		45.3%		52.2%		50.2%	
Variable	Coefficient	t-stat	Coefficient	t-stat	Coefficient	t-stat	Coefficient	t-stat
C	3.92	9.0	3.89	8.1	4.21	10.5	4.08	9.2
Yield for 10Y treasury	-0.45	-7.3	-0.47	-7.2	-0.43	-7.7	-0.46	-7.6
Spread between BBB and AAA	0.04	0.2	0.01	0.0	0.20	0.8	0.09	0.4
NCREIF return					-0.04	-3.6	-0.03	-1.7
Write Offs for CP Loans	0.35	2.7						
Write Offs for All Loans			0.49	2.5			0.32	1.4

Table VI
Time Series Regression: Macro-economic Effects on LTV Ratios

Three different regression specifications with the coefficients of the quarterly time dummy variable from Table III as the dependent variable. The independent variables are the quarterly values for the ten year Treasury rate, the spread between the BBB and AAA corporate bonds, the NCREIF index return over the previous year, the write offs for commercial property loans cumulative over the previous year, and the write offs for all loans cumulative over the previous year.

Adjusted R-squared	47.3%		44.0%		50.0%	
Variable	Coefficient	t-stat	Coefficient	t-stat	Coefficient	t-stat
C	0.459	16.2	0.466	15.8	0.438	15.7
Yield for 10Y treasury	-0.015	-3.0	-0.015	-2.9	-0.016	-3.5
Spread between BBB and AAA	0.128	5.5	0.135	5.5	0.115	5.2
NCREIF return					0.003	3.9
Write Offs for CP Loans	-0.024	-3.2				
Write Offs for All Loans			-0.035	-2.5		