Price Discovery in Commercial Mortgage Backed Securities: What Factors Determine Pricing at Origination and After Origination in the CMBS Market?

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Submitted to the Department of Urban Studies and Planning and the Department of Architecture in Partial Fulfillment of the Requirements for the Degree of Master of Science in Real Estate Development

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ABSTRACT

The commercial mortgage-backed securities (CMBS) market has vastly evolved over the last decade, but it remains a very private and proprietary market in comparison to other bond markets such as corporate or municipal bonds. The formation of CMBS data source providers such as Trepp and Intex in recent years has added transparency to the market, but large gaps still remain in available information for CMBS investors, particularly in the secondary trading market. This thesis examines pricing of CMBS at origination, when it is sold by the issuer, and after origination, when it is traded in the secondary market. Using a sample of AAA rated CMBS this thesis seeks to determine which factors influence price at origination and after.

This thesis is essentially split into two separate studies, one examining pricing at origination and the other pricing after origination. For both parts, regression analyses were performed on fifty AAA rated securities issued from June of 2001 to December of 2006. All deal level information was provided by Trepp, while JP Morgan Chase provided historical AAA rated CMBS market information as a comparison. Secondary pricing data, based on a proprietary pricing model was also provided by Trepp. A small sample of data from actual closed transactions in the secondary market was supplied by Morgan Stanley for comparison.

The results of the first part of this thesis are very similar to previous works done on the topic and show that Debt Service Coverage Ratios, geographic concentration, and property type are all important factors in determining the initial price of a CMBS issuance. The results of the price at origination study show that investors preferred seasoned CMBS deals over new issues even though the fact that overall market spreads decreased during the studies time frame. This preference suggests that investors were more attracted to seasoned CMBS than they were to newer issuances. The second part of this thesis illustrated a similar inclination by investors to more seasoned CMBS in the secondary trading market. The authors conclude that variations do exist in the pricing of CMBS in the secondary trading market and that overall the market has significant enough transparency to incorporate different factors into investment decisions.

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Chapter 1

Introduction

From June of 2007 to June of 2008, the average spread over swaps for AAA rated Commercial Mortgage Backed Securities increased by one hundred and thirty basis points to one hundred and fifty eight basis points. This vast increase was slight compared to March of 2008, when the average price for a AAA rated CMBS topped out at three hundred and ten basis points over swaps, an increase of two hundred and eighty five basis points from an average spread of just twenty five basis points in March of 2007. For close to twelve months now, the CMBS market has seen tumultuous increases in spreads, even in the least risky class of securities, those that are AAA rated.

Though this turmoil has not been exclusive to the CMBS market and is part of the larger credit crisis that has nearly paralyzed the American economy, the lack of transparency in this still fairly young market has added an extra layer of fear and confusion. In the well seasoned world of corporate stocks and bonds, it is quite simple to look up a company's current stock price and forecasted performance, but in the world of CMBS, it can be difficult for even sophisticated investors to find accurate and detailed information on their investments. Companies such as Trepp and Intex offer detailed databases that did not exist ten years ago, but their services can be expensive, and therefore not worthwhile for the average CMBS. Furthermore, these vendors still have limitations in their data collection due to the proprietary nature of the CMBS trading environment, relying on models to estimate CMBS pricing.

This thesis sets out to determine what the most important factors in pricing CMBS are, in both the initial pricing of the bonds as well as secondary pricing, given the current economic environment along with the lack of transparency in the CMBS market. Using data provided by Trepp, as well as one investment bank, regression models will be designed to answer the question of how CMBS are and should be priced. Prior to discussing these models, it is important to begin with a history of CMBS to understand how the market has evolved to its current state.

1.1 History of Commercial Mortgage Backed Securities

Commercial Mortgaged Backed Securities (CMBS) began to emerge in the United States during the late 1980's. The main catalyst for their development was the formation of the Resolution Trust Corporation (RTC), which was set up by the United States Government in 1989 to take over the (mainly real estate) assets of the savings and loan associations that were declared insolvent following the Savings and Loan Crisis (S&L) of the 1980's. The RTC's chief purpose was to liquidate the billions of dollars of real estate assets that it took over from banks during the S&L crisis. In the capital starved environment that followed the S&L Crisis, the creation of CMBS offered the RTC a way to sell these assets quickly.

Leading up the formation of the RTC, a larger trend toward securitization with Residential Mortgage Backed Securities (RMBS), Asset Backed Securities (ABS), and Collateralized Bond Obligations (CBO) emerged as popular investment tools. The biggest restraint that the CMBS market faced in its development in comparison to these types of securities was its perceived lack of transparency due to the heterogeneity of the underlying assets. With pools of residential mortgages or asset backed securities such as those backed by credit card debt or car loans, the

underlying assets are more uniform and, therefore are easier to assess overall risk. With pools of commercial mortgages, the underlying assets not only cross across various building types (office, hotel, multi-family, etc) and market locations, but also have varying term lengths. [1]

Rating Agencies Enter the Scene: CMBS Market Evolves

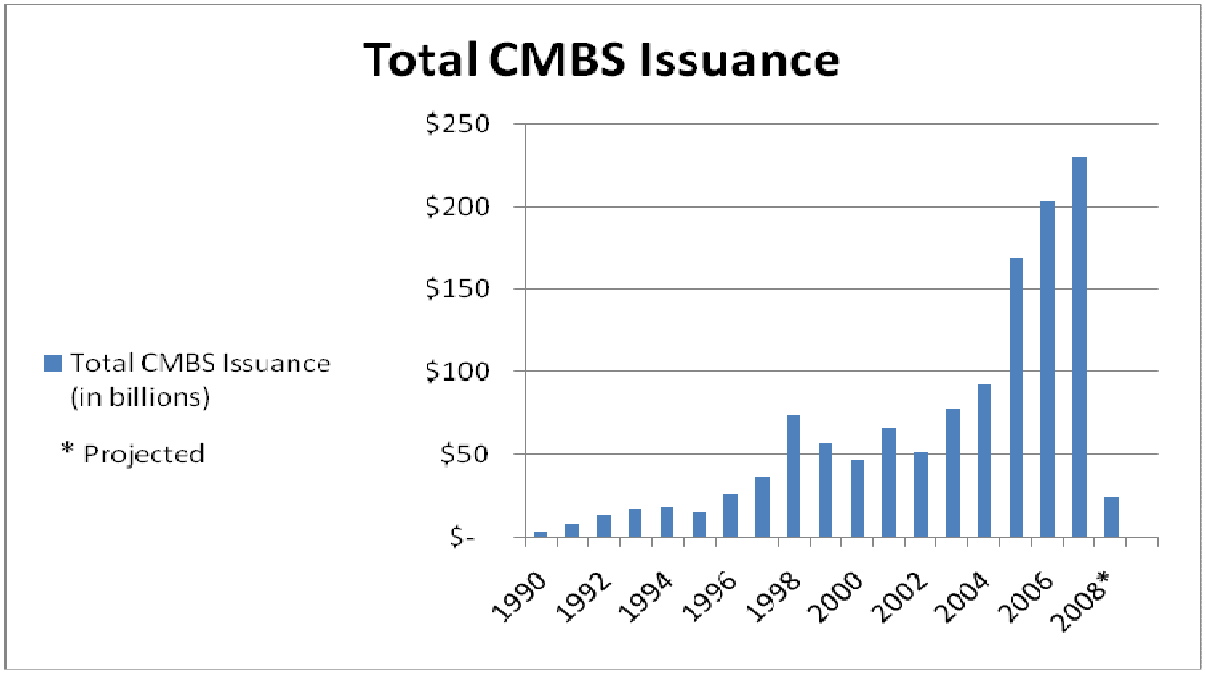
When the three main rating agencies, Fitch, Moody's, and Standard and Poor's, introduced their respective models for rating these complex securities, investors started to feel more comfortable with their investments and the CMBS market began to attract more investment. With a rating system that was similar to that of more familiar securities such as corporate bonds, investors began to have more confidence in these assets and the likelihood they would receive coupon payments and, ultimately, the principal in a timely manner; investors felt that they were being fairly compensated for the risk of not seeing future cash flows. As the industry grew, these rating companies began to have more of an impact on the market and became, in many ways, the "de facto watchdog over the mortgage industry."[2]

Over the last twenty five years, the CMBS market has evolved fairly rapidly. In 1990, there were approximately $5 Billion in new CMBS issuances, close to $75 Billion in issuances by 1998, and by 2006 that number was more than $200 Billion. Total CMBS issues through the fall of 2006 accounted for approximately 26% of the total U.S. Commercial Debt Market, up from 6% just a decade ago.[3]

[1] Buttimer, Richard, "Commercial Mortgage Backed Securities," The Belk College of Business UNC Charlotte
[2] Lowenstein, Roger,. "Triple A Failure," New York Times April 27, 2008.
[3] Shugrue, Edward L. III, "Understanding Commercial Real Estate CDO's," PREA Quarterly Fall 2006.

Figure 1.1 demonstrates the growth of CMBS volume over the last twenty years, including the forecasted volume for 2008.

Figure 1.1: Total CMBS Issuance Annually (In Billions): 1990 - 2008



Source: Commercial Real Estate Alert

Subprime Market Implodes: CMBS Issuances Grind to a Halt

As this chart exhibits, the CMBS market has followed a fairly even growth pattern throughout its history until midway through 2007, when the subprime market began to implode and the current credit crisis began. The majority of the $230 Billion in CMBS issuances in 2007 occurred in the first half of the year and by the start of 2008, the market for new issues was almost completely non-existent. In January of 2008, there were zero new issuances of CMBS, the first month of such an occurrence since the RTC stopped issuing CMBS in 1995.

As default rates on subprime and Alt-A residential mortgages began to soar in 2007, the millions of Americans who lost their homes were not the only casualties. The RMBS and Collateralized Debt Obligations (CDOs), as well as other complicated investment vehicles where these mortgages had been sold into, began to lose vast amounts of value, an unexpected event by many players in this market. These major players included the mortgage companies that had underwritten these mortgages and then quickly sold them off their balance sheets, as well as the investment banks that had bought the mortgages, pooled them together, and sold them as securitized bonds, while keeping large portions of these securities on their own books. As a result of these large losses, the investment banks and mortgage companies were forced to write-down billions of dollars in lost value of these securities, which led to the current crisis in the financial markets. While the commercial real estate market had not seen anywhere near the erosion that the residential market was experiencing, all these factors led to fear in the overall financial markets, and particularly in real estate related markets that essential shut down the CMBS market by early 2008.

Lax Underwriting Standards

Fear was probably the biggest single factor that caused the CMBS market to dry up, but investors also had fundamental reasons to turn away from CMBS. As the CMBS market grew, the rating agencies began to deploy looser and looser criteria for their ratings. In 2002, the average Debt Service Coverage Ratio (DSCR) (using the rating agency method which incorporates lower cash flows than models that use the actual and forecasted cash flows more commonly used by banks and other mortgage underwriters) was over 1.15 and the average Loan to Value (LTV) (also using the rating agency method) was at or below 85%. As Table 1.1 demonstrates, all three

major rating agencies (Moody's, Fitch, and Standard & Poor's) saw a significant decrease in the average DSCR and a substantial increase in average LTV in recent years as the commercial real estate industry boomed.

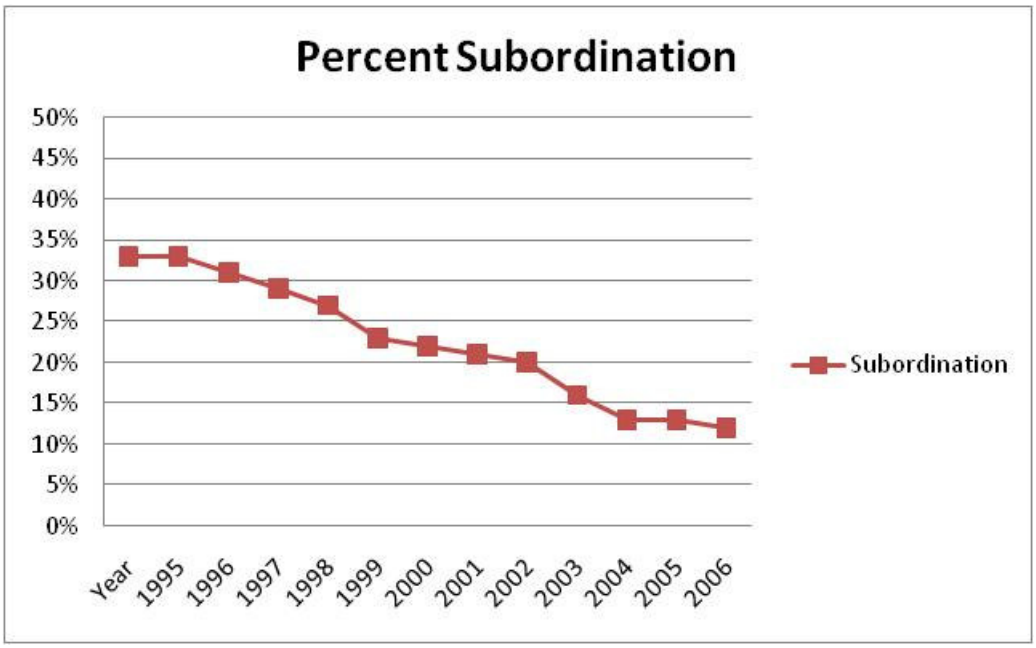
Table 1.1: Average CMBS Characteristics By Rating Agency: 2004 – 2007

Deal	Mortgage Pool Size ($M)	Moody LTV	Fitch LTV	S&P LTV	Moody DSCR	Fitch DSCR	S&P DSCR
2004 Average	$ 1,233	85%	87%	88%	1.16	1.27	1.58
2005 Average	$ 2,111	95%	92%	95%	1.16	1.35	1.46
2006 Average	$ 2,651	101%	96%	99%	1.01	1.18	1.37
YTD 2007 Average	$ 3,368	111%	107%	112%	0.91	1.10	1.30

Source: Holliday Fenoglio Fowler, L.P. Rating Agency Presales, ytd November 20, 2007

Subordination levels, which add a cushion to the higher rated tranches in a CMBS pool, also decreased significantly in recent years, as higher portions of CMBS pools were being classified as investment grade. Figure 1.2 tracks the decrease in the average subordination level of CMBS deals from 1995 through 2007, when subordination decreased from thirty three percent all the way down to twelve percent.

Figure 1.2: Percent of CMBS Pools Subordination: 1995 - 2006



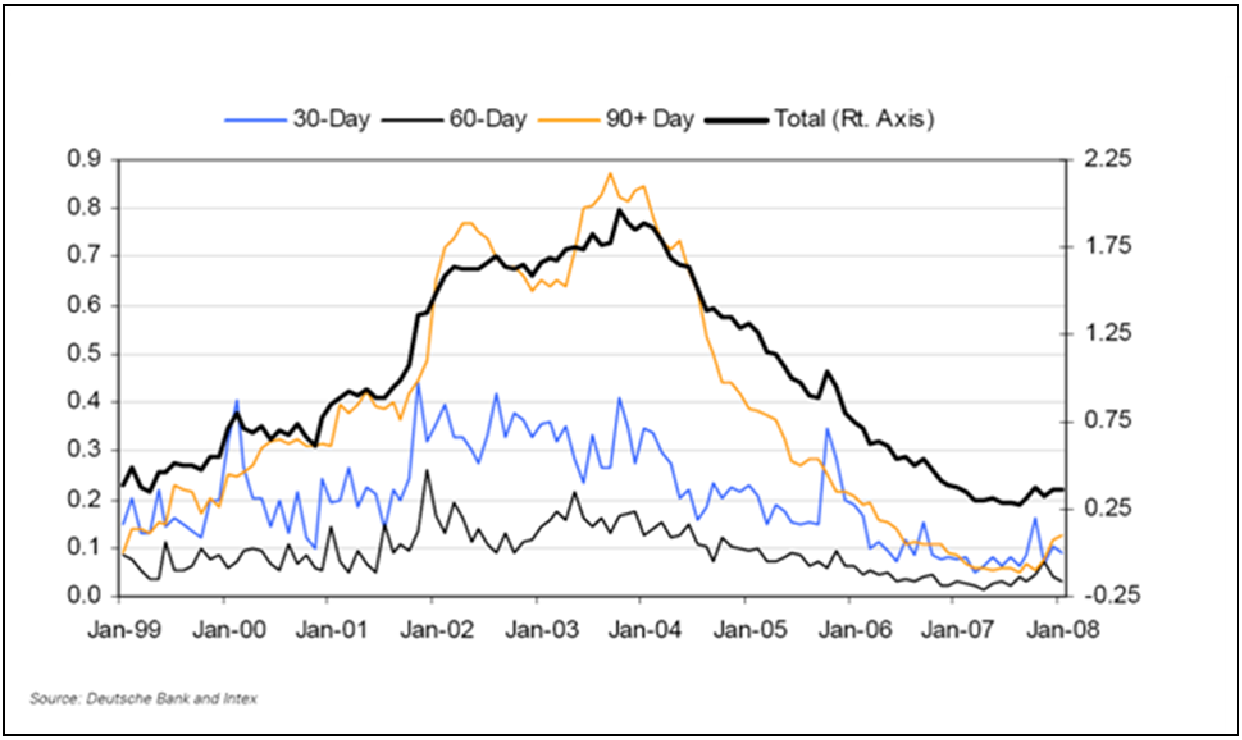
Source: Holliday Fenoglio Fowler, L.P. GS Research; Commercial Mortgage Alert

Further adding to the problem of eroding underwriting standards, in the most recent years leading up to the subprime meltdown of 2007, future income based on rental projections and assumptions was counted for Debt Service Coverage tests, such that often times debt service exceeded the cash flows on certain buildings at the start of the loan. In addition, the number of interest only loans issued increased dramatically. In the first quarter of 2007, eighty five percent of conduit deals were interest only, giving the issuers and bond holders less and less protection from balloon payment risk.

Spreads on CMBS Skyrocket

Despite all of these factors, default rates on commercial mortgages still remain historically low. Figure 1.3, where the y axis on the right hand side represents total default rates and the x axis represents the date, indicates that even with a recent increase to a .33% default rate, defaults on commercial loans are still well below the historic average over the last ten years.

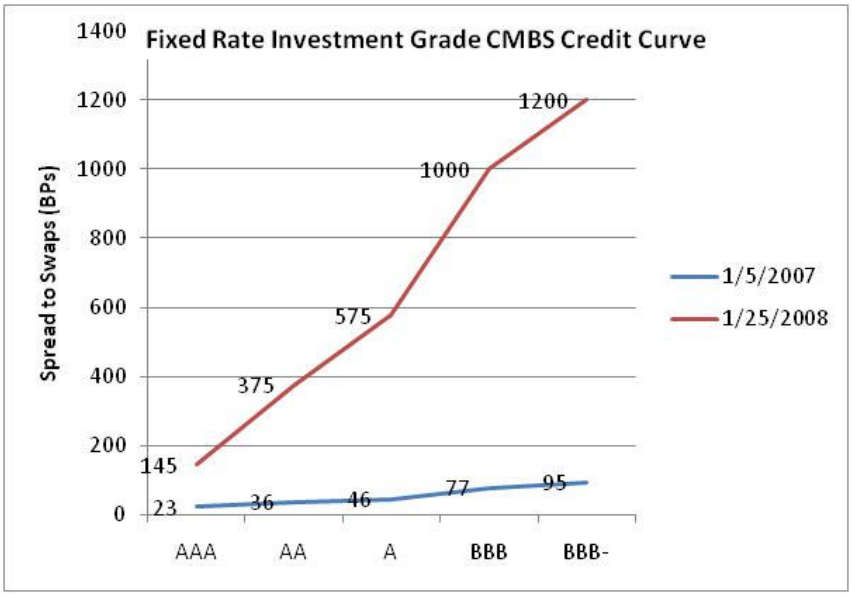
Figure 1.3: Default Rates on Commercial Loans: January 1999 – January 2008



Source: Deutsche Bank and Intex

Historically low default rates, however, have done little to lessen the fear in the CMBS market throughout 2008. Though there have been a few new issuances in more recent months, spreads on those offerings have been at historical highs. Figure 1.4 demonstrates the difference in spreads from January 2007 to January 2008 for Fixed Rate Investment Grade CMBS.

Figure 1.4: Spreads on Fixed Rate Investment Grade CMBS: January 2007 – January 2008



Source: JP Morgan Chase

Figure 1.5 shows the pricing on one particular deal in April of 2008. The AAA rated tranches were priced at a 200-500 basis point spread and the riskier BBB pieces were priced at historically high spreads of 1300-1800 basis points.

Figure 1.5: Pricing on an Actual CMBS Issuance from April 2008

Pricing date:	April 17
Closing date:	April 29
Amount:	$1,007.1 million
Seller/borrowers:	Lehman Brothers, UBS
Lead managers:	Lehman Brothers, UBS
Co-manager:	Bank of America
Master servicer:	Wachovia
Special servicers:	CWCapital Asset Management, LNR Partners
Trustee:	LaSalle Bank
Offering type:	SEC-registered

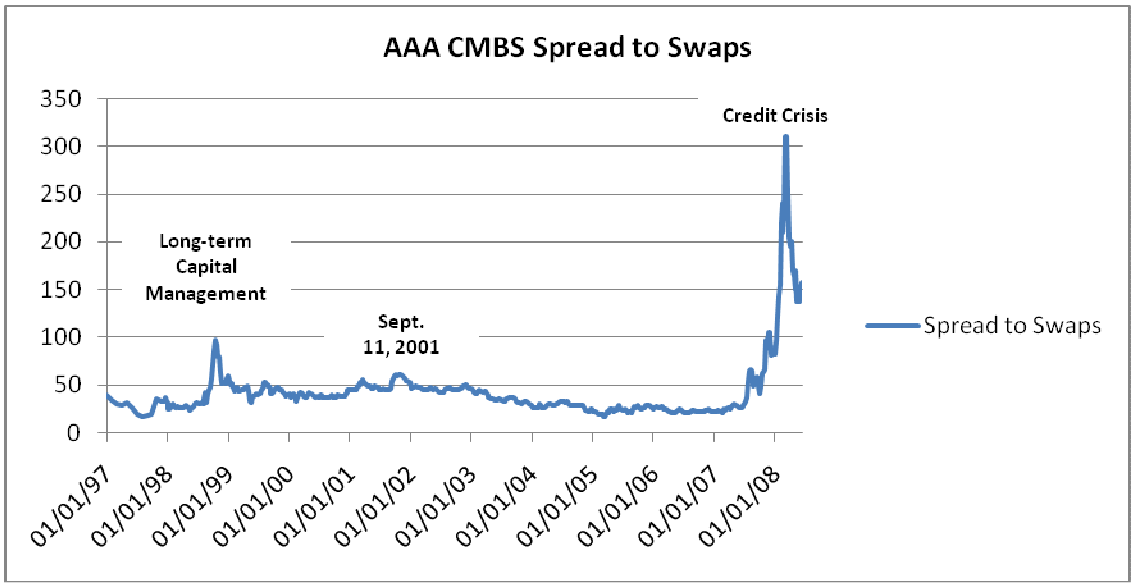
Property types: Retail (43.5%), office (23.2%), hotel (13.4%), mixed-use (12.6%), industrial (4.1%), multi-family (1.6%), parking (1.2%) and self-storage (0.4%).
Concentrations: Maryland (18.9%) and Indiana (15.6%).
Loan contributors: UBS (51.3%) and Lehman (48.7%).
Largest loans: A $140 million loan to Westfield Group on the 1.4 million-sf Westfield Southlake Mall in Merrillville, Ind.; a $116.6 million loan to Chevy Chase Land on Chevy Chase Center, a 398,000-sf office and retail complex in Chevy Chase, Md.; a $91 million loan to Mark Karasick on the 614,000-sf Regions Harbert Plaza office building in Birmingham, Ala.; a $75.3 million portion of a $185 million loan to Portman Holdings on the 700-room Westin Charlotte in Charlotte; and a $73.2 million loan to UrbanAmerica on the 325,000-sf Computer Sciences Building in Lanham, Md.
B-Piece buyer: CWCapital.
Notes: Lehman and UBS teamed up to securitize large loans and conduit mortgages. TIAA-CREF originated some of the loans and subsequently sold them to Lehman or UBS. See article on Page 1. **CMA code:** 20080024.

Class	Amount ($Mil.)	Rating (Moody's)	Rating (S&P)	Subord. (%)	Coupon (%)	Dollar Price	Yield (%)	Maturity (Date)	Avg. Life (Years)	Spread (bp)	Note Type
A-1	47.990	Aaa	AAA	30.00	5.611	100.498	5.458	4/17/41	2.88	S+215	Fixed
A-AB	50.023	Aaa	AAA	30.00	6.150	99.707	6.349	4/17/41	6.77	S+225	Fixed
A-2	506.964	Aaa	AAA	30.00	6.150	100.041	6.296	4/17/41	9.44	S+190	Fixed
A-2FL	100.000	Aaa	AAA	30.00				4/17/41	9.44		Floating
A-M	100.711	Aaa	AAA	20.00	6.150	90.811	7.668	4/17/41	9.86	S+325	Fixed
A-J	69.239	Aaa	AAA	13.13	6.150	78.633	9.769	4/17/41	9.88	S+535	Fixed
B	13.848	Aa1	AA+	11.75	6.150	75.303	10.419	4/17/41	9.88	S+600	Fixed
C	11.330	Aa2	AA	10.63	6.150	73.829	10.719	4/17/41	9.88	S+630	Fixed
D	7.553	Aa3	AA-	9.88	6.150	71.456	11.219	4/17/41	9.88	S+680	Fixed
E	8.813	A1	A+	9.00	6.150	69.184	11.719	4/17/41	9.88	S+730	Fixed
F	7.553	A2	A	8.25	6.150	66.162	12.419	4/17/41	9.88	S+800	Fixed
G	11.330	A3	A-	7.13	6.150	61.685	13.433	4/17/41	10.11	S+900	Fixed
H	11.330	Baa1	BBB+	6.00	6.150	45.780	17.542	4/17/41	11.58	S+1,300	Fixed
J	12.589	Baa2	BBB	4.75	6.150	38.785	19.636	4/17/41	13.04	S+1,500	Fixed
K	8.812	Baa3	BBB-	3.88	6.150	32.255	22.689	4/17/41	13.93	S+1,800	Fixed
L	8.812	Ba1	BB+	3.00	4.081			4/17/41	14.99		Fixed

Source: Commercial Mortgage Alert

Clearly, with default rates still at historical lows, BBB bonds priced at a 1300 basis point spreads are taking into account current credit market conditions and liquidity fears, as opposed to any expected default rates or other credit factors. The CMBS market has seen spreads jump substantially in a short period of time due to macroeconomic factories in other periods of history as well. With the collapse of Long-term Capital Management in 1998 as well as the terrorist attacks of September 11th, CMBS spreads saw a quick increase; however those events did not lead to a jump in spreads of anywhere near the same magnitude that the current credit crisis has caused. Figure 1.6 demonstrates the average spread over swaps for AAA CMBS from 1997 through 2008, with short lasting increases in late 1998 as well as in 2001.

Figure 1.6: AAA CMBS Spread to Swaps: January 1997 to January 2008



Source: JP Morgan Chase

1.2 Summary and Goals of This Study

Given the current credit environment, the authors felt that it was an appropriate time to study Commercial Mortgage Backed Securities. The main goal of this paper is to analyze the factors that influence the pricing and valuing of Commercial Mortgage Backed Securities both in the initial issuance market, as well as in the secondary trading market. To accomplish this goal, this paper will address two separate studies. The first study will examine pricing of CMBS at origination, and the second study will examine pricing of CMBS after origination.

A number of studies, which will be discussed further in the literature review, have already examined the major drivers of pricing at origination, therefore the first part of this paper will seek to build upon those existing studies and provide a current look at what drives spreads in the initial pricing market. In today's market, large variations in initial pricing spreads of similarly rated CMBS deals still exist, suggesting that investors in the CMBS market continue to use other factors outside of the just the rating to price CMBS at their origination. With the credit crisis

still fresh in investor's minds, the authors believe that it is an opportune time to explore these criteria further.

For the second part of this study, because published literature on pricing after origination does not currently exist, the authors will attempt to uncover what the most important variables are in determining secondary pricing spreads of CMBS. This part of the thesis analyzes pricing in the secondary market from two different perspectives. The first perspective (scenario) is to analyze current prices as dependent on current market and performance variables. The second perspective (scenario) analyzes the changes in current prices since origination as a function of changes of current market and performance variables since origination.

Both studies evaluate market as well as deal level variables, but the specific variables analyzed at origination and after origination are different. At origination there is more emphasis on underlying loan characteristics such as Debt Service Coverage Ratio, Loan to Value, and geographic concentration. After origination emphasis is on credit status characteristics such as delinquency and foreclosure percentages.

Pricing in the CMBS market at origination is transparent. This transparency is evidenced by the dispersion in pricing spreads for similarly rated CMBS deals. In the secondary market, price transparency is not as obvious. Secondary market data on individual deals is not readily available, therefore the second part of this study, pricing after origination, will also try to conclude whether or not the secondary CMBS market is transparent.

Chapter Two

Literature Review

Due to the enormous growth in Commercial Mortgage Backed Securities over the last twenty five years, extensive research has been focused on CMBS. Research has focused on a range of topics such as default rates, structure, and subordination levels, though minimal research, at least in publication, has been performed on price discovery, initial pricing, the secondary pricing market, and valuation of CMBS. Unlike other bond markets, such as the corporate bond market where company information and financials are readily available to investors, it remains incredibly difficult to find the information necessary to properly price and value bonds in the CMBS market. This lack of data is likely the major hindrance to any substantial research papers being written on the topics of pricing and valuation in CMBS. The authors suspect that investment banks and private research companies have done extensive research on these issues, but have not made the results public due to the proprietary nature of the information.

Polleys and Kilgore in "An Empirical Investigation of Commercial Mortgaged-Backed Securities Pricing and the Role of the Rating Agencies" evaluate the impact of credit, non-credit, and rating agency factors on the pricing of AAA rated CMBS. The study analyzed pricing at origination and focused on 51 transactions, representing 89 AAA securities that were issued between the 1st quarter 1994 and the 1st quarter 1996. The results of their "pricing spread regression analysis show that both non-credit and credit factors impact pricing of CMBS, but that there is no pricing impact based on the rating agency(s) which rates the transaction." (1996, 2) Polleys and Kilgore concluded that the "existence of significant credit variables effects indicate there is a disparity in the evaluation of credit risk between the market and the rating agencies." (1996, 2)

The Polleys and Kilgore study is an excellent framework for this paper. Written in 1996 when the CMBS market was still a relatively new area of study, the Polleys and Kilgore study has yet to be updated or expanded upon, despite the quadrupling in size of the CMBS market over the last twelve years. This paper will also evaluate pricing at origination and builds upon the work of Polleys and Kilgore, with some modifications. One major difference between the two studies is that while both papers attempt to examine any factors that influence initial spreads at origination, this paper is less concerned about differentiating between credit and non-credit variables, a major component of the Kilgore and Polleys study.

The authors in this study also have the advantage of more up-to-date databases that track CMBS data. One of the major challenges that Kilgore and Polleys faced was data collection, and data arrangement so that their model would make a fair and accurate comparison between securities. Much of the data that was analyzed for the purposes of this paper came from Trepp Analytics, which is now the leading provider of CMBS and commercial mortgage information. Trepp began collecting and selling their extensive services and database in 1997, after the Kilgore and Polleys' thesis was written. Without access to such a database, Kilgore and Polleys had to depend upon deal prospecti and the rating agencies for their data.

Polleys, individually, went on to write a follow-up paper to the thesis she had written with Kilgore. The updated Polleys article adds additional credit and non credit variables to her original analysis and uses 70 transactions, representing 125 AAA securities. The updated study

has similar results to the original study, that both credit and non-credit factors impact pricing at origination.

Brian Lancaster in "Introduction to Commercial Mortgage-Backed Securities" (Fabozzi, 2001, 1) examines the key factors that influence pricing of CMBS and provides a basic framework for investors when analyzing CMBS transactions. Lancaster indicates that debt service coverage ratio (DSCR) and the loan to value ratio (LTV) are the two most important indicators of the credit quality of the collateral backing a CMBS. Lancaster notes the importance of evaluating not only the weighted average DSCR, but also the range of DSCRs for the loans in the pool. Other factors that Lancaster evaluates are property location and types, loan types, loan underwriting standards, loan size/concentration, and prepayment terms/call protection. Lancaster's analysis of these factors gives the authors a strong foundation to investigate which factors would be most important in their study.

Lancaster also discusses how CMBS trade. Because of "their excellent prepayment protection and sensitivity to credit risk, highest quality investment grade CMBS (AAAs through As) tend to trade more like corporate bonds than residential MBS." (Fabozzi, 2001, 14) Due to risk associated with the average life and price risk, "CMBS tend to trade at wider spreads than same rated and same average life corporate bonds. In addition, the nature of CMBS collateral can pose a greater analytical challenge than corporate debt." (Fabozzi, 2001, 16) Lancaster also discusses that within the CMBS sector, similarly rated CMBS with comparable average lives can trade at spreads as different as 20 bps. Lancaster's explanation is that the market evaluates other factors beyond the rating, prepayment risk, liquidity, and how well a "name" trades and has traded

versus other "names." One could argue that these factors are non-credit factors and that the rating agencies did not take these factors into account when assigning a rating to the CMBS. The purpose of this study will be to evaluate any factors that the authors feel might influence initial spreads when an issue is first marketed, either non-credit or credit factors.

Jacob and Patel in "The Efficient Frontier for CMBS and Commercial Mortgages Using a Risk-Return Framework" (Fabozzi, 2001, 89) analyze, on a risk-adjusted basis, the relative value between the various classes in a CMBS deal. Even though this study focuses solely on the AAA class, is the study is still noteworthy to mention as it attempts to analyze pricing and valuation. Jacob and Patel make the argument that the stated, initial pricing spread is simply the internal rate of return, usually assuming no default (and possibly no prepayment). "It is not the expected or average return in any sense." (Fabozzi, 2001, 89) Some investors run yield tables based on default and prepayment scenarios to overcome these shortcomings, but Jacob and Patel argue that the scenarios typically do not match the quality of the underlying collateral. Jacob and Patel have created a model that chooses "scenarios that directly link to the quality of the loan pool," (Fabozzi, 2001. 90) and the results show an efficient frontier that represents "the set of investments with the highest expected returns for each level of risk." (Fabozzi, 2001. 90)

Gordon and Gibson in "Structure, Valuation, and Performance of CMBS" (Fabozzi, 2001, 97) provide a similar analysis to Lancaster's article. The main difference between the two analyses is that Gordon and Gibson emphasize the possibility of extension risk. Most commercial mortgages are underwritten with a stated final maturity of 15-30 years and a balloon payment due after 10 years. The lockout protection in the underlying commercial real estate loans provides excellent

protection from prepayment risk, whereas extension will only occur to the extent that borrowers cannot make their balloon payment and make arrangements with the servicer to extend their repayment schedules. The Gordon and Gibson study provides the frame work for another factor that the authors can consider in their analysis. It is worth noting that the original Polleys and Kilgore thesis did not include balloon payment as a factor, but that the updated Polleys article did. Unfortunately, the authors were unable to measure extension risk in this study. The deal history of the fifty deals used in this study did not have one occurrence of an unintended extension event, most likely due to borrower's ease of re-financing during the time frame of this study.

Chapter Three

Data and Methodology

3.1 Data

The main source of data for this research was Trepp, LLC, the leading provider of CMBS and commercial mortgage information to the issuers, investors, and all users of CMBS. Fifty AAA rated CMBS securities issued between June 2001 and December 2006 were chosen from Trepp's extensive database. The individual fifty AAA rated securities were chosen with a preference for higher total loan balance, and excluded FNMA and Freddie Mac multifamily CMBS. The authors felt that securities with higher loan balances would have a higher number of investors compared to securities with smaller loans balances, and, therefore, price history of these securities would be more reflective of the market. Table 3.1 is a summary of the average deal statistics.

Table 3.1: Average Deal Statistics of Data

Deal Statistics	Average	Minimum	Maximum
Mortgage Pool Size	$ 1,698,429,058	$ 722,145,490	$ 4,273,091,953
DSCR	1.66	1.32	3.12
LTV (%)	66.7	46.78	72.75

Data was concentrated to this particular investment class as well as this specific time period for the following reasons. With limited time available to complete this thesis, it was necessary to choose only one class to focus on. AAA rated securities were chosen over another rating category, mainly due to the more frequent and transparent nature of the AAA market versus other non-investment grade classes. While a variety of investors often purchase AAA rated CMBS bonds due to their perceived relative low risk, buyers are more concentrated when it

comes to the junior pieces, particularly the non-investment grade classes. Therefore, the authors felt detailed information if needed outside of Trepp's database would be easier to obtain in the AAA class. The time period was chosen because it offered a period long enough to control for specific macroeconomic changes, but short enough to provide some meaningful results.

For each of these fifty securities, Trepp also provided specific deal level data including the initial price (quoted as a spread over treasury), as well as numerous credit-and non credit variables from the time of issuance through January of 2008, updated on a monthly basis.[4] In addition, Trepp provided secondary pricing for each of these fifty securities based on their proprietary pricing model from origination through June of 2008, updated on a daily basis.[5] Trepp emphasizes in its pricing description that while CMBS is categorized as a Mortgage Backed Security, the process of establishing prices for CMBS bonds is different from pricing Residential MBS. According to Trepp, in the RMBS universe, credit concerns are dwarfed by interest rate risk considerations. In the CMBS universe, however, the opposite is true. Credit risk dominates the analytical process in CMBS, as interest rate sensitivity, while still relevant, is of secondary concern.

Trepp utilizes multiple sources of information to analyze collateral data, and a number of elements are constantly updated in their model. Key elements that are analyzed include:

- Property Type Diversity
- Ongoing Financial Performance of Collateral
- Exposure to Troubled Tenants
- Unique Geographical Risk
- Delinquency Statistics

[4] See Appendix, Exhibit 1 for all deal history variables provided by Trepp
[5] See Appendix, Exhibit 2 for all price history variables provided by Trepp

- Appraisal Reductions
- Loan Modifications
- Loan Defeasances

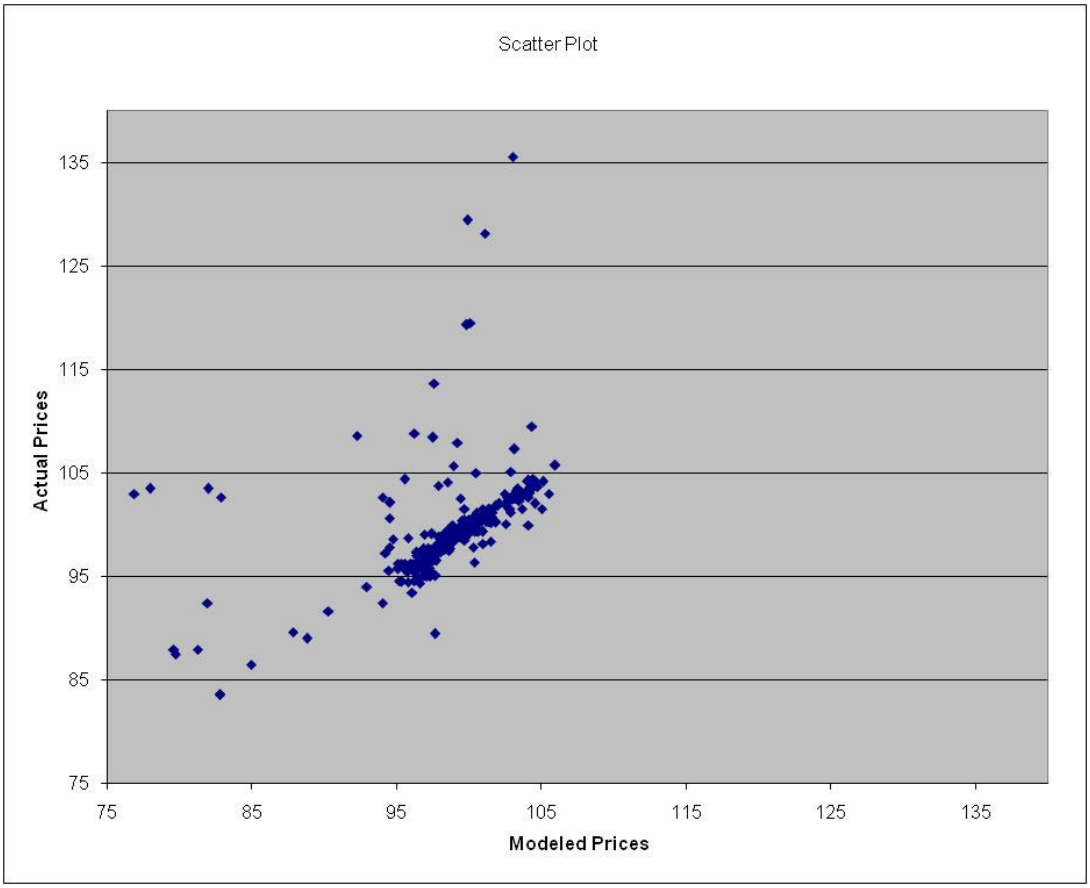
While the second study, pricing after origination, uses the modeled prices provided from Trepp, the authors were able to obtain limited secondary pricing data from Morgan Stanley based on actual closed transactions in the secondary market. The pricing data from Morgan Stanley consisted of 384 price points ranging across fifteen of the fifty CMBS deals used in this paper. This pricing data is compared to the 46,283 price points across the fifty CMBS deals provided by Trepp. The pricing data from Morgan Stanley provided a check on Trepp's pricing data, to help understand how much of the actual market transaction pricing is being captured by Trepp's internal model. Figure 3.1 shows the regression results of this comparison, while Figure 3.2 is a scatter plot of the observations, looking at actual transaction price versus modeled price. The data from Morgan Stanley was paired with the pricing data from Trepp based on date. Only 349 price points of the 384 from Morgan Stanley were able to be paired with the Trepp price points, due to mismatches in dates.

Figure 3.1: Regression Results for Comparison Between Trepp Pricing Model and Morgan Stanley Data

Regression Statistics	
Multiple R	0.490314914
R Square	0.240408715
Adjusted R Square	0.238219691
Standard Error	4.240752768
Observations	349

	Coefficients	*Standard Error*	*t Stat*
Intercept	43.37070172	5.357173477	8.095818048
Trepp Price	0.56838419	0.05423656	10.47972422

Figure 3.2: Scatter Plot of Observations of Trepp Modeled Prices (x axis) and Actual Morgan Stanley Prices (y axis)



The outliers on Figure 3.2 are specific to the time frame between January 2008 and April 2008, and are not specific to any one CMBS deal. The outliers, authors believe, are specific to this time frame for the following reasons: volatility in the CMBS market, irrational investor behavior, or the lag associated with Trepp's model to incorporate actual prices at this time. The authors believe that this comparison between Morgan Stanley and Trepp validates the use of Trepp's modeled prices prior to 2008. Unfortunately, the discrepancy between Morgan Stanley and Trepp prices from January 2008 until April 2008 demonstrates the ambiguity of CMBS pricing.

The Deal Variables: Pricing At Origination Model

Table 3.2 names and explains each of the deal variables used for the "Pricing at Origination" model. A more detailed description of why these variables were chosen over others for this analysis can be found in section 3.2.

Table 3.2: Deal Variables for Pricing at Origination Model With Descriptions

Pricing At Origination	
Variable	**Description**
Average Market Spread	Benchmark spread provided by J.P. Morgan matched to duration
Date	Number of Days from first deal in Model 1 data set (from 6/1/01)
RetailAnchoredPct	Percent of pool classified as Retail/Anchored
State1Pct	Percent of pool concentrated in largest state, by balance, at the property level
Duration	Duration of the Bond
CutoffDSCR_NCF	DSCR as of closing, based on net cash flow
CutoffAaaSubordination	Lowest Credit enhancement at the AAA level as of closing
HotelFullPct	Percent of pool that is Full Service Hotel (generally, includes some form of restaurant and meeting rooms)
RetailUnanchoredPct	Percent of pool classified as Retail/Unanchored
Top5LoansPct	Percent of pool concentrated in 5 largest loans
OfficePct	Percent of pool classified as office

MultifamilyPct	Percent of pool classified as Multi-family
CutoffLTV	Average loan to value ratio at closing
IndustrialPct	Percent of pool classified as Industrial
MonthsYM	Average number of months before the end of the yield maintenance period. Generally starts at the end of lockout
MonthsPenalty	Average number of months before the end of the fixed prepayment penalty period

The Deal Variables: Pricing After Origination Model – First Scenario

Table 3.3 names and explains each of the variables used for the first scenario examining pricing after origination.

Table 3.3: Deal Variables for Pricing After Origination Model (First Scenario) With Descriptions

Pricing After Origination – First Scenario	
Variable	**Description**
Current Deal Spread	Current Deal Spread over relevant treasury
Current Mkt Spread	Current market spread over treasury, matched to treasury rate from current market spread
Date	Number of Days from Origination
Current DSCR	Current DSCR, based on net cash flow
Current AAA Subordination	Current Lowest Credit enhancement at the AAA level
ASER Pct	Current balance of loans subject to ASER, as a % of Current Balance
PerformSpecialSrvcdPct	Percent, based on balance of loans in Special Servicer
Delinq90DayPct	Percent, based on balance of loans more than 90 days delinquent
ForeclosurePct	Percent, based on balance of loans in Foreclosure

The Deal Variables: Pricing After Origination Model – Second Scenario

Table 3.4 names and explains each of the variables used for the second scenario modeling pricing after origination.

Table 3.4: Deal Variables for Pricing After Origination Model (Second Scenario) With Descriptions

Pricing After Origination – Second Scenario	
Variable	**Description**
Diff in Deal Spread	Difference between current deal spread and spread at origination
Diff in Current Mkt Spread	Difference between current market spread and market spread at origination
Date	Number of Days from Origination
Diff in DSCR	Difference between Current DSCR and DSCR as of closing (origination), based on net cash flow
Diff in AAA Subordination	Difference between current Lowest Credit enhancement at the AAA level and AAA level as of closing (origination)
ASER Pct	Current balance of loans subject to ASER, as a % of Current Balance
PerformSpecialSrvcdPct	Percent, based on balance of loans in Special Servicer
Delinq90DayPct	Percent, based on balance of loans more than 90 days delinquent
ForeclosurePct	Percent, based on balance of loans in Foreclosure
REOPct	Percent, based on balance of loans classified as Real Estate Owned

The Market Variable

All pricing spreads provided by Trepp needed to be compared to some benchmark spread or market variable in order to control for variations in the market. As with all investment types, spreads in Commercial Mortgage Backed Securities respond to specific market conditions and occurrences. It is necessary to compare all securities to the same market benchmark in order to determine which characteristics of one security make it different from another, resulting in a dispersion in pricing spread. The point of reference used for the all of these models was the

average market spread calculated by investment banks that frequently trade and issue CMBS bonds. JP Morgan Investment Bank provided average spreads on a weekly basis for AAA CMBS bonds of four different durations, three, five, seven, and ten years. In the "Pricing At Origination" model, the initial spread of each bond was compared to the average AAA CMBS spread over treasury for the corresponding duration at that point in time. For the "Pricing After Origination" first scenario model, the current deal specific spread was compared to the current market spread of CMBS bonds of a corresponding duration. For the "Pricing After Origination" second scenario model, the difference in the current pricing spread and the initial spread was compared to the change in the market spread for bonds of a comparable duration over the corresponding time period.

The Time Variable

In addition to market and deal variables, it was also necessary to create a time variable for each model. For the "Pricing At Origination" model, each of the fifty bonds had an initial issuance date in the month/day/year format. In order to analyze pricing over time, these dates had to be converted to a time variable in the format of days. The first date of issuance of any of the bonds was 06/01/2001, and considered day zero and every other date of issuance was converted to a number of days from 6/1/01. The time variable, therefore, ranges from 0 to 2022 (2022 days from 06/01/2001 or 12/14/2006. For both scenarios of the "Pricing After Origination" model, the time variable created was the time elapsed since origination, again in the number of days format.

3.2 Methodology

The authors used regression analysis in Microsoft Office Excel to analyze each of the deal level variables, time variables, and market variables. The process for the "Pricing At Origination" model was slightly different from that of the "Pricing After Origination" models in that it utilized a step regression analysis procedure. In this process, each variable was tested initially using univariate regression analysis, meaning each variable was tested for significance as a single independent variable that may or may not significantly impact the dependent variable (in this case the initial spread). This process was an important step for the "Pricing At Origination" model due to the significant number of variables initially provided to the authors by Trepp. Trepp's deal history data included one hundred and seventy five different variables, many of which the authors suspected would not have any impact on the initial pricing spreads. As each variable was tested individually, only those that appeared significant were then utilized in the multivariate regression analysis. Through this step regression process, the authors were able to narrow down the variables from Trepp's initial one hundred and seventy five variables to a more manageable sixteen factors, including the market and time variables. The final sixteen variables in addition to market and time were percent retail anchored, percent in state one percent, duration, cutoff DSCR, cutoff AAA subordination, percent hotel, percent retail unanchored, percent in top five loans, percent office, percent multi-family, cutoff LTV, percent industrial, months yield maintenance, and months penalty. These sixteen variables were then analyzed in different combinations with each other to find out which had the most significance.

The first scenario in the "Pricing After Origination" model uses a standard linear regression equation, setting current deal spread as the dependent variable and the other factor variables

listed in table 3.3 as the independent variables, to help determine which factors are influencing current market spreads over time. The second scenario in the "Pricing After Origination" model was created after interpreting the results from the first scenario. The second scenario controls for changes in these variables from origination. Using a standard linear regression equation, the regression sets the difference in current deal spread since its inception as the dependent variable and the other variables listed in table 3.4 as the independent variables. The authors believe that the second scenario will improve upon the results observed from the first model.

For all of the models, before beginning regression analysis, the authors considered each variable in depth and attempted to forecast whether the occurrence of such a variable would have a positive or negative impact on the price of the security (whether the initial price or the secondary price depending on the model). The predicted coefficients were then compared to the actual coefficient results and any surprising results were addressed further.

Chapter 4

Pricing At Origination Model and Results

4. 1 Coefficient Predictions

Table 4.1 demonstrates the authors' initial thoughts on how each variable would impact the initial pricing spread. A positive (+) coefficient means that the variable would lead to a higher pricing spread, while a negative (-) coefficient means the opposite, that the variable would cause the pricing spread to be lower, commonly referred to as "tighter spread."

Table 4.1: Coefficient Predictions - Pricing at Origination Model

Variable	Predicted Coefficient	Reason
Initial Spread		*Dependent Variable*
Average Market Spread	+	Each specific bond is expected to correlate strongly with the market
Date	-	Market Spreads decreased over time during this time period so it is expected an increase in time would correlate to a decrease in initial spread.
RetailAnchoredPct	-	Anchored retail suggests a strong tenant roster and less risk
State1Pct	+	Higher concentration in one state suggests more geographic risk
Duration	-	Bonds of shorter duration are thought to be less risky
CutoffDSCR_NCF	-	Higher DSCR suggests more cushion for payment of loans
CutoffAaa Subordination	-	Higher subordination gives more protection to the AAA holder
HotelFullPct	+	Hotels are perceived to be a more risky property type
Retail UnanchoredPct	?	Retail unanchored properties are thought to be more risky than anchored retail but retail is still considered a strong property type, particularly if it is in a mixed use property.
Top5LoansPct	+	More concentration in fewer loans seen as more risky
OfficePct	?	Office properties have a relatively low delinquency rate but longer term leases add risk
MultifamilyPct	-	Short term nature of leases lessens risk and allow revenue to rise with expenses
CutoffLTV	-	Lower LTV adds cushion to the risk of default
IndustrialPct	+	Specialized uses add to rollover risk

MonthsYM	+	
MonthsPenalty	-	The more months left on the pre-payment penalty the less risk

4. 2 Regression Results

(Dependent Variable = Initial Spread)

Figure 4.1 shows the regression results for this model:

Figure 4.1: Regression Results for Pricing at Origination Model – All Sixteen Variables

Regression Statistics	
Multiple R	0.97242076
R Square	0.945602134
Adjusted R Square	0.918403201
Standard Error	6.016238983
Observations	50

	Coefficients	*Standard Error*	*t Stat*
Intercept	38.9888368	46.06009344	0.84647759
AAA Spread Over Treasury	1.11220804	0.105297521	**10.5625283**
Date	0.00551744	0.003529388	1.56328377
RetailAnchoredPct	-0.1813911	0.109344336	-1.6588983
State1Pct	0.32250077	0.175944687	1.83296682
Duration	-1.0033942	0.627065628	-1.6001423
CutoffDSCR_NCF	-9.1405071	4.903415376	-1.8641103
CutoffAaaSubordination	-0.0007951	0.269764066	-0.0029472
HotelFullPct	0.30275316	0.344368634	0.87915428
RetailUnanchoredPct	-0.1290878	0.195988387	-0.6586501
Top5LoansPct	0.06974658	0.146232165	0.47695787
OfficePct	-0.0189223	0.093700979	-0.2019432
MultifamilyPct	0.06262929	0.132813982	0.47155644
CutoffLTV	-0.4338893	0.422944609	-1.0258773
IndustrialPct	0.30467405	0.256854961	1.18617156
MonthsYM	0.30225856	0.365366421	0.82727516
MonthsPenalty	-0.3932943	0.418462063	-0.9398566

Using the methodology described in Chapter 3, the authors obtained 97.2% of the variation in initial deal spread as compared to the average market spread. Only one of the independent variables is significant at a 95% confidence level.

Because only one independent variable was found to be significant, regression analyses was re-run with different combinations of variables in an attempt to identify other independent variables that were significant. Figure 4.2 shows the regression results for a combination of nine different variables, five of which were found to be significant.

Figure 4.2: Regression Results for Pricing at Origination Model – Nine Variables

Regression Statistics	
Multiple R	0.968107673
R Square	0.937232467
Adjusted R Square	0.922747651
Standard Error	5.853887388
Observations	50

	Coefficients	*Standard Error*	*t Stat*
Intercept	10.71773061	10.93839308	0.979826793
AAA Spread Over Treasury	1.131466997	0.096169311	**11.7653645**
CutoffDSCR_NCF	-4.914121103	2.7868365	-1.763333121
Date	0.006181988	0.003056351	**2.022669334**
RetailUnanchoredPct	-0.111784635	0.159773553	-0.699644169
RetailAnchoredPct	-0.197748095	0.09210821	**-2.14691063**
HotelFullPct	-0.03509817	0.285792926	-0.122809792
State1Pct	0.273566319	0.095143577	**2.875299915**
Duration	-1.34031983	0.586683987	**-2.284568624**
CutoffAaaSubordination	-0.147318158	0.242156309	-0.608359776

This regression analysis produced a 96.8% variation in initial deal spread as compared to the average market spread.

Figure 4.3 shows the regression results for the same variables, excluding Hotel Percent, Retail Unanchored, and Cutoff Subordination, all of which did not have a significant T-stat in the previous regression analysis. The authors kept Cutoff DSCR despite the fact it was not significant because the T-Stat of -1.76 was close to the 1.9 T-Stat significance level. The authors obtained a 96.8 % of the variation in initial deal spread as compared to the average market spread, with five out of six variables significant within a 95% confidence level. Cutoff DSCR was still not found to be significant, but it will be discussed in the following sections due to its possible relevance.

Figure 4.3: Regression Results for Pricing at Origination Model – Six Variables

Regression Statistics	
Multiple R	0.967520666
R Square	0.93609624
Adjusted R Square	0.926967131
Standard Error	5.691774654
Observations	50

	Coefficients	*Standard Error*	*t Stat*
Intercept	-1.88535493	12.75585711	-0.14780308
AAA Spread Over Treasury	1.12216498	0.092127439	**12.1805728**
CutoffDSCR_NCF	-4.55455158	2.672369737	-1.70431191
Date	0.006067402	0.002829852	**2.14407061**
RetailAnchoredPct	-0.17513089	0.084120202	**-2.08191233**
State1Pct	0.296991302	0.085615884	**3.46888086**
Duration	-1.40509018	0.562290879	**-2.49886711**

4.3 Discussion of Variables

Table 4.2: Discussion of Variables - First Scenario Pricing After Origination Model

Average Market Spread	The positive sign is expected. A 1% increase in the average market spread results in a 1.12% increase in the initial spread.
Date	The positive sign is unexpected. Each year beyond 6/1/01 results in an initial spread increase of 2.21%.
RetailAnchoredPct	The negative sign is expected. A 1% increase in percent anchored retail results in a .175% decrease in the initial spread.
State1Pct	The positive sign is expected. A 1% increase in the percent of pool in State 1 results in a .297% increase in the initial spread.
Duration	The negative sign is expected. A 1% increase in duration results in a 1.405% decrease in the initial spread.
CutoffDSCR_NCF	The negative sign is expected. An increase of 1% in the DSCR results in a 4.55% decrease in the initial spread.

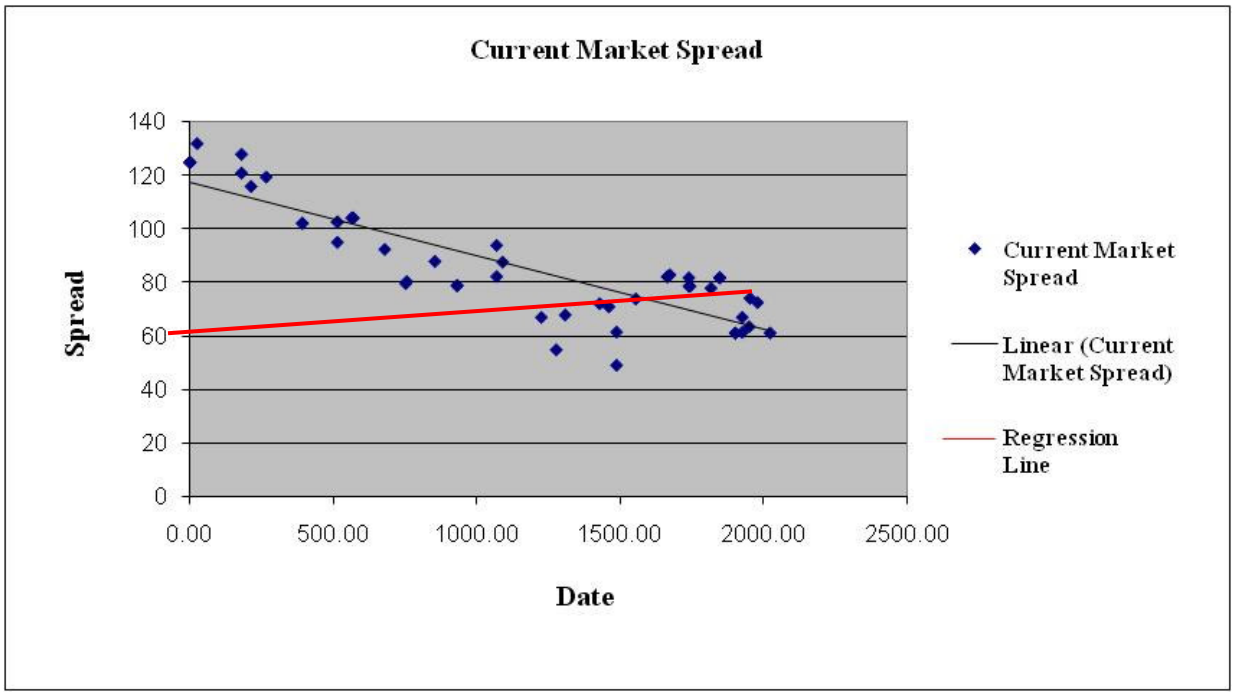
This regression analysis returned very similar results to the Kilgore and Polleys study, though the chosen variables are slightly different and therefore the two studies cannot be compared exactly. In one test performed by Kilgore and Polleys' in which they were testing the percent subordination required by investors, a .1 increase in Debt Service Coverage Ratio resulted in a 2.39% decrease in the required subordination. This is consistent with the author's results showing that a 1% increase in the DSCR resulted in a 4.55% decrease in the initial spread, demonstrating that investors favor higher Debt Service Coverage Ratios. In the same test,

Kilgore and Polleys' found Retail[6] to have a downward influence on the required subordination, with a 10% increase in retail collateral in a pool resulting in a 1.029% drop in the required subordination, showing that investors at that time favored retail as a property type. The Polleys Kilgore results are similar to the results here, in which an increase of 1% in the percent of anchored retail resulted in a .175% decrease in the initial spread, demonstrating that investors still favor retail. Kilgore and Polleys' also found similar results concerning geographic concentration. In the same test, they found that a 10% increase in the geographic concentration of the collateral resulted in a .67% increase in the required subordination, revealing that investors did not favor high concentration in one geographic location. In this study, a 1% increase in the concentration of properties in the top state resulted in a .297% increase in the initial spread.

One variable that returned surprising results is the date variable. Kilgore and Polleys' performed another test to study dispersion in spreads and found that for each additional year after their start date of March, 1994, spreads declined by 2.8 basis points. This decline was consistent with a trend of lower average spreads in the AAA rated CMBS market over the same time period. While, the same trend was true for the AAA rated CMBS market for the time period in this study (as demonstrated in Figure 4.4), the date variable in this study varied from that of the Kilgore and Polleys's study, producing a positive coefficient sign, indicating that spreads on new issues have increased over time.

[6] In the Polley's and Kilgore study this variable was not split up between retail anchored and retail unanchored

Figure 4.4: Average Market Spreads for AAA CMBS: June 2001 – December 2006



Source: JP Morgan Chase

This unexpected result suggests that the authors are missing an important factor in their analysis. One very relevant factor that may be missing is the change in actual treasury rates over this time period. This analysis carefully tracks changes in market spreads, but this model does not control for any changes in treasury rates. This could be an important factor due to the total expected return of a particular security. For example, if the base treasury rate that a spread is quoted on is just 1%, a 100 basis point spread would mean a risk premium of 100% above the treasury (considered to be the risk free rate). At the same time if treasury rates are higher, say 4%, a 100 basis point spread would only mean a 25% risk premium over the risk free rate despite the same spread level.

In order to test for changes in treasury, the authors added a variable for corresponding treasury rates to control for any changes in treasuries. The expectation was that once treasury rates were

controlled for, the result would be a negative coefficient for the date variable. The authors ran this using the six final variables from the initial regressions (the five significant variables plus the Cutoff DSCR) plus the treasury rates.

Figure 4.5 shows the regression results for the five significant variables, plus Cutoff DSCR and with the addition of Treasury rates.

Figure 4.5: Regression Results for Pricing at Origination Model – Six Variables Plus Treasury Rates

Regression Statistics	
Multiple R	0.967544769
R Square	0.93614288
Adjusted R Square	0.925240445
Standard Error	5.758665745
Observations	50

	Coefficients	*Standard Error*	*t Stat*
Intercept	-2.13351329	12.98519511	-0.16430352
AAA Spread Over Treasury	1.137532222	0.128740538	**8.83585105**
Date	0.006558258	0.004030294	1.62724081
Corresponding Treasury	-0.00372684	0.0215364	-0.17304843
Duration	-1.41206321	0.570324332	**-2.47589509**
State1Pct	0.299354713	0.087692128	**3.41370108**
CutoffDSCR_NCF	-4.53240735	2.706802573	-1.67445066
RetailAnchoredPct	-0.18050633	0.090600401	**-1.99233477**

When controlling for changes in Treasury Rates, signs of all coefficients remain exactly the same as in the original model, including the date variable, though now the date variable does not have a significant T-stat. The positive date variable shows that changes in treasury rates are not the missing factor.

After further consideration, the authors concluded that the lack of an exact comparison between the deal level variables and the market variable was causing this unexpected result. The market variable includes both new issuances and trades in the secondary market, while the deal variables look exclusively at initial issuances. Thus while the market spreads for AAA rated CMBS clearly decreased from 2001 to 2006, demonstrating a fondness by investors for AAA rated CMBS overall, the regression results show an aversion over this same period to new CMBS issuances. In fact, an increase of one year, when controlling for Treasury Rates and all the other variables, results in a 2.39% increase in the initial spread. This relationship implies that investors were skeptical about newer issued CMBS and were inclined to pay a premium for seasoned AAA rated CMBS. Given the looser underwriting standards by the rating agencies in recent years, clearly demonstrated in Table 1.1 of the Introduction chapter, it is not surprising that investors favored re-sales in the secondary market over new issuances and demonstrates that investors concluded that a AAA rated CMBS issued in 2006 was not of the same quality as a AAA CMBS issued a few years before.

Chapter 5

Pricing After Origination Models and Results

5.1 Coefficient Predictions – First Scenario Pricing After Origination Model

Table 5.1 shows the coefficient predictions for the first scenario of the "Pricing After Origination" Model. As with the "Pricing At Origination" Model, a positive (+) coefficient means that the variable would lead to a higher pricing spread, while a negative (-) coefficient means the opposite, that the variable would cause the pricing spread to be lower, commonly referred to as a "tighter spread."

Table 5.1: Coefficient Predictions - First Scenario Pricing After Origination Model

Variable	Predicted Coefficient	Reason
Current Deal Spread		*Dependent Variable*
Current Mkt Spread	+	Each specific bond is expected to correlate strongly with the market
Time Elapsed	-	Stronger performance for seasoning
Current DSCR	-	Stronger performance due to higher DSCR levels over time
Current AAA Subordination	-	Stronger performance due to positive changes in subordination levels over time
ASER Pct	-	Stronger performance due to higher ASER levels
PerformSpecialSrvcdPct	+	Weaker performance due to higher Special Servicer levels
Delinq90DayPct	+	Weaker performance due to higher Delinquency levels
ForeclosurePct	+	Weaker performance due to higher Foreclosure levels
REOPct	+	Weaker performance due to higher REO levels

5. 2 Regression Results – First Scenario Pricing After Origination Model

Figure 5.1 shows the regression results for the first scenario of the "Pricing After Origination" study.

Figure 5.1: Regression Results for First Scenario of Pricing After Origination Model (Dependent Variable = Current Deal Spread)

Regression Statistics	
Multiple R	0.952835503
R Square	0.907895496
Adjusted R Square	0.907799342
Standard Error	9.43392659
Observations	8631

	Coefficients	*Standard Error*	*t Stat*
Intercept	13.12414268	0.822059475	15.96495519
Current Mkt Spread	0.761867788	0.002625107	290.2235146
Time Elapsed (Days)	-0.003261202	0.000191753	-17.00727436
CurrentDSCR_NCF	1.801957777	0.281286609	6.406127124
CurrentAaaSubordination	0.435732501	0.029453066	14.79413027
ASERPct	5.055271493	0.796433702	6.347385202
PerformSpecialSrvcdPct	1.032199863	0.212885934	4.848605274
Delinq90DayPct	1.631779786	0.255799131	6.379145147
ForeclosurePct	-4.542314117	0.515571202	-8.810255696
REOPct	3.294919816	0.308056356	10.69583455

Using the methodology described in Chapter 3, the authors were able to capture 95.3% of the variation in current deal spread as it changed over time. All independent variables are significant at a 95% confidence level.

5. 3 Discussion of Variables – First Scenario Pricing After Origination Model

Table 5.2: Discussion of Variables - First Scenario Pricing After Origination Model

Current Market Spread	The positive sign is as expected. A 1% increase in the market spread results in a .76% increase in the expected spread
Time Elapsed (Days)	The negative sign is as expected. There is a strong preference for seasoning. Each year of seasoning decreases the expected deal spread by 1.18%.
CurrentDSCR NCF	The positive sign is not expected. The regression shows that spreads increase with a higher current level of DSCR.
CurrentAAA Subordination	The positive sign is not expected. The regression shows that spreads increase with a higher current level of AAA subordination.
ASER Pct	The positive sign is not expected. The regression shows that spreads increase with a higher level of ASER loan balance.
Perform Special Servicer	The positive sign is as expected. A 1% increase of the loan balance in Special Servicer increases the expected deal spread by 1.03%.
Delinquency 90 Days	The positive sign is as expected. A 1% increase of the loan balance in 90 days delinquency increases the expected deal spread by 1.63%.
Foreclosure Pct	The negative sign is not expected. A 1% increase of the loan balance in foreclosure decreases the expected deal spread by 4.54%.
REO Pct	The positive sign is as expected. A 1% increase of the loan balance in REO status increases the expected deal spread by 3.29%.

The authors are unable to explain the sign on the CurrentDSCR NCF, Current AAA Subordination, ASER Pct, and Foreclosure Pct variables. There must be other factors in the data set that are influencing the incorrect sign on these variables and that are not being controlled for in the regression.

The abbreviated regression equation for this scenario is,

$$P_{it} = \alpha + \beta X_{it} + \ldots + \delta_i + \varepsilon_{it}$$

In this abbreviated regression equation the BX_{it} is the CurrentDSCR NCF variable, and sigma (δ) represents the omitted factors that are not included in the regression. There is something inherently more risky with the deals in that a higher DSCR ratio, higher subordination ratio, or a Foreclosure Percent, would result in a higher current spread. This can be explained by the sigma, which represents the omitted factors.

The results of this first scenario model run counter to theory. The authors recognized that a new model, the second scenario, was needed to eliminate the sigma, or omitted factors, in this regression analysis.

5.4 Coefficient Predictions – Second Scenario Pricing After Origination Model

Table 5.3 shows the coefficient predictions for the second scenario of the "Pricing After Origination" Model.

Table 5.3: Coefficient Predictions – Second Scenario Pricing After Origination Model

Variable	Predicted Coefficient	Reason
Diff in Deal Spread		*Dependent Variable*
Diff in Current Mkt Spread	+	Each specific bond is expected to correlate strongly with the market
Time Elapsed	-	Stronger performance for seasoning
Diff in DSCR	-	Stronger performance due to higher DSCR levels over time

Diff in AAA Subordination	-	Stronger performance due to positive changes in subordination levels over time
ASER Pct	-	Stronger performance due to higher ASER levels
PerformSpecialSrvcdPct	+	Weaker performance due to higher Special Servicer levels
Delinq90DayPct	+	Weaker performance due to higher Delinquency levels
ForeclosurePct	+	Weaker performance due to higher Foreclosure levels
REOPct	+	Weaker performance due to higher REO levels

5.5 Regression Results – Second Scenario Pricing After Origination Model

Figure 5.2 shows the regression results for the second scenario of the "Pricing After Origination" study.

Figure 5.2: Regression Results for Second Scenario of Pricing After Origination Model (Dependent Variable = Diff in Current Deal Spread)

Regression Statistics	
Multiple R	0.957890211
R Square	0.917553657
Adjusted R Square	0.917467586
Standard Error	10.93939698
Observations	8631

	Coefficients	*Standard Error*	*t Stat*
Intercept	2.953438833	0.224524974	13.15416626
Diff in Current Mkt Spread	0.772911569	0.002748988	281.162195
Time Elapsed (Days)	-0.005649949	0.00022456	-25.1601304
Diff in DSCR	-6.893235823	0.556544473	-12.38577716
Diff in AAA Subordination	-0.657270572	0.054618356	-12.0338769
ASERPct	-1.980245409	0.929002068	-2.131583424
PerformSpecialSrvcdPct	2.372389336	0.24594456	9.646032956
Delinq90DayPct	2.50856353	0.291573246	8.60354497
ForeclosurePct	-4.283588852	0.601751855	-7.118530369
REOPct	4.366589741	0.355191421	12.2936239

Using the methodology described in Chapter 3 the authors were able to capture 95.8% of the variation in the difference in current deal spread since origination. All independent variables are significant at a 95% confidence level.

5. 6 Discussion of Variables – Second Scenario Pricing After Origination Model

Table 5.4: Discussion of Variables - Second Scenario Pricing After Origination Model

Diff in Curr Mkt Spread	The positive sign is as expected. A 1% increase in the market spread results in a .77% increase in the expected change in deal spread.
Time Elapsed (Days)	The negative sign is as expected. There is a strong preference for seasoning. Each year of seasoning decreases the expected change in deal spread by 2.09%.
CurrentDSCR NCF	The negative sign is as expected. A 1% increase in the current DSCR level results in a 6.89% decrease in the expected change in deal spread.
CurrentAAA Subordination	The negative sign is as expected. A 1% increase in the current subordination level results in a .65% decrease in the expected change in deal spread.
ASER Pct	The negative sign is as expected. The regression shows that spreads decrease with a higher level of ASER loan balance.
Perform Special Servicer	The positive sign is as expected. A 1% increase of the loan balance in Special Servicer increases the expected change in deal spread by 2.37%.
Delinquency 90 Days	The positive sign is as expected. A 1% increase of the loan balance in 90 days delinquency increases the expected change in deal spread by 2.51%.
Foreclosure Pct	The negative sign is not expected. A 1% increase of the loan balance in foreclosure decreases the expected change in deal spread by 4.28%.
REO Pct	The positive sign is as expected. A 1% increase of the loan balance in REO status increases the expected change in deal spread by 4.37%.

After analyzing the results of the first scenario, this model was created to try to minimize the influence of the omitted factors on the coefficients signs in the first scenario. The authors recognized that the pricing data was in panel data format, but the authors did not want to build a panel model. Instead, the authors built a model based on first differences. This model analyzes the changes in current prices since origination as a function of changes of current market and performance variables since origination.

The signs on the variables are now as expected except for Foreclosure Pct. This model greatly improves upon the first scenario. By controlling for changes since origination for the market and performance variables, the second scenario eliminates the omitted factors found in the first scenario and predicts the change in pricing since origination as a function of changes in these variables. The abbreviated regression equation for this scenario is,

$$P_{it} - P_{0t} = (\beta X_{it} - \beta X_{0t}) + \ldots + (\delta_i - \delta_i) + \varepsilon_{it}$$

The omitted factors are eliminated in this scenario, which creates a pure effect of the regression variables. Using first differences, the authors are properly able to analyze the price data, which is in panel model format, without having to actually build a panel model.

The sign on the Foreclosure Pct, which is still positive as in the previous model, might be due to the analysis of strictly AAA deals. Once an underperforming loan goes into Foreclosure the loss is attributed to the lower rated deal tranches. Therefore the AAA deals end up with a stronger pool of loans. Another explanation for the positive sign might be that before the foreclosure stage

is reached, there could be uncertainty on the extent of the loss. Once it enters foreclosure the extent of the loss is better known.

This model shows that logical changes to credit status (delinquency, REO, and ASER) and underlying loan quality (DSCR and AAA Subordination levels) influence deal spreads appropriately.

The analysis in this scenario proves that investors do use credit status characteristics in pricing Commercial Mortgage Backed Securities. The authors can conclude that the secondary market is transparent in that investors are using available information to price securities appropriately.

Chapter 6

Conclusion

6.1 Conclusion

In conclusion, tremendous growth in the CMBS market over the last two and a half decades, this thesis clearly demonstrates that accurately pricing CMBS remains a complicated undertaking. Unlike corporate or municipal bonds, the performance of CMBS is still difficult to predict, and the data necessary to do so is not readily available, leaving the investor to make a lot of assumptions that may or may not turn out to be true. This study scrutinizes the pricing issue at two different stages, at origination and after origination, in an attempt to reveal which factors are most important in determining the appropriate price of a Commercial Mortgage Backed Security at each of these points in time.

In studying pricing at origination, the authors show that although market spreads on CMBS decreased over time from 2001 to 2006, investors were actually shying away from newer issuances of CMBS in favor of resales and were willing to pay a premium for these older CMBS. These results demonstrate that the lax underwriting standards of recent years were not completely unnoticed by CMBS investors.

In examining pricing after origination the authors demonstrate that variations do exist in the pricing of CMBS and that overall the market has significant enough transparency to incorporate different factors into investment decisions. The second scenario builds upon the first scenario by predicting the change in pricing since origination as a function of change in those variables, and

eliminates the omitted factors found in the first scenario. The second scenario greatly improves upon the first as the results are more intuitive.

The authors recognize that the pricing data provided by Morgan Stanley did not validate the pricing data during the first half of 2008, but that it did validate the prices prior 2008. The authors were not able to determine the reason behind this discrepancy. Due to the proprietary nature of the CMBS market, and news coverage during the first half of 2008, very few companies were willing to provide specific pricing data that could have helped the authors provide an explanation for this discrepancy. The authors believe that volatility in the market, irrational investor behavior, or the lag associated with Trepp's model to incorporate actual prices during this time frame are possible explanations.

The authors have shown that the CMBS pricing market is transparent at origination and after, and have identified pricing factors in both markets. However, the factors that influence pricing are different. At origination, there is more emphasis on underlying loan characteristics such as Debt Service Coverage Ratio, Loan to Value, and geographic concentration. After origination, emphasis is on credit status characteristics such as delinquency and foreclosure percentages.

6.2 Areas of Future Research

A potential follow up to this thesis by a future MSRED student would be to obtain actual transactions for at least fifty deals over a two to three year time frame. The student(s) would need to begin gathering data as soon as possible and attempt to obtain a corporate sponsor for the thesis in order to gain access to the actual closed transaction prices in the secondary market.

Another potential paper could explore CMBS pricing in the first half of 2008. This paper demonstrates that pricing during this time frame was extremely volatile and there are still many unanswered questions as to why this period saw more volatility than any other economic crisis in history, including the Savings and Loan Scandal. The most difficult task for such a study would likely be procuring the data necessary to provide a meaningful analysis.

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Appendix

Exhibit 1

DealName	
DealType	
Distdate	Distribution Date. Packed date in the form of yyyymmdd
CutoffBalance	Collateral Balance as of the original collateral cutoff date for the transaction. Generally, the cutoff date is the first of the month in which the transaction closes
CurrentBalance	Current Collateral Balance
CutoffAssetCount	Number of Loans as of the original cutoff date
CurrentAssetCount	Current Number of Loans
MonthsLocked	Average numbers of months before the loans can prepay--"lockout". For modeling purposes, loans which can be defeased are treated as locked out.
MonthsYM	Average number of months before the end of the yield maintenance period. Generally starts at the end of lockout
MonthsPenalty	Average number of months before the end of the fixed prepayment penalty period
MonthsToMaturity	Average number of months to maturity
CutoffDSCR_NOI	DSCR as of closing, based on net operating income
CurrentDSCR_NOI	Current DSCR, based on net operating income
CutoffDSCR_NCF	DSCR as of closing, based on net cash flow
CurrentDSCR_NCF	Current DSCR, based on net cash flow
CutoffLTV	Average loan to value ratio at closing
CurrentLTV	Current average loan to value ratio
CutoffAaaSubordination	Lowest Credit enhancement at the AAA level as of closing
CurrentAaaSubordination	Current lowest credit enhancement at the AAA level
CutoffBaa3Subordination	Lowest Credit enhancement at the Baa3 level as of closing. Break point between investment grade and "B pieces"
CurrentBaa3Subordination	Current lowest credit enhancement at the Aaa3 level
GrossWAC	Weighted average coupon on the collateral, before servicing fees.
ASERAmt	Current balance of loans subject to "Appraisal Subordinate Entitlement Reductions", i.e., loans where the servicer is no longer advancing
ASERCnt	Current count of loans subject to ASER
ASERPct	Current balance of loans subject to ASER, as a % of Current Balance
CutoffDate	Original collateral cutoff date
SettleDate	Original Settlement Date
Underwriters	
RatingAgencies	
MonthsSeasoned	Average number of months the collateral has seasoned
MaturityLTV	Projects LTV value at maturity, assuming appraisal as of cutoff

Factor	Ratio of current collateral balance to cutoff balance
NetWAC	Weighted average coupon on the collateral, after servicing fees.
PerformSpecialSrvcdAmt	Current balance of loans which are not delinquent but have been transferred to the special servicer
PerformSpecialSrvcdCnt	Count
PerformSpecialSrvcdPct	Percent, based on balance.
Within30DayAmt	Balance of loans which are current
Within30DayCnt	
Within30DayPct	
Delinq30DayAmt	Balance of loans which are > 30 days delinquent, but less than 60 days
Delinq30DayCnt	
Delinq30DayPct	
Delinq60DayAmt	Balance of loans which are > 60 days delinquent, but less than 90 days
Delinq60DayCnt	
Delinq60DayPct	
Delinq90DayAmt	Balance of loans which are > 90 days delinquent
Delinq90DayCnt	
Delinq90DayPct	
CurrentExtendedBalloonAmt	Balance of loans which are past their original maturity date, but are current on payment of principal and interest, other than the balloon
CurrentExtendedBalloonCnt	
CurrentExtendedBalloonPct	
ForeclosureAmt	Balance of loans in foreclosure
ForeclosureCnt	
ForeclosurePct	
REOAmt	Balance of loans categorized as "real estate owned"
REOCnt	
REOPct	
DelinqUnknownAmt	Balance of loans without a delinquency status code, or with a code which is not recognized
DelinqUnknownCnt	
DelinqUnknownPct	
RetailUnanchoredAmt	Balance of loans classified as Retail/Unanchored
RetailUnanchoredCnt	
RetailUnanchoredPct	
RetailAnchoredAmt	Balance of loans classified as Retail/Anchored
RetailAnchoredCnt	
RetailAnchoredPct	
WarehouseAmt	Balance of loans classified as Warehouse
WarehouseCnt	
WarehousePct	
IndustrialAmt	Industrial
IndustrialCnt	

IndustrialPct	
OfficeAmt	Office
OfficeCnt	
OfficePct	
MixedUseAmt	Mixed Use (office/retail/multifamily)
MixedUseCnt	
MixedUsePct	
OtherAmt	Other
OtherCnt	
OtherPct	
MultifamilyAmt	Multifamily (excluding Cooperative Housing once that type was introduced)
MultifamilyCnt	
MultifamilyPct	
MobileHomeAmt	Secured by Mobile Home Park or other form of Manufactured Housing
MobileHomeCnt	
MobileHomePct	
HotelLimitedAmt	Limited Service Hotel
HotelLimitedCnt	
HotelLimitedPct	
HotelFullAmt	Full Service Hotel (generally, includes some form of restaurant and meeting rooms)
HotelFullCnt	
HotelFullPct	
HotelOtherAmt	Other type of Hotel
HotelOtherCnt	
HotelOtherPct	
HealthcareAmt	Healthcare, generally nursing home or hospital. Most doctors offices would be under office
HealthcareCnt	
HealthcarePct	
SelfStorageAmt	Self Storage facility
SelfStorageCnt	
SelfStoragePct	
CTLAmt	Current balance of loans which are categorized as "credit tenant leases"
CTLCnt	
CTLPct	
TypeUndefinedAmt	
TypeUndefinedCnt	
TypeUndefinedPct	
State1Name	Largest state concentration, by balance, at the property level
State1Amt	
State1PropCnt	

State1Pct	
State2Name	
State2Amt	
State2PropCnt	
State2Pct	
State3Name	
State3Amt	
State3PropCnt	
State3Pct	
State4Name	
State4Amt	
State4PropCnt	
State4Pct	
State5Name	
State5Amt	
State5PropCnt	
State5Pct	
Top1LoansAmt	Largest loan balance
Top1LoansPct	
Top5LoansAmt	Current balance of 5 largest loans
Top5LoansPct	
Top10LoansAmt	10 largest
Top10LoansPct	
Top15LoansAmt	15 largest
Top15LoansPct	
FixedAmt	Balance of loans paying a fixed interest rate
FixedCnt	
FixedPct	
FloatingAmt	Balance of loans paying a floating interest rate
FloatingCnt	
FloatingPct	
LockPct	Percent of loans, by balance, currently in lockout
YMPct	Percent of loans, by balance, currently subject to yield maintenance prepayment penalties
PPPct	Percent of loans, by balance, currently subject to fixed prepayment penalties
OpenPct	Percent of loans, by balance, prepayable without penalties
Issuer	
Series	
NonPerfMatBalloonAmt	Current balance of loans past their maturity date, which are not current on principal and interest
NonPerfMatBalloonCnt	
NonPerfMatBalloonPct	
IsRed	Deal is currently "red", ie, still in the offering stage
Updated	Last time the deal was updated

RestrictedTranches	Does the deal contain restricted tranches, generally, not publicly offered
DealCategory	Which "library" is it in
MSAs_1_25_Count	Number of loans which are located in the 25 largest MSA's
MSAs_1_25_Percent	
MSAs_1_25_Amount	
MSAs_26_50_Count	Number of loans which are located in the 26th through 50th MSA
MSAs_26_50_Percent	
MSAs_26_50_Amount	
MSAs_51_Count	Number of loans outside the 50 largest MSA's, but still in an MSA
MSAs_51_Percent	
MSAs_51_Amount	
Not_in_MSA_or_NA_Count	Number of loans which are outside of MSA
Not_in_MSA_or_NA_Percent	
Not_in_MSA_or_NA_Amount	
AllCollateralIDIn	
CallProvisions	Clean up call provisions
CurrBalMfDirected	Current balance of loans which pay the "multifamily directed" class
LoanPmtFreqFlag	
DefeaseCnt	Number of loans which have been defeased, ie, are now secured by government obligations
DefeaseAmt	
DefeasePct	
CoopHousingAmt	Current balance of loans which are secured by cooperative housing loans
CoopHousingCnt	
CoopHousingPct	

Exhibit 2

DealName
Full Name
CUSIP
TrancheName
Bond Balance
OriginalSubordinationPct
OriginalSnPRating
OriginalMoodysRating
OriginalFitchRating
pricingDt
Price
Yield
Spread
Duration
Wal
Yieldto
ppymeth
Ppyspd
updateDt
Dm
Swap
swapspread