Efficiency in Public Real Estate Securities: Extensions of an Equity-Based Pricing Model on CMBX 2.0

by

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Abstract

In this paper, we expand on the literature on CMBX 1.0 pricing and analyze whether returns on commercial real estate, expressed by REIT returns, provide an adequate explanation of returns observed on CMBX 2.0. We find that REIT returns have substantial explanatory power for CMBX 2.0 returns. Additionally, we analyze whether deteriorating underwriting standards across vintages between 2012 and 2015 are reflected in increased sensitivity of CMBX returns to REIT returns. We find increasing sensitivities to REIT returns across CMBS 2.0 vintages, holding fixed the credit ratings, suggesting that commercial mortgage investors understand the deterioration in underwriting standards and are skeptical of the credit ratings.

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Please note: The Literature Review has figures embedded into the body of the page. To avoid any confusion between Literature Review figures and primary research figures, the latter will be presented in the appendix.

1. *Literature Review*

This thesis was inspired by a paper written on the CMBX market published in 2011 by Joost Driessen and Otto Van Hemert titled, “Pricing of Commercial Real Estate Securities during the 2007-2009 Financial Crisis.” As such, in this section, we provide a summary and analysis of the work of Driessen and Van Hemert.

In their paper, Driessen and Van Hemert postulate that returns in the real estate investment trust (REIT) market should provide an accurate proxy for CMBX returns due to the similarities of the underlying collateral and relative liquidity of the two markets. The relationship between REITs and CMBX leads the authors to develop a pricing model, which uses stock price and option data on REITs and the S&P 500 to price CMBX tranches.

1.1 Understanding CMBS contracts

Figure 1

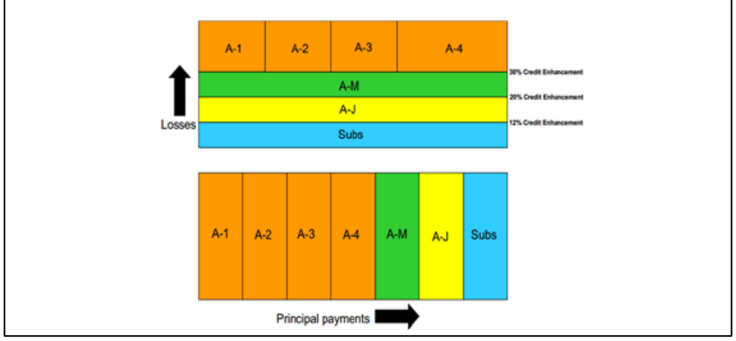


Figure 3: Basic structure for the cash flow allocation to different traches

The figure illustrates the basic structure for the cash flow allocation to different tranches. In practise many variations exist.

To understand CMBX contracts, one has to understand the risk characteristics of the CMBS deals which underlie the CMBX contract. The figure above is an illustration the authors provide which shows the cash flow and loss characteristics of CMBS (Van Hemert, Driessen 2009). A commercial mortgage backed security is a bond whose payments are derived from an underlying pool of individual commercial mortgages. Individual mortgages are bundled together and then pooled into a special purpose vehicle, which usually takes the form of a real estate mortgage investment conduit. Once pooled into the special purpose vehicle, the cash flows of the underlying mortgages are structured into bonds which are split into separate tranches based on credit risk. This format allows CMBS originators to take illiquid commercial mortgages and create liquid securities in the form of CMBS. Additionally, by the mechanism of credit enhancement, it allows CMBS originators to create AAA rated securities even though the underlying loans of a CMBS would not necessarily receive the same rating if rated on a standalone basis. For investors, the CMBS structure allows for liquid investments in the traditionally illiquid commercial mortgage market. The CMBS structure also allows investors to choose the security they invest in according to their individual risk tolerance and return preferences. Investors in the CMBS market can invest in AAA rated bonds which offer relatively low yields and commensurate credit risk, or they can invest in the more opportunistic securities of CMBS, for instance BBB- rated CMBS which should offer relatively higher yields, but also higher credit risk.

As the underlying loans of the CMBS pay each month, payments are passed on to the bondholders of the CMBS from the master servicer on the deal according to the specific payment criteria of the bond they hold. As shown in the illustration above, the top bonds of the credit stack, A-1 through A-4, are supported via credit enhancement by the securities below them. This continues throughout the capital stack. The class which Driessen and Van Hemert refer to as the “Subs,” is actually made up of numerous securities with credit ratings ranging from AA to unrated. The Subs act as a buffer to the AAA rated tranches of the CMBS. When losses occur on a CMBS they flow from the bottom of the capital stack to the top, thus the unrated bonds of a CMBS absorb the first losses in the event of a default on one of the loans in the pool. As mentioned earlier, this makes lower rated bonds riskier than their higher rated counterparts. Investors demand higher yields on these securities as compensation for the risk. Therefore, we can describe yields as increasing as one moves down the capital stack.

As shown in the illustration above, principal repayments also flow across the capital stack. While, the A-1 through A-4 bonds all have the same subordination levels, they have different prepayment criteria. The A-1 bond is known as the first-pay bond of a class dubbed the “super seniors” while the A-4 bond is referred to as the last pay bond of this class. In the event of prepayments, the A-1, A-2, A-3 and A-4 bonds are paid sequentially. After the “super seniors” absorb all prepayments, the remaining CMBS bonds are paid according to credit ratings with prepayments flowing down the capital stack to the extent that there are no losses on the tranches. The figure below is representative of a typical CMBS offering during the period of Driessen and Van Hemert’s writing and is shown for the reader to better understand tranching of CMBS. The CMBS deal, GSMS 2007-GG10 was securitized in 2007, had 202 underlying loans at origination, and is a constituent of CMBX Series 5, which is included in the authors’ analysis.

Figure 2

STRUCTURAL OVERVIEW

OFFERED CERTIFICATES

CLASS	S&P	MOODY'S	FITCH	APPROX. CERTIFICATE BALANCE	APPROX. CREDIT SUPPORT(1)	APPROX. % OF CUT-OFF DATE BALANCE	WEIGHTED AVERAGE LIFE(2)	PRINCIPAL WINDOW(2)	ASSUMED FINAL DISTRIBUTION DATE(2)	RATE TYPE
A-1(3)	AAA	Aaa	AAA	$ 75,000,000	30.000%	0.992%	4.15	08/07 - 04/12	04/12	Fixed
A-2(3)	AAA	Aaa	AAA	$ 725,300,000	30.000%	9.590%	4.85	04/12 - 07/12	07/12	Fixed(4)
A-3(3)	AAA	Aaa	AAA	$ 246,609,000	30.000%	3.261%	6.62	01/14 - 06/14	06/14	Variable(5)
A-AB(3)	AAA	Aaa	AAA	$ 72,000,000	30.000%	0.952%	7.41	07/12 - 01/17	01/17	Variable(5)
A-4(3)	AAA	Aaa	AAA	$3,661,032,000	30.000%	48.409%	9.72	01/17 - 05/17	05/17	Variable(5)
A-1A(3)	AAA	Aaa	AAA	$ 514,000,000	30.000%	6.796%	9.35	08/10 - 05/17	05/17	Variable(5)
A-M	AAA	Aaa	AAA	$ 756,277,000	20.000%	10.000%	9.86	05/17 - 06/17	06/17	Variable(5)
A-J	AAA	Aaa	AAA	$ 519,941,000	13.125%	6.875%	9.92	06/17 - 06/17	06/17	Variable(5)
B	AA+	Aa1	AA+	$ 75,628,000	12.125%	1.000%	9.92	06/17 - 06/17	06/17	Variable(5)
C	AA	Aa2	AA	$ 94,535,000	10.875%	1.250%	9.92	06/17 - 06/17	06/17	Variable(5)
D	AA-	Aa3	AA-	$ 56,720,000	10.125%	0.750%	9.92	06/17 - 06/17	06/17	Variable(5)
E	A+	A1	A+	$ 56,721,000	9.375%	0.750%	9.92	06/17 - 06/17	06/17	Variable(5)
F	A	A2	A	$ 75,628,000	8.375%	1.000%	9.92	06/17 - 06/17	06/17	Variable(5)

NON - OFFERED CERTIFICATES

CLASS	S&P	MOODY'S	FITCH	APPROX. CERTIFICATE BALANCE / NOTIONAL AMOUNT	APPROX. CREDIT SUPPORT	APPROX. % OF CUT-OFF DATE BALANCE	WEIGHTED AVERAGE LIFE(2)	PRINCIPAL WINDOW(2)	ASSUMED FINAL DISTRIBUTION DATE(2)	RATE TYPE
G(6)	A-	A3	A-	$ 75,628,000	7.375%	1.000%	9.99	06/17 - 07/17	07/17	Variable(5)
H(6)	BBB+	Baa1	BBB+	$ 103,988,000	6.000%	1.375%	10.00	07/17 - 07/17	07/17	Variable(5)
J(6)	BBB	Baa2	BBB	$ 94,534,000	4.750%	1.250%	10.00	07/17 - 07/17	07/17	Variable(5)
K(6)	BBB-	Baa3	BBB-	$ 75,628,000	3.750%	1.000%	10.00	07/17 - 07/17	07/17	Variable(5)
L(6)	BB+	Ba1	BB+	$ 37,814,000	3.250%	0.500%	10.00	07/17 - 07/17	07/17	Fixed(4)
M(6)	BB	Ba2	BB	$ 18,907,000	3.000%	0.250%	10.00	07/17 - 07/17	07/17	Fixed(4)
N(6)	BB-	Ba3	BB-	$ 28,360,000	2.625%	0.375%	10.00	07/17 - 07/17	07/17	Fixed(4)
O(6)	B+	B1	B+	$ 18,907,000	2.375%	0.250%	10.00	07/17 - 07/17	07/17	Fixed(4)
P(6)	B	B2	B	$ 18,907,000	2.125%	0.250%	10.00	07/17 - 07/17	07/17	Fixed(4)
Q(6)	B-	B3	B-	$ 18,907,000	1.875%	0.250%	10.00	07/17 - 07/17	07/17	Fixed(4)
S(6)	NR	NR	NR	$ 141,802,702	0.000%	1.875%	10.08	07/17 - 05/18	05/18	Fixed(4)
X(6)(7)	AAA	Aaa	AAA	$7,562,773,702	N/A	N/A	N/A	N/A	N/A	(7)

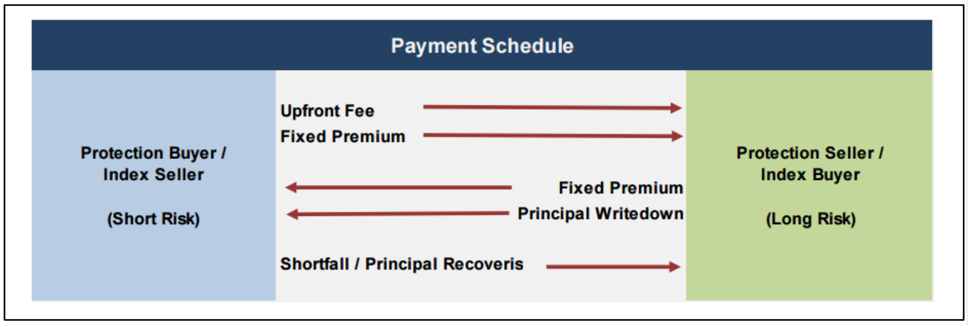
1.2 Understanding CMBX Contracts

Once the reader is familiar with the basics of CMBS contracts, we can begin to look at CMBX contracts. CMBX is a standardized collection of credit default swaps (CDS) on an underlying reference pool of 25 CMBS deals. Markit, a financial services company, standardizes the CMBX contracts. Markit chooses the underlying reference CMBS obligations, standardizes the contractual agreement between protection buyer and protection seller, and sets the fixed coupon payable by the buyer of protection on a CMBX security. At origination, each CMBX tranche trades at a price that sets the value of the value of the underlying CDS equal to zero – if the coupons set by Markit reflected the market price for protection at origination, then each tranche of CMBX would trade at $100 notional. For transactions after the origination date, the buyer and seller of protection enter into a contract at price $100 - P, for which the buyer of protection pays an upfront premium of P and additionally pays the fixed leg of the bond via the coupon set forth in the contract. In the event that the price of the CMBX is greater than 100, the seller of protection would pay an upfront premium to the buyer of protection. Current market convention is to express the CMBX contract's price in nominal dollar terms (100-P), however before the financial crisis it was common for market quotes to be given in terms of spread.

CMBX is structured as a pay-as-you-go ("PAUG") contract. As the underlying loans of the 25 constituent CMBS deals can default at any point during the life of the contract, CMBX is structured to allow for multiple credit event payments to occur throughout the life of the contract. The picture below provides an illustration of the payment streams of a CMBX contract. The buyer of protection via a CMBX contract pays a monthly fixed premium to the protection seller throughout the life of the contract based on the outstanding principal of the contract. In return, the protection seller pays the protection buyer in the event of any principal write-downs on the protection buyer's tranche. It is important to remember that as CMBX is a collection of 25 credit default swaps on 25 CMBS tranches, the value of the CMBX is not affected by the absolute losses on an underlying CMBS, but rather the losses on the specific reference tranche of the underlying CMBS. A simple illustration of this would be to imagine a BBB- CMBX where losses above 5% cause the BBB- tranche to be wiped out. Assuming for instance that 24 of the 25 underlying CMBS deals will suffer no losses, and the remaining CMBS deal will suffer 8% losses, wiping out the BBB- tranche, we should only have a principal write down of $4, which represents the proportional notional balance of the one CMBS deal in the CMBX. Crucially, if the loss on the one CMBS deal that suffers losses increases to 15%, we should not witness additional write downs on the CMBX, as the reference tranche has already been completely wiped out. The figure below presents an illustration of the payment obligations of both the protection buyer and protection seller in a CMBX contract.

(Note: the fixed premium paid by the protection seller, as shown in the figure below, is based on the accrued premium should the contract be entered in between two settlement dates. It is not indicative of a fixed premium owed from the protection seller to the protection buyer throughout the life of the contract).

Figure 3



1.3 The Options-based pricing model of Driessen, Van Hemert

The authors of the paper argue that since an investor selling protection via a CMBX contract has to pay the protection buyer in the event of a default on a reference CMBS obligation, which is most likely to occur when commercial property prices drop, CMBX can be viewed as a derivative on commercial real estate property values. The authors then argue that as CMBX can be viewed as a derivative on property values, returns on Real Estate Investment Trusts (REITs) should provide a good indicator of performance on CMBX. As REITs represent equity claims on commercial real estate assets, they should provide an accurate sample of the returns on the commercial real estate mortgages that underlie a CMBX. The authors further argue that options on REITs should provide additional information regarding the risk-neutral probability distribution of future property values. Using this logic, the authors propose REIT equity prices and option volatilities can be used to price CMBX.

The framework the authors develop has a number of simplifying assumptions for the sake of keeping model calculations brief. The authors list the following:

1. The authors assume that mortgages in the underlying CMBS deals are interest-only, that is, that they do not amortize over the life of the CMBS.
2. They ignore defeasance and pre-payment options in commercial mortgages.
3. They assume defaults only occur at maturity and therefore do not take into account term defaults on CMBX or REITs.
4. They do not allow for loan extensions or model bankruptcy costs.
5. REITs are actively managed and their prices may reflect growth options or manager skill in selecting investment opportunities. The authors do not explicitly model either of these conditions.
6. They assume risk-free rates are constant and therefore indicate that risk-free rates are independent from property value movements.

A number of the simplifying assumptions that the authors make are required due to the large size of a CMBX deal. As each underlying CMBS deal of a CMBX can have upwards of 100 loans, the level of analysis needed in order to model amortization or prepayment on the entire pool of loans can become very tedious. While the simplifying assumptions made by Driessen and Van Hemert may not be ideal, they do not appear to have a significant impact on the effectiveness of the model. An explanation of Driessen and Van Hemert’s model findings are explained in Section 1.6.

1.4 Model for Commercial Real Estate Property Values

In their paper, Driessen and Van Hemert develop a model for property values across three commercial real estate sectors which are typically present in CMBS pools. They denote these sectors using the notation: j, j = 1, . ,3. Where 1 to 3 denote the sector: office, retail, or multifamily. They then let i be equal to an individual property within a given sector. Thus, in equation (1), V_{ij}, represents the value of a specific property i, within sector j. Equation (1) gives the value of a property based on market-wide shocks, real estate sector shocks, and idiosyncratic shocks, where r denotes the risk free-free rate, q the dividend rate, $\frac{dS}{S}$ the return of the S&P 500 index which is driven by volatility and Brownian motion W_0, the factor $\gamma_j dW_j$ represents a sector level shock driven by Brownian motion W_j, and the final term represents a property specific shock.

$$\frac{dV_{ij}}{V_{ij}} = (r - q)dt + B_j\sigma_s dW_0 + \gamma_j dW_j + \sigma_j dZ_{ij} \quad (1)$$

$$\frac{dS}{S} = rdt + \sigma_s dW_0 \quad (2)$$

Essentially, the authors view single asset real estate returns as being driven by the dividend rate (or unlevered return of the property), sector exposure to the S&P 500, sector specific shocks, and lastly idiosyncratic shocks to individual real estate assets. Thus if we take a diversified portfolio of risky real estate assets the last term should be eliminated due to diversification benefits (Markowitz, 1952). This effect is exactly what the authors propose occurs in a REIT, which is essentially a diversified portfolio of real estate assets.

$$\frac{dV_{ij}}{V_{ij}} = (r - q)dt + B_j\sigma_s dW_0 + \gamma_j dW_j \ (3)$$

Equation (1) becomes Equation (3) when the underlying REIT is well diversified. Following Merton (1974) and assuming that the value of a REIT is a call option on a portfolio of real estate assets over and above the capital structure liabilities of the firm, where debt has face value D_j and maturity T_j, the firm's equity can be priced via the Black-Scholes formula for call options.

1.5 Model for CMBX Valuation

$$P(CE^L, CE^H) = 100 + 4 * \sum_{k=1}^{25} \sum_{t=1}^{T} e^{-rft} E^q(CF_{t,k}^{fixed} \text{-} CF_{t,k}^{floating}) \ (4)$$

CMBX is a contract, which insures 25 underlying CMBS deals, that each contain a number of underlying commercial mortgages, usually 80 or more. Each underlying reference CMBS has the same weight in the CMBX – in other words each credit default swap on an underlying CMBS carries a maximum notional value of $4 out of the $100 notional value of the CMBX. The price of a CMBX, at any given time should be equal to $100 notional minus the difference between the present value of the expected losses on each underlying reference obligation and the present value of the coupon payments paid by the protection buyer throughout the life of the contract. If were we looking at two hypothetical CMBX tranches both of which had no potential for losses, the difference in realized price should be the difference in the present values of the fixed coupons paid by each security.

Equation (4) presents a method for calculating the price of a CMBX by finding the difference of the present value of the fixed coupon payments payable from the buyer of protection to the seller of protection and floating loss payments payable to the buyer of protection from the seller of protection. Where the present values are equal to the summation across deals *k*, and payment dates *t*. E^Q denotes the risk-neutral probability at each time *t.* In their 2011 paper, Driessen and Van Hemert use a Monte Carlo simulation with 100 steps: $dt = (T-t)/100$ to simulate the risk-neutral distribution at time *t.* They then use the simulated risk-neutral distribution to price the security as shown in Equation (4).

$$CF_{t,k}^{fixed} = \left(1 - L_{t-1,k}^{tranche}\right) * C \quad (5)$$

Equation (5) provides the amount owed by the protection buyer under the fixed leg portion the CMBX at time t. Where $L_{t-1,k}^{tranche}$ is the cumulative tranche loss up to one period before the present and C is equal to the fixed coupon amount payable by the protection buyer under the standard CMBX contract administered by Markit.

$$CF_{t,k}^{floating} = L_{t,k}^{tranche} - L_{t-1,k}^{tranche} \quad (6)$$

Equation (6) gives the value that the protection seller must pay the protection buyer at time *t* on underlying reference obligation *k.* Each period, the protection seller must pay the buyer a floating payment equal to the losses on all 25 CMBS reference obligation tranches between the periods. The total floating payment at time *t*, is thus equivalent to the cumulative loss on the tranche at time *t* minus the cumulative loss at time *t* – 1.

$$L_{t,k}^{tranche} = \frac{\max\left\{L_{t,k}^{ptf} - CE^L, 0\right\} - \max\left\{L_{t,k}^{ptf} - CE^h, 0\right\}}{CE^H - CE^L} \quad (7)$$

Equation (7) gives the cumulative loss of a tranche on the underlying CMBS reference obligation *k*, at time *t.* CE^H and CE^L represent the attachment points of the CMBX tranche as defined in the standard terms set by Markit. The loss of a tranche at time *t* on obligation *k* is simply equal to the proportion of the tranche that is wiped out at time *t* due to the total amount of losses across loans in the CMBS. $L_{t,k}^{tranche}$, is thus, the proportion of a tranche that is wiped-out due to loan losses across the CMBS. As attachment points increase, (increasing subordination or credit enhancement), expected losses should decrease (See Stanton, Wallace 2010).

$$L_{t,k}^{ptf} = L_{t-1,k}^{ptf} + \sum_{i=1}^{I} w_k^i * D_{t,k}^i * \max\{1.0 - V_{t,k}^i, 0\} \quad (8)$$

Equation (8) represents the total loss of a CMBS deal *k* at time *t,* where *w* represents the weight of each loan *i* in CMBS deal *k*, *D* represents a threshold for default which must be passed before a default occurs, and *V* is the value of a specific loan *i* at time in CMBS deal *k*. The loss of a portfolio of loans, or a CMBS, is equal to the cumulative loss in the last period plus the value of the loss in the current period. The default trigger is set to equal the amount due at maturity for each loan *i*. If the loan passes below this threshold, the loan is considered defaulted.

$$V_{t,k}^{i} = \frac{1}{LTV_{0,k}^{i}} * \frac{V_{j,t}}{V_{j,0}} * e^{-.5\sigma_j^2 t + \sigma_j \sqrt{t}\varepsilon i} \quad (9)$$

Equation (9) is the formula that is used to describe the value of an individual loan *i* in CMBS deal *k* at time *t*. This formula presents the fundamental connection between commercial mortgage loan values and commercial real estate investment trust values. The explanation of Equation (9) will begin with the second term on the right hand side, which is equal to the value of real estate sector *j* at time *t* divided by the value of real estate sector *j* at time *0*, or the beginning observation value of V_j. This term creates the connection between observed returns on the REIT sample index and CMBX valuation throughout the observation period. As REIT returns increase throughout the period, the value of an individual loan underlying CMBX, expressed by $V_{t,k}^{i}$ should increase as well. Likewise, if commercial property values within a sector fall, the value of loans on properties within the sector should lose value as well. The left most term, $\frac{1}{LTV_{0,k}^{i}}$ represents the inverse loan-to-value ratio at origination of loan *i* in CMBS deal *k*. Driessen and Van Hemert argue that the LTV ratio “is the most common ratio [used] to examine the probability of default and expected losses on a CMBS.” (Driessen, Van Hemert 2011). Inverse LTVs are one of the potential measures for loan riskiness at origination. As, LTV increase, the probability of default, and therefore the expected losses of a loan, increase. This is due to the fact that high LTV loans have a smaller equity cushion to rely upon in the event of falling property values, or in the event of a shock to the sector or property. Therefore, the lower the LTV at origination, the higher the value of the loan. LTV’s are static in this model as it is assumed that all loans are interest-only. While LTV does not change, the debt to equity ratio of a property in sector *j* at time *t* can change based upon the total return of REITs in sector *j* at time *t*. The right most term of Equation (9) is simply a shock value which is applied on each day during the sample. The shock value depends on the equity volatility of the sector in which the real estate is segmented and on time to maturity of the CMBX deal. In their model Driessen and Van Hemert use both an implied volatility on REIT options as well as using implied sector level real estate volatilities as implied by loan level data (see Downing, Stanton, Wallace, 2007). As the deal approaches maturity, the shocks become smaller, which should increase the value of the loan. The last term in the right-most term ε*i* is an independent and identically distributed random variable, which provides normally distributed randomness to the shock value.

1.6 Findings of Driessen and Van Hemert

Employing their REIT equity and options-based pricing model, Van Hemert and Driessen arrive at the conclusion that the pricing model generates expected CMBX prices that are within reason of the actual prices observed during their period of observation. Looking specifically at Series 1 AA prices, at the beginning of their sample they observe that the model predicts small losses for the AA tranche, which is supportive of the market price during the period which was near $100. As the financial crisis unfolded, actual and model prices for the S1 AA tranche fell to $20, ultimately recovering to a price around $60 during the sample. Their model for CMBX prices appears to be accurate throughout the time series, although substantial short-term mispricing appears to occur during the period. Calculating the difference between the predicted model CMBX price and the actual observed price throughout the sample, Driessen and Van Hemert arrive at an actual minus model price differential of $8.22. Across the time series, the correlation of the model prices with the actual prices was 96%. This leads to an R-squared value of 91%, which means that 91% of the variation in CMBX prices can be explained by variation in the model prices. As their model does not calibrate CMBX prices to REIT returns, they conclude that their findings support the absence of substantial relative mispricing between CMBX and REIT markets.

They repeat their findings for other tranches in the Series 1 vintage and find similar high correlations between model prices and actual prices. However, they do indicate that there are short windows in which relative mispricing appears to exist. While some short-term pricing does appear to exist, the authors conclude that overall, there is little evidence of long-term relative mispricing between the REIT market and CMBX market. The authors claim that this conclusion is even more significant because their period of study was during a financial crisis.

The authors also examine the market-implied default rates given via observed CMBX prices throughout their sample period. To get from the observed CMBX prices to implied-probabilities of default, the authors utilize the risk neutral probability. They use the equation:

$$P(CE^L, CE^H) - 100 + 4 * \sum_{k=1}^{25} \sum_{t=1}^{T} e^{-rft} E^q (CF_{t,k}^{fixed} - CF_{t,k}^{floating}) = -100e^{-rf} Q(CE^L, CE^H)$$

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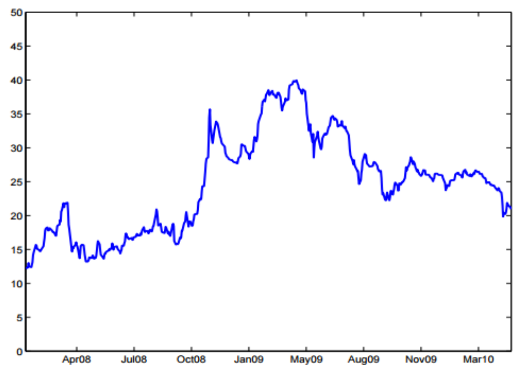
Where $Q(CE^L,CE^H)$ represents the risk-neutral loss probability of the tranche given the upper and lower attachment points. To solve for risk-neutral loss probability across their data set, the authors set forth a system of four equations corresponding to three ranges implied by the Series 1 AJ, AA, A tranches. Solving the system of equations using a 60% fixed recovery rate, the authors observe an implied default rate across the CMBS at a maximum of 40% throughout their observation period.

Figure 4

Fig. 10: Implied risk-neutral default rate for deals referenced by CMBX 1 (%)

The figure shows the implied risk-neutral default rate for deals reference by CMBX 1 (%). The sample period runs from January 4th, 2008 (when the CMBX 1 AJ tranche was introduced) until April 29th, 2010.



2. Introduction

Following the results of the work of Driessen and Van Hemert (2011), we became interested in exploring whether returns on CMBX 2.0 (CMBX with reference CMBS originated after the financial crisis) could still adequately be explained by REIT returns. There are numerous reasons to suspect that post-crisis CMBX could behave differently than pre-crisis CMBX. Most prominently, the CMBS that underlie CMBX 2.0 feature much more conservative underwriting standards than the CMBS which underlie pre-crisis CMBX. This may severely dampen the sensitivity of CMBS prices to REIT returns. Additional hypothesized reasons for changes in the explanatory power of commercial real estate returns on CMBX may include changed investor preferences and perceptions regarding the riskiness of commercial real estate. This paper will explore the adequacy of using REIT returns to explain returns on CMBX 2.0. In addition, and connected with the hypothesis that underwriting standards may change the explanatory power of REIT returns on CMBX returns, we analyze the connection between loosening loan underwriting standards across CMBX 1.0 and CMBX 2.0 vintages and examine the sensitivity of CMBX returns to REIT returns across CMBX vintages.

3. CMBS Background

The commercial mortgage backed securities (CMBS) market has become an important source of funding for commercial real estate investors since the market began to develop in the early 1980’s. Numerous advantages over traditional forms of financing allowed the CMBS market to develop, including: the ability for banks to transfer risk off their balance sheets, reduced funding costs for borrowers, and the creation of new investment products, which banks could pitch to their clients. The early to mid 2000's witnessed a large increase in CMBS originations volume, as the numerous benefits of securitization led to a large growth of capital and competition within in the space. Total CMBS origination volume peaked in 2007, with total origination of $230.5 billion. (See Appendix 1). As the economy slowed and credit markets faltered in 2008, CMBS volumes fell dramatically, with total origination volume of $12 billion. Originations volume fell to a cyclical low in 2009, with only $2.8 billion in originations. After the throes of the financial crisis, CMBS volumes have recovered and in 2015, CMBS originations totaled $95.1 billion – the largest amount since the recession.

As shown in Appendix 2, throughout the first half of the 2000's spreads for investment grade CMBS traded within a tight band. AAA CMBS traded at a minimum spread of 22 basis points over ten-year treasuries during 2006. While it is hard to observe due to the scale of the graph, spreads for CMBS as a whole fell from the beginning of the sample in 2002 before beginning to widen slightly in 2005 and 2006. The slight spread widening that occurred in 2005 and 2006 was certainly not a clear indication of the level of distress that was about to befall the CMBS market. In the period from 2007 to 2009, spreads widened dramatically in concert with the financial crisis. The most tumultuous period of spread widening began with the bankruptcy of Lehman Brothers in September 2008. In the period from the Lehman Brothers bankruptcy until November 21st 2008, some 67 days later, spreads on AAA CMBS rose 760 basis points. AA, A and BBB spreads rose 2800, 3225 and 2493 basis points, respectively. Market commentators reasoned that the reason CMBS spreads rose so dramatically over the course of a few weeks in November 2007 is due to the Federal Reserve's announcement of the first iteration of the Term-Asset Backed Securities Loan Facility (TALF 1.0). Crucially, the Federal Reserve indicated that older vintage non-AAA CMBS would not be included in the TALF 1.0 program. This caused spreads for these securities to widen as investors came to the realization that they would not receive credit support from the government. (Durden, 2011). Spreads for these securities, excluding BBB which continued to experience price volatility through 2010, peaked in early 2009. At its peak in 2009, AAA CMBS traded at 1200 basis points over treasuries. To put this in perspective, from 2002 until 2006 AAA CMBS traded at an average of 33 basis points over treasuries.

While a portion of the high spreads exhibited during the financial crisis can be explained by general panic, Appendix 3 shows the underlying state of the commercial mortgage market during the period. Mortgage delinquencies began to tick upwards in 2007, while 2008 and 2009 experienced large-scale delinquency rates, which continued through 2010 and 2011. As investors began to anticipate these delinquency rates in 2008, spreads widened to reflect the potential for losses on these bonds, as well as the uncertainty around loss severity, resolution timing, and other cash flow factors.

While legacy CMBS spreads remain elevated above their pre-crisis historical levels even today, the period from 2011 – 2015 produced a recovery in spreads from the lows of the financial crisis. The recovery in spreads is most noticeable in the AAA tranche of legacy CMBS, see Appendix 2. While CMBS spreads remained elevated in the period from 2009 through the beginning of 2011, almost no CMBS origination took place. When CMBS 2.0, so called as it provides a designation from legacy CMBS product, launched in 2011 the underlying loans were underwritten to strict standards and origination volumes remained significantly below their pre-crisis values.

4. *CMBX Background*

The first CMBX contract was issued by Markit in 2006. Markit, a financial services firm, creates CMBX by standardizing the CMBX contracts, setting the coupons for each of the tranches, and selecting the 25 underlying reference CMBS deals on which credit default swaps will be written. CMBX represents a contractual agreement between the buyer of protection and the seller of protection on a specific tranche of the basket of 25 CMBS underlying reference obligations. After Markit chooses the reference obligations to be included in a CMBX pool, the reference obligations underlying the pool are static. One way to view CMBX is as an insurance-like product – the buyer of protection pays a premium to the seller of protection and in return, the seller agrees to cover any losses on the underlying bonds. As the CMBX positions are settled on a monthly basis, with the seller of protection covering any losses to the buyer during the period, the derivative takes on a structure known as "pay-as-you-go" (PAUG). The PAUG structure of CMBX is important as it allows any credit events on the underlying bonds to be settled on a monthly basis, while also allowing any un-impacted reference obligations to remain un-impacted by credit events on other reference obligations. Therefore, unlike conventional CDS, a credit event does not cause the entire CDS to become payable. As CMBX represents a basket of CMBS each holding a pool of loans, the PAUG structure allows for the CMBX payments to accurately reflect the credit risks of holding CMBS.

CMBX is an important product in the CMBS market as it allows actors in the market to take positions and express investment hypotheses in a manner that CMBS does not. CMBS cash bonds are generally hard to borrow and therefore are not practical to short with the exception of a small number of highly liquid bonds. Additionally, CMBX allows an investor to enter into relative value trades. Within a single CMBX series, an investor can construct a relative value trade based on their view of bond pricing. If an investor feels that BBB- CMBX trades expensively relative to the A tranche, they can buy protection on the BBB- tranche while selling protection on the A tranche. (Manzi and Whetten, 2006). An investor can also set up a relative value trade to express credit risk across CMBS vintages, for instance by buying protection on Series 5 AA bonds while selling protection on Series 4 AA bonds. These relative value trading strategies are very difficult to execute in the cash bond market. Additionally, CMBS originators may use CMBX to hedge their risk to spread widening during the loan-warehousing period before a CMBS deal is originated. CMBX also allows investors to express views on the CMBS market without requiring the large capital outlays that are required in the cash market. An investor in a CMBS deal trading at par will require a $100 cash outlay, while an investor in a

CMBX deal that is trading at par will only be required to pay the accrued fixed coupon to the protection seller. Lastly, an investor can purchase CMBX to hedge and express a view on a basket of CMBS on the underlying. For instance, an investor can buy 15 cash bonds, which are reference obligations to a CMBX and then buy protection through the CMBX, which will create a short position on the remaining 10 CMBS bonds underlying the CMBX. (Lehman, et al., 2013). The numerous uses of CMBX create demand from both buyers and sellers of protection on the synthetic product.

From 2006 until 2008, 5 series of CMBX were issued. As with the underlying CMBS obligations, CMBX spreads widened significantly during the financial crisis. (See Appendices 4 and 5). According to the data provided by Driessen and Van Hemert in their paper, CMBX 1 AA traded at prices near $100, indicating little implied probability of default. As the financial crisis unfolded, Series 1 CMBX AA spreads widened significantly and prices of the AA tranche ultimately fell below $30.

5. *Data Sources*

Data for this project came from a variety of sources. CMBX prices are based on the observed daily closing price as reported by Bloomberg data provider CMAN. As a few of tranches in older CMBX series were less frequently traded during the observation period, prices on days that there were no trades registered, were linearly interpolated between days with a marked trade. This creates some smoothing in the price return data for CMBX, but avoids several large price movements caused by certain tranches being marked after not trading for what sometimes is a substantial period of time. REIT prices were obtained by using CRSP data for 6-year period beginning on January 4, 2010 and lasting throughout the observation period which ended December 31, 2015. The volatilities for each REIT in the sample is based off of the historical realized volatility of the prior 252 trading days. The sample for REIT returns consisted of 29 individual companies across 4 sectors (multifamily, office, retail and industrial) subject to a minimum market cap constraint.[1] Balance sheet data filed with the SEC was used for calculating each firm's outstanding debt, preferred equity and net cash position during each quarter of the sample. These values were held constant throughout the quarter and recalibrated every three months to coincide with the beginning of a new quarter. Swap rates were used to calculate the risk free rate to maturity throughout the period based on swap price data supplied from the Federal Reserve. We linearly interpolated 1, 2, 3, 4, 5, 7, and 10 year swaps on each day during the sample period to obtain a risk free rate to maturity for each security in the data set. Lastly, data for underwriting standards across CMBX vintages was collected from Trepp and Credit Suisse Fixed Income Research.

6. *CMBX 2.0 Loan Level Data*

[1] The tickers included in our sample are: AIV, ARE, AVB, BMR, BXP, CPT, DCT, DDR, DEI, DRE, EQR, ESS, FRT, GGP, HIW, KIM, KRC, LPT, MAA, MAC, NNN, O, PLD, REG, SLG, SPG, TCO, UDR, VNO

CMBX Series 6 is a unique CMBX vintage due to the strict underwriting standards of mortgages that underlie the reference CMBS obligations. Following the financial crisis CMBS origination volumes remained subdued and in 2012 CMBS volume was $44.4 billion. While this represented the highest post-crisis origination volume, it was still lower than the $48.0 billion that was originated in 2000 when the CMBS market was much less developed. Market commentators predicted that the post-recession CMBS market would remain tepid due to only modest real estate price recovery, rising rates of default on legacy CMBS, and banks remaining cautious among a changing regulatory landscape. (Lehman, et al., 2012). In this market environment CMBS originators were hesitant to originate any loans which could not easily be packaged and sold into the CMBS market. Given the subdued demand for CMBS product from investors during this time period, we see that the loans underlying CMBX Series 6 were the most conservative of any CMBX vintage on record.

As shown in Appendix 6, underwriting standards for the CMBS that backed Series 6 were much more conservative than for pre-crisis CMBX. For the pre-crisis loans that backed CMBX Series 1 through 5, weighted average loan to value (WALTV) averaged 68.70% while for the loans that backed Series 6 WALTV was 63.41%. The 63.41% WALTV for the reference obligations of Series 6 represented the lowest WALTV of any CMBX Series, about 450 basis points lower than the WALTV of Series 1 which was the closest CMBX vintage to S6 in terms of WALTV. Another key indicator of post crisis conservatism in CMBS underwriting can be seen in the level of loans with loan to value ratios greater than 80%. Pre-crisis CMBX had significant exposure, ranging from the high-teens to mid-twenties in percentage point terms, to these high leverage loans. Loans with higher loan to value ratios tend to be riskier as there as the highly leveraged capital structure makes the loans more susceptible to default. (For additional information see Wiggers, Ashcraft 2012). Assuming that borrowers are rational and default on a loan at some trigger value at which their property value is less than the amount owed on the mortgage, then higher LTV's should, all else being equal, raise the likelihood that this default trigger level is breached. (Vandell 1992). For the collateral which underlies CMBX 6, we observe exposure to 80% + LTVs which are far below historical averages. For CMBX 6 we observe 80%+ LTV exposure of just 0.71%. The relatively low exposure to high leverage loans in the post crisis CMBS which underlie CMBX Series 6 is reflective of conservatism on both the side of originators as well as the investors in CMBS. This trend of avoiding 80%+ LTV exposure is reflected in both Series 7 and Series 8, even as other underwriting standards have begun to loosen.

While CMBX 6, was reflective of tight underwriting standards, an analysis of the underwriting standards on the loans which underlie CMBX Series 7 and Series 8 shows that post-crisis underwriting standards have loosened across vintages. As shown in Appendix 6, the weighted average loan to value ratios of both Series 7 and Series 8 exceeded that of Series 6, though they are both below pre-crisis averages. The mortgages which underlie Series 8 CMBX also show deteriorating debt yields in comparison to Series 6 and Series 7 CMBX (see Appendix

7). Debt yield is a popular metric for evaluating the underwriting discipline on a loan, as unlike debt service coverage ratio it cannot be skewed by the amount of interest-only or partial interest-only loans in a CMBS pool. Debt yield is equal to the net operating income of a property divided by the total loan balance outstanding. This figure represents the total yearly earning power of the real estate over its outstanding debt obligations, with higher values corresponding to higher safety. In CMBX Series 8 we see a 50 basis point decline in debt yield from Series 7 to a nominal debt yield of 10%. Lastly, Appendix 8 shows the percentage of loans in a CMBX pool with interest-only or partial interest-only payment features. The presence of interest-only and partial interest-only payment features increase the risk on an underlying pool of loans as interest-only loans have zero amortization over the life of the loan. Partial interest-only loans are hybrid loans which start out as interest-only loans for a set period and then begin paying amortization after the interest-only period expires. These features lead to higher risk for CMBS investors as, all else held equal, they increase the risk that a borrower will not be able to refinance their mortgage at maturity and pay the full balloon payment owed on the underlying mortgage. As Appendix 8 shows, the presence of full interest-only loans was common amongst the loans underlying CMBX 1.0. Series 3 and 4 had the highest levels of full interest-only loans with 49.34% and 52.81%, respectively. Additionally, adding partial interest-only loans to the picture, we observe that the total presence of some interest-only feature amongst S3, S4, and S5 vintages was 81.41%, 84.24% and 82.69%, respectively. Aggressive real estate borrowers heavily favor interest-only loans as it decreases the monthly debt service of the mortgage and thus raises the levered yield that an investor receives from the real estate investment. The loans underlying post-crisis CMBX featured much tighter standards on interest-only and hybrid features. Only 13.15% of Series 6 were full interest-only, while total exposure to interest-only or hybrid payment options totaled 36.12%. This exposure is far below any pre-crisis Series. Series 7 and Series 8 show an expanding exposure to these payment types, with a bias towards partial interest-only payment options. This indicates that CMBS originators are beginning to test the CMBS investment market with loosening standards.

7. Procedure

In order to examine the feasibility of using REIT returns to explain CMBX returns on CMBX 2.0, we first construct a sample REIT index in a manner similar to that presented by Driessen and Van Hemert (2011). On each day we calculate the firm value of 29 REITs across multifamily, industrial, office and retail sectors based on the Merton Model for firm value (Merton 1974). Firm debt levels are based on book value of debt inclusive of preferred equity and net of cash and are recalibrated on a quarterly basis throughout the sample. Volatility is based on a one-year realized volatility based on REIT closing price levels during the last 252 days of the sample. Risk free rates are linearly interpolated based on reported values of the two, three, four, five, seven and ten year swaps at time T based on the time to maturity of Series 6 CMBX. By using Equation (10), we can calculate the firm value on each day across each sector.

$$E_j = BS(V_{j,}D_j, \sigma_{j,}T_j) \ (10)$$

These values are shown in Appendix 9. Appendix 10 shows the cross sector correlations of price levels. Appendix 11 shows an equal sector weight index based on our results from Equation (10).

Our sample of CMBX return data begins on January 28, 2013 – the origination date for the Series 6 issue. The sample period continues until 12/31/2015. To analyze the appropriateness of using REIT returns to explain returns in the CMBX market, we run univariate, comtemporaneous linear regressions of daily CMBX returns on daily REIT returns for the maximum applicable days for each Series. For Series 5 and Series 6 there are 735 observation days. For Series 7 there are 486 observation days. And for Series 8 there are 231 observation days. Results of these regressions are discussed in the results section below.

To analyze whether deteriorating underwriting standards influence the return profiles of CMBX vintages, we run additional univariate regressions of CMBX return data on REIT return data across the observation days above. If our reasoning is correct, we should observe an increasing sensitivity to REIT returns across CMBX vintages as CMBS underwriting standards loosen. This sensitivity would be reflected by the slope coefficient of the linear regression. We run our test three times, once for CMBX S5 and CMBX S6, once for CMBX S6 and CMBX S7, and once for CMBX S6, S7, and S8. We run the test three times to keep the number of observation days equal across vintages.

8. Results

8.1 REIT Returns

Throughout the observation period real estate values increase across the four sectors observed. Most notably, the multifamily sector performs strongly – with a cumulative return of 65.8% during the period. Industrial, office, and retail also return 14.5%, 25.3%, and 23.6%, respectively. (See Appendix 9). Across sectors, we see that returns are strongly positively correlated with a minimum sector correlation of 0.87. (See Appendix 10). In Appendix 11, we aggregate the individual returns across each sector and create a real estate price return index in which each real estate sector is given an equal weight. In total, commercial real estate price levels increased by 32.3% throughout the observation period, or 9.6% on an annualized basis. Comparing Appendices 10 and 11, it is clear that the strong performance of the multifamily sector during the period strongly influenced the returns of the equal-weighted index.

8.2 Univariate Regressions Results

Switching to the results of the univariate regressions of CMBX 2.0 returns on REIT returns, we find broad support for the explanatory power of REIT returns on CMBX 2.0 returns. Running our regressions for each vintage across the total number of observed trading days for each respective vintage, we generally observe R-squared coefficients in the low to mid-teens across tranches and vintages. As we may expect to see, the R-squared coefficient on the BBB- bond, that is the bond which is the closest to the equity in our sample, is the highest across tranches in our data for Series 6, 7 and 8. We reason that this should be the case as the returns subordinate CMBS bonds should be more dependent on commercial real estate returns. Further we can draw a relationship to the LTV argument presented by Driessen and Van Hemert (2009) which states that LTV is the most common figure used to predict defaults on CMBS. As one moves down the CMBS capital stack, credit enhancement levels fall. One way to conceptualize this movement is in an exposure to LTVs. For instance, one can describe a AAA bond with 30% subordination on a CMBS that has a WALTV of 60% as sitting in the capital stack between WALTV 0% of 42%. A BBB- bond with 6% subordination and 1% thickness on the same deal could be conceptualized as sitting between 55.8% WALTV and 56.4% WALTV. This provides a simple measure for risk on each tranche via the LTV measure. As tranche LTV increases, credit rating falls and exposure to LTV factor increases which should cause the bond price to be more sensitive to commercial real estate returns.

The univariate regressions on CMBX 2.0, shown in Appendices 12 through 31, largely show that commercial real estate price levels have some explanatory power on CMBX returns. Most of the CMBX tranches across vintages have R-squared values in the low to mid-teens when regressing CMBX return on the returns of the sample REIT index. REIT returns are statistically significant variables on the regressions for all but one of the CMBX 2.0 tranches. The one tranche were we do not observe statistically significant results, Series 8 AAA, appears to have very little correlation with the sample REIT returns during the period.

The regression data indicates that REIT returns should be useful in explaining CMBX prices. This is generally supportive of the model presented by Driessen and Van Hemert and also in accordance with the findings of Stanton and Wallace (2010). Stanton and Wallace create a multivariate model for CMBX prices and find statistical significance for REIT returns as a contemporaneous variable for CMBX prices across CMBX Series 1 to 5. Our regressions of CMBX 2.0 returns against the REIT returns appear to be in accordance the earlier findings of Driessen and Van Hemert (2011) and Stanton and Wallace (2010).

8.3 Underwriting Standards and CMBX Return Sensitivity to REIT Returns

Considering the loosening standards in CMBS underwriting from Series 6 to Series 8, we hypothesize that CMBX price returns should become more sensitive to observed REIT returns throughout the period. As a first test of this hypothesis, we analyze the difference in slope coefficients among tranches in CMBX S5 and S6 vintages. There was a large gulf in underwriting standards between these two vintages, reflecting the extremely loose pre-crisis underwriting standards and conservative post-crisis underwriting standards of Series 5 and Series 6, respectively. As we have a good sense of what the outcome should look like between these two Series, that is S5 should be more sensitive to REIT returns than S6, we can use the results from this test to analyze our tests on S6, S7 and S8 vintages. Results from this test are shown in Appendix 32. Throughout the sample we generally find our hypothesis to be reflected in the difference in observed slopes between the two CMBX vintages. While Series 5 has significant pricing complications during the sample, which will be discussed further in Section 8.5, we observe that returns on the S5 BBB- tranche are noticeably more sensitive to REIT returns than the Series 6 BBB- tranche. This makes sense intuitively as Series 5 had much looser underwriting standards than Series 6, which featured the tightest standards throughout the history of CMBX. We observe similar qualities in the S5 AJ tranche when compared to the S6 AS tranche.[2] However, it is clear that our hypothesis does not hold across all tranche comparisons between the two vintages. Notably, the AAA and A tranche comparisons do not follow our predictions. We believe this may be due to the effects of CMBS seasoning and liquidity. These effects will be covered in more depth in our analysis of the S5 BBB- tranche in Section 8.5.

Appendix 33 shows the slope coefficients across tranches for Series 6, Series 7, and Series 8 CMBX. In general, we observe results which are in line with our hypothesis. Slope coefficients increase across vintages, holding fixed the credit rating, reflecting higher sensitivity to REIT price returns as loan underwriting standards loosen across vintages. As explained earlier, this should intuitively be the case if (i) less strict underwriting standards should make CMBX returns more reliant on price returns on commercial real estate, and (ii) if the ratings do not fully account for the effect of deteriorating UW standards. However, there are a few anomalies in the data. Noticeably, the slope coefficient of the Series 8 AAA tranche is far lower than the AAA tranche of S6 and S7. It is unclear why this is so; however, it should be noted that the S8 AAA tranche was the only tranche of CMBX 2.0 where REIT returns were not a statistically significant variable in explaining CMBX price returns (see Appendix 25). Across the rest of the sample, observed slope coefficients generally match our predictions, increasing both across vintage and across tranche. However, the observed changes in slope coefficients appear underwhelming considering the drop in underwriting standards between vintages. Our data indicates that the standards between Series 7 and Series 8 deteriorated significantly, with WALTV, debt yield and exposure to interest-only and hybrid interest-only loans increasing at a noticeable rate. However, our results show that the change in sensitivity of CMBX price returns to REIT price returns across vintages is minimal. The difference between slope on S8 BBB- and S7 BBB- bond – the bond that one may expect to show the most sensitivity in response to changing underwriting standards due to its position in the capital stack – is only 0.0014. This difference is not statistically significant. In fact, we do not see any statistically significant differences in slope coefficients between post-crisis CMBX vintages. So while we observe declining underwriting standards and increasing sensitivities to REIT returns, we cannot conclude that these differences are statistically significant at any reasonable level of confidence.

[2] CMBX 2.0 replaced the AJ and AM tranches in CMBX 1.0 by combining them and labeling the combined tranche AS.

To corroborate our results, we run an additional test on Series 6 and Series 7 CMBX vintages expanding the data set to include all of the days in which both S6 and S7 are traded. Our results mirror those observed in the test of S6, S7 and S8 CMBX (See Appendix 34). Namely, we see that the absolute slope coefficients increase from S6 to S7 across every tranche. There is no significant difference in steepness of slope coefficients across the two vintages, however, and counter to expectations, the slope coefficients of Series 6 are slightly steeper than those of Series 7. However, once again none of the observed differences in slope coefficients between Series 6 and Series 7 can be deemed statistically significant.

8.4 The Complications of the "Ratings Game"

While our results would seem to indicate that changing underwriting standards do not seem to have a substantial impact on sensitivities to REIT returns across vintages, our results are confounded by the "ratings game" played by CMBS originators. As underwriting standards have loosened across CMBX 2.0 vintages, CMBS originators have begun to use techniques such as increasing subordination levels across CMBS tranches or "ratings shopping" in order to get their deals originated at proper price levels (Lehman, et al., 2015). For CMBS lenders increasing subordination levels is a natural response to increasing risk across CMBS tranches due to deteriorating underwriting standards. Appendix 35 shows the evolution of credit enhancement levels across CMBX 2.0 vintages. We observe that subordination levels increase in every tranche but the AAA from S7 to S8. This is a reflection of CMBS originators supplying the minimum level of subordination needed for the rating agencies to rate their CMBS tranches at a level which allows the originators manufacture the highest potential profits. Thus, as we see increasing average subordination levels across CMBX vintages, we can infer that rating agencies are of the opinion that the underlying loans of the later CMBX vintages carry more risk than earlier vintages. Another technique used by originators, "ratings shopping," consists of getting a CMBS tranche rated by multiple agencies and then selecting the ratings which are most favorable to the originator (Lehman, et al., 2014). For instance, according to Credit Suisse Fixed Income Research, through November 2014, Moody's had rated 40 of 43 conduit deals brought to market that year. On 37 out of the 40 deals rated by Moody's, the originator chose to drop the Moody's rating on the BBB- tranche, effectively ignoring the rating opinion of Moody's on these tranches. Dropping the Moody's ratings and showing the more favorable ratings of other agencies allows the originator to keep subordination levels as low as possible. In the third quarter of 2014, the average subordination level needed to achieve a Moody's rating of BBB- was 10.6%, the average subordination level of originated BBB- CMBS during the same time period was 7.8%, demonstrating the power of "ratings shopping."

The phenomena of evolving subordination levels and "ratings shopping" across CMBX vintages significantly effects the results presented earlier. Although we do not make adjustments for the evolving effects of the "ratings game" across vintages, viewing the results with the understanding that these actions are occurring leads us to hypothesize that if both credit enhancement levels and the frequency of "ratings shopping" were held equal across vintages, we would see increased statistical significance of REIT return sensitivities in our data. Holding credit enhancement equal across vintages may allow us to see statistically significant changes in CMBX price sensitivities in our data, and may potentially be an area of future research.

8.5 Explaining the Results of Series 5

One key observation made in the examination between S5 and S6 slope coefficients was the seeming lack of model predictability on Series 5 CMBX. While we observed data that generally supported our hypothesis of rising slope coefficients across CMBX 2.0, the comparison between S5 and S6 vintages while somewhat supportive of our hypothesis, had some large discrepancies from our prediction, namely the smaller slope coefficients of S5 A and S5 AAA when compared to S6 A and S6 AAA. To analyze this relationship further we ran the univariate model we ran across CMBX 2.0 vintages on Series 5 (see Appendices 26 to 31). Our results indicate that REIT returns have almost no explanatory power on returns across all of the tranches of CMBX Series 5.

In this section, we will offer a few explanations for why REIT price returns may hold less predictive power for these bonds. The collateral underlying CMBX Series 5 bonds was significantly impacted by distress in the commercial real estate market during and post the financial crisis. According to Trepp, two CMBS which underlie the CMBX have suffered losses into the AJ tranche. Additionally, 15 out of the 25 CMBS have suffered greater than 6% losses across their respective pools. This represents a significant risk to the BBB- bonds as the average detachment point for the A tranche across CMBX S5 was 5.3%. This would imply that numerous S5 BBB- tranches suffered write downs, and many suffered complete losses. Though we do not have time series data of the credit losses for the CMBS that underlie CMBX S6, the price pattern of CMBX S5 BBB- shown in Appendix 36 indicates that by the beginning of our sample period in January 2013, most of the write downs on the S5 BBB- tranche had already occurred. The price movements of CMBX S5 BBB- appear to indicate that investors in the BBB- tranche may be attempting to predict specific events such as loan resolution timing, recovery rates, and default rates across the remaining pool. In any event, returns on this tranche do not appear to be correlated to REIT returns during our sample. The BBB- tranche in this vintage also likely suffers from a lack of liquidity. Although we do not have information on the volume of CMBX S5 outstanding, we predict that few buyers of protection are willing to pay the large upfront fees associated with entering the tranche at current price levels. If investors wish to make a relative value trade, they can do so more cheaply in the more senior tranches of the CMBX. It is likely that the remaining CMBX S5 volume represents stale trades that were entered before our observation period.

9. Conclusion:

We conclude that observed returns on real estate investment trusts offer some explanatory power to CMBX 2.0 price returns. This extends earlier findings on CMBX 1.0 vintages byDriessen and Van Hemert (2011) and Stanton and Wallace (2009). We find that the explanatory power of REIT returns decreases in the event of tranche illiquidity or distress, finding REIT returns to have little explanatory power across CMBX Series 5 vintages. We see the same lack of predictive power on CMBX Series 8 AAA bonds which are neither illiquid nor distressed, however the sample size for this issuance is much lower. Most importantly, we conclude that deteriorating CMBS underwriting standards have an observable impact on the sensitivity of CMBX vintages to REIT returns, holding fixed credit ratings. Though our results on the slope coefficients presented in the paper are not statistically significant, we believe that adjusting CMBX vintages for both subordination levels and prevalence of “ratings shopping” could yield results which would show a statistically significant difference in the return profiles between vintages.

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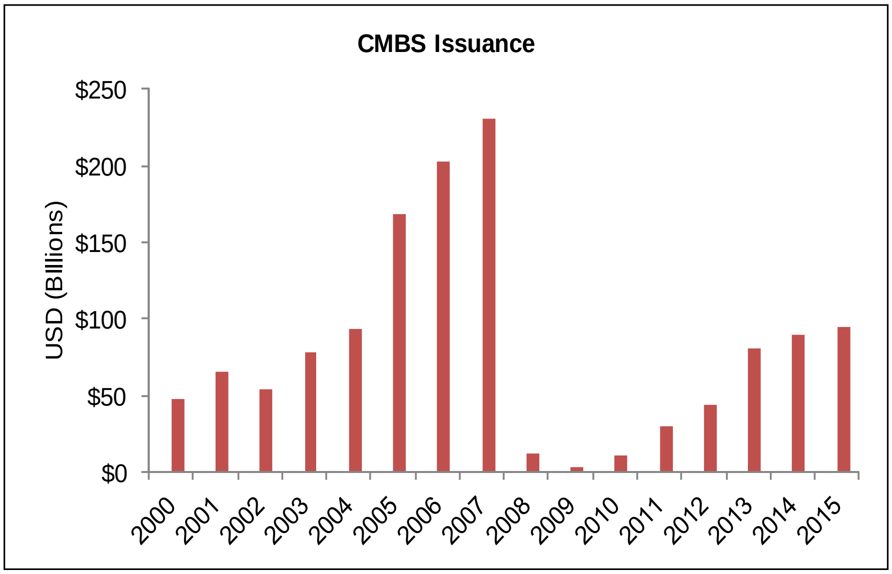
Wiggers, Tyler and Ashcraft, Adam (2012), "Defaults and Losses on Commercial Real Estate Bonds during the Great Depression Era," Federal Reserve Bank of New York Staff Reports, 1-42.

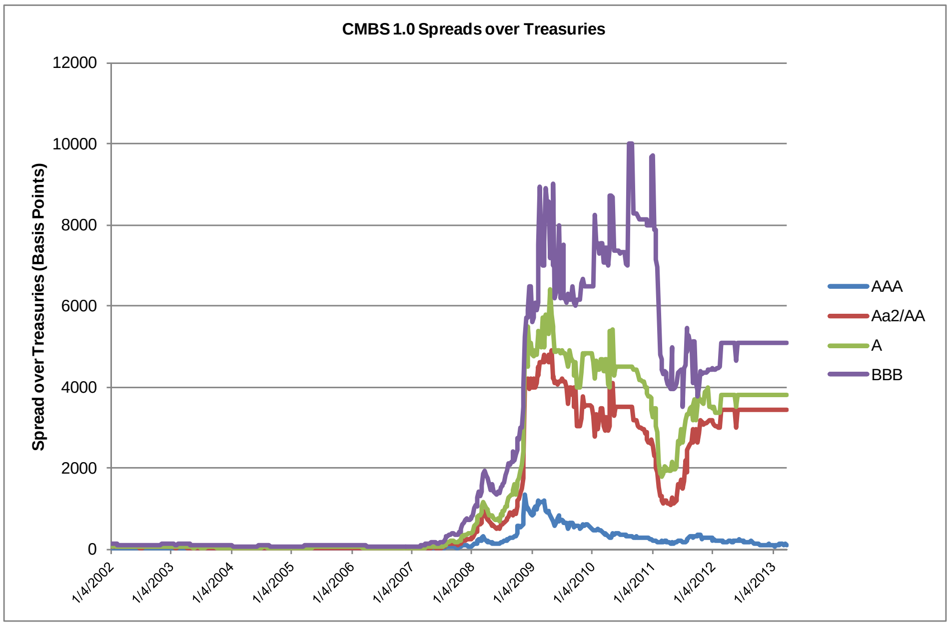
Appendix:

Figure 1:



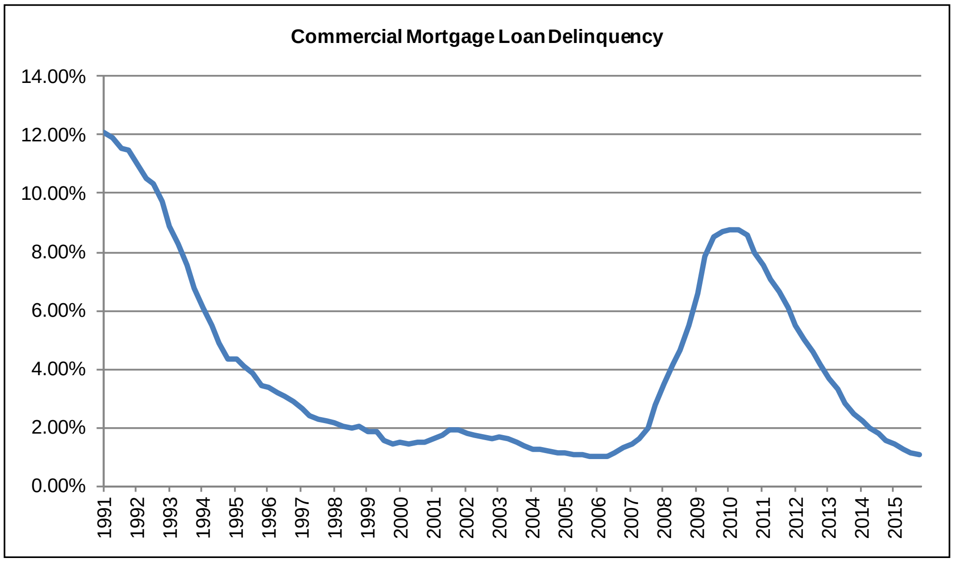
Source: CREFC

Figure 2:



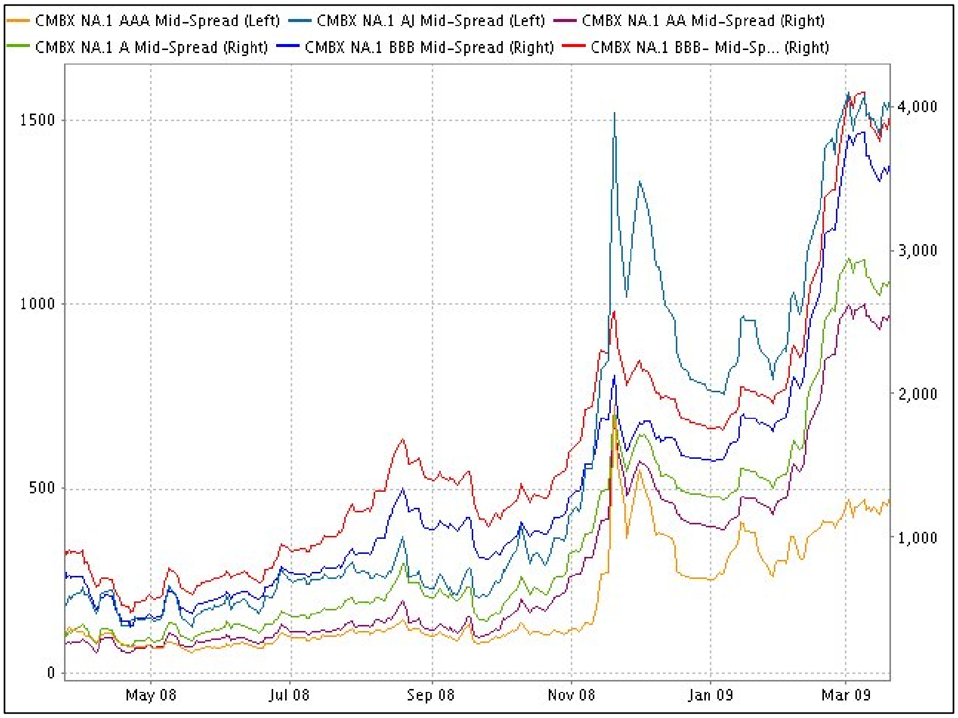
Source: CREFC

Figure 3:



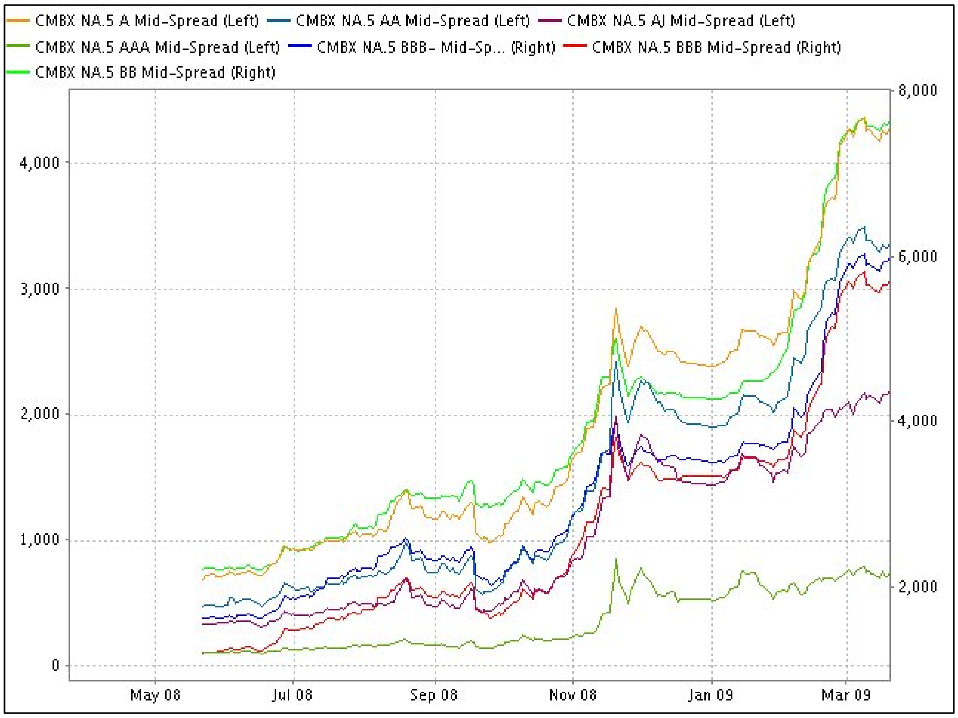
Source: FRED

Figure 4:



Source: Zero Hedge

Figure 5:



Source: Zero Hedge

Figure 6:

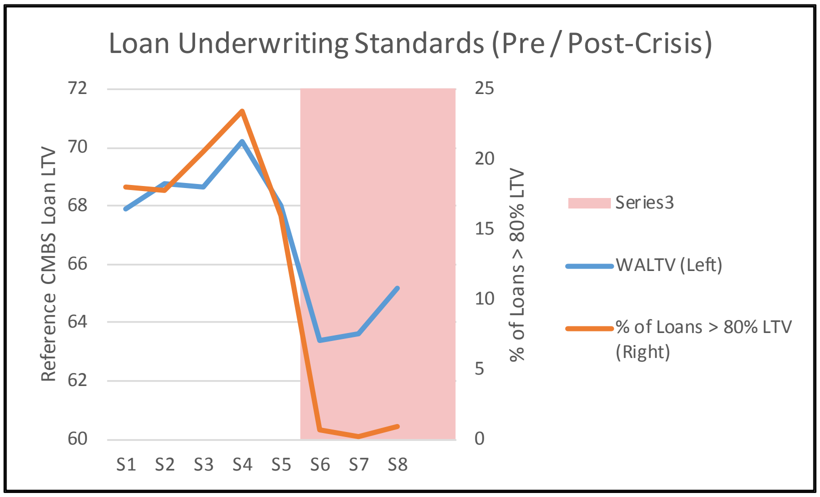
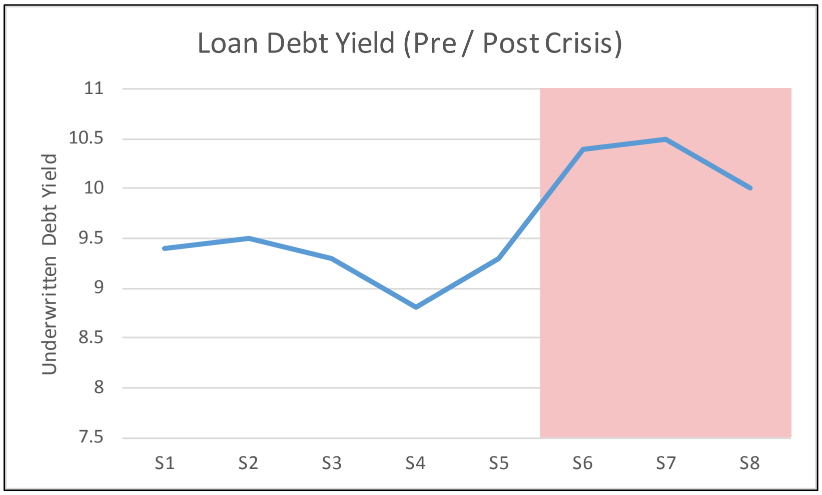

Loan Underwriting Standards (Pre / Post-Crisis)
Reference CMBS Loan LTV
% of Loans > 80% LTV
72
70
68
66
64
62
60
25
20
15
10
5
0
S1
S2
S3
S4
S5
S6
S7
S8
Series3
WALTV (Left)
% of Loans > 80% LTV (Right)

Figure 7:



Loan Debt Yield (Pre / Post Crisis)
Underwritten Debt Yield
11
10.5
10
9.5
9
8.5
8
7.5
S1
S2
S3
S4
S5
S6
S7
S8

Figure 8:

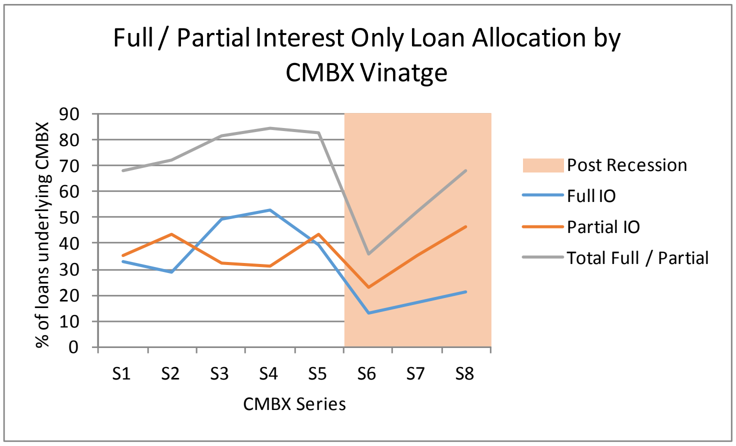

Full / Partial Interest Only Loan Allocation by CMBX Vinatge
% of loans underlying CMBX
90
80
70
60
50
40
30
20
10
0
S1
S2
S3
S4
S5
S6
S7
S8
CMBX Series
Post Recession
Full IO
Partial IO
Total Full / Partial

Figure 9:

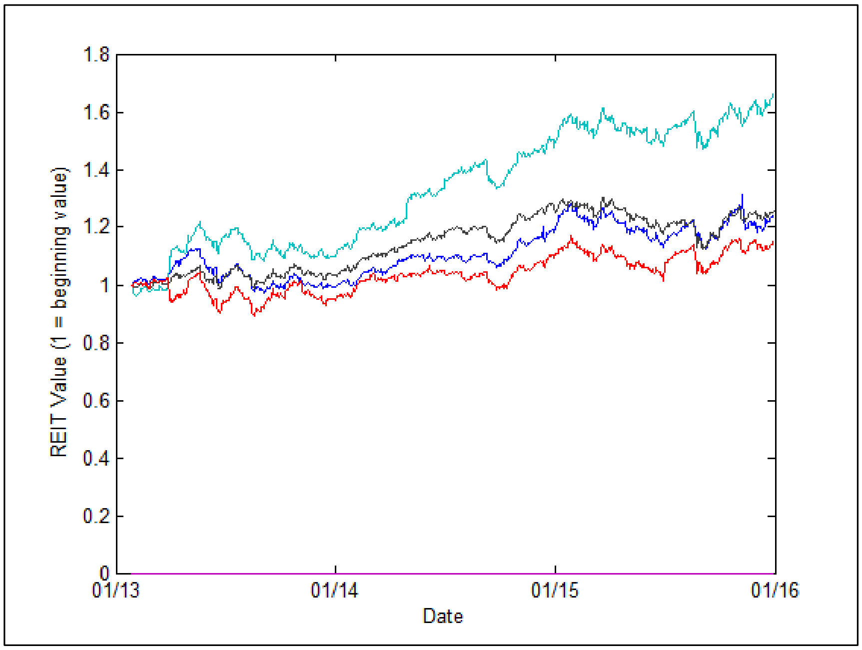

1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
REIT Value (1 = beginning value)
01/13
01/14
01/15
01/16
Date

Figure 10:

Correlation Matrix	Ind.	MF.	Office	Retail
Ind.	1	0.8722	0.8823	0.9297
MF.	0.8722	1	0.9501	0.9295
Office	0.8823	0.9501	1	0.9028
Retail	0.9297	0.9295	0.9028	1

Figure 11:

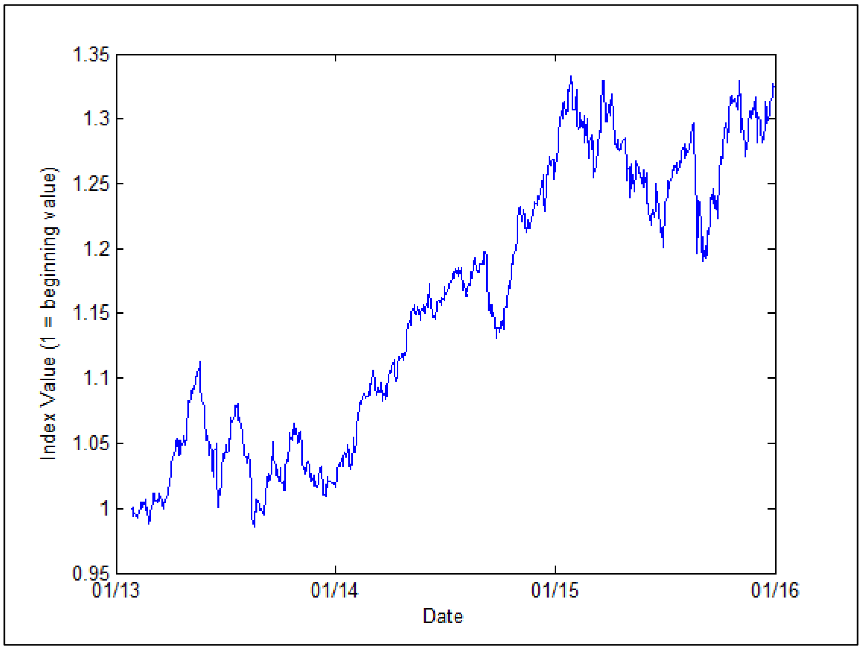
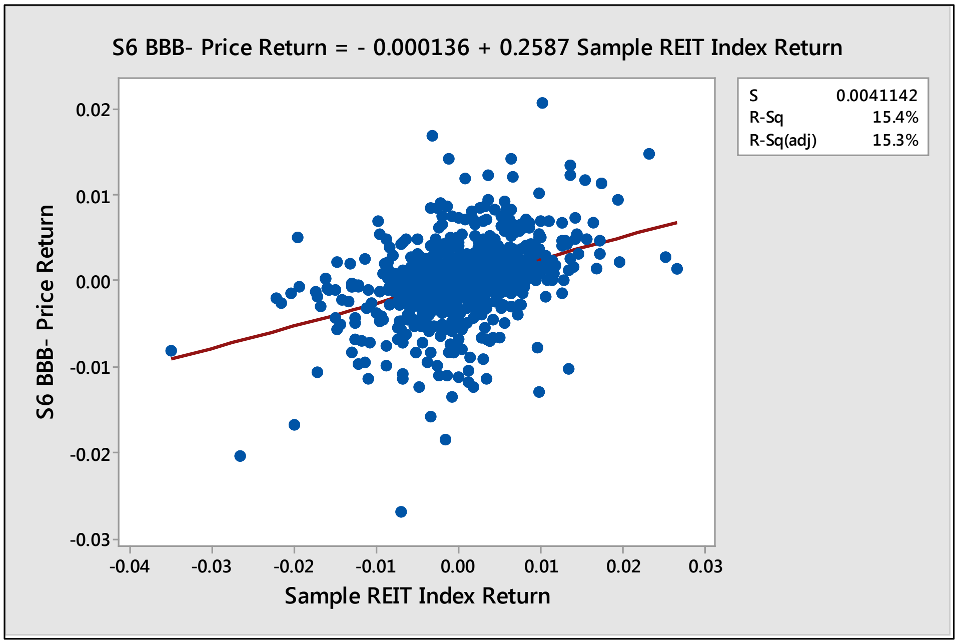

1.35
1.3
1.25
1.2
1.15
1.1
1.05
1
0.95
Index Value (1 = beginning value)
01/13
01/14
01/15
01/16
Date

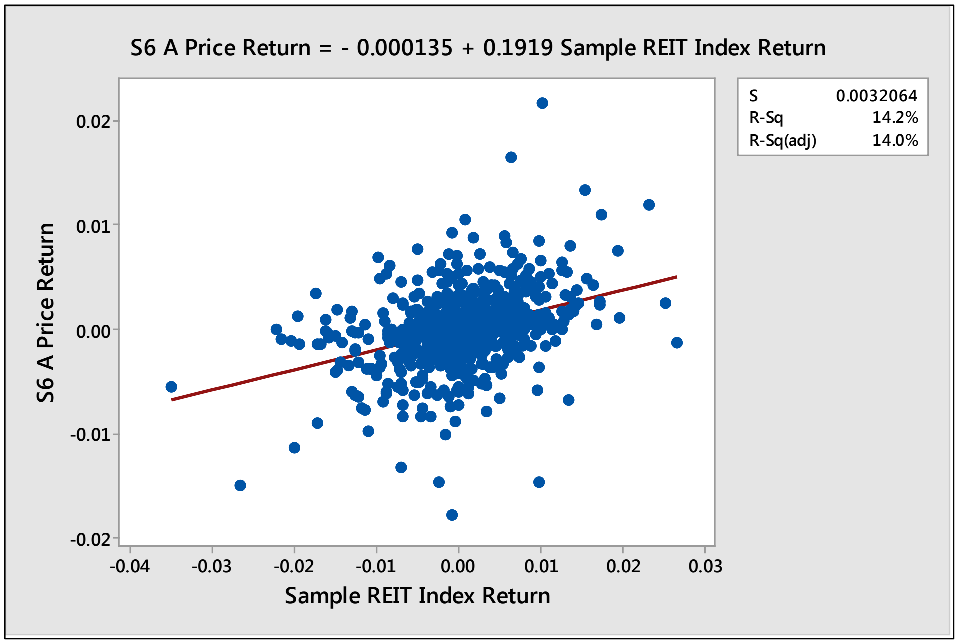
Figure 12:




```
Model Summary

        S    R-sq  R-sq(adj)  R-sq(pred)
0.0041142  15.40%     15.28%      14.83%


Coefficients

Term                            Coef   SE Coef  T-Value  P-Value   VIF
Constant                   -0.000136  0.000152    -0.90    0.370
Sample REIT Index Return      0.2587    0.0224    11.55    0.000  1.00


Regression Equation

S6 BBB- Price Return = -0.000136 + 0.2587 Sample REIT Index Return
```

Sample Size: 735

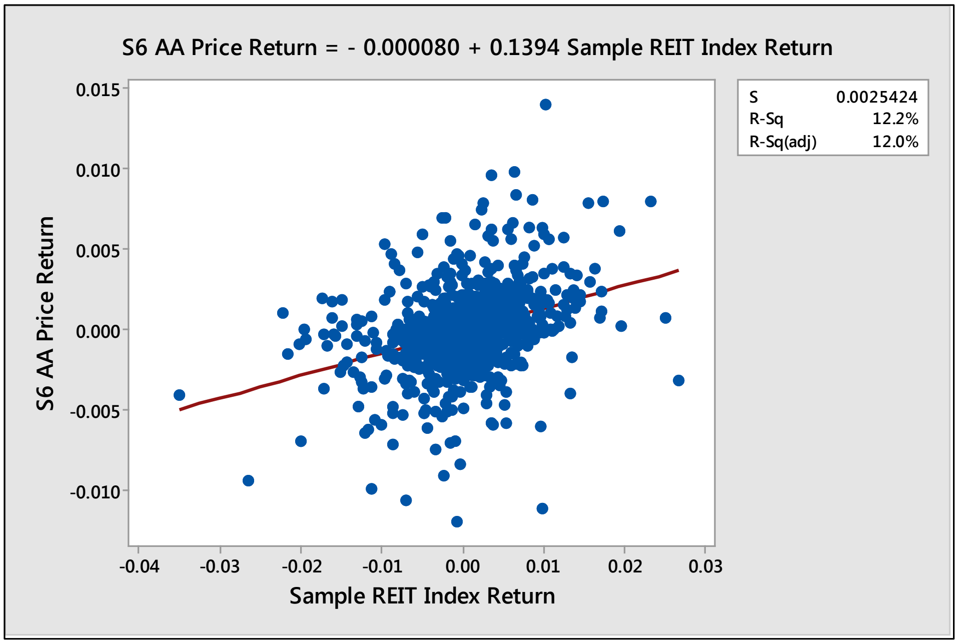
Figure 13:




```
Model Summary

        S    R-sq  R-sq(adj)  R-sq(pred)
0.0032064  14.15%     14.04%      13.54%


Coefficients

Term                           Coef   SE Coef  T-Value  P-Value   VIF
Constant                  -0.000135  0.000118    -1.14    0.256
Sample REIT Index Return     0.1919    0.0175    10.99    0.000  1.00


Regression Equation

S6 A Price Return = -0.000135 + 0.1919 Sample REIT Index Return
```

Sample Size: 735

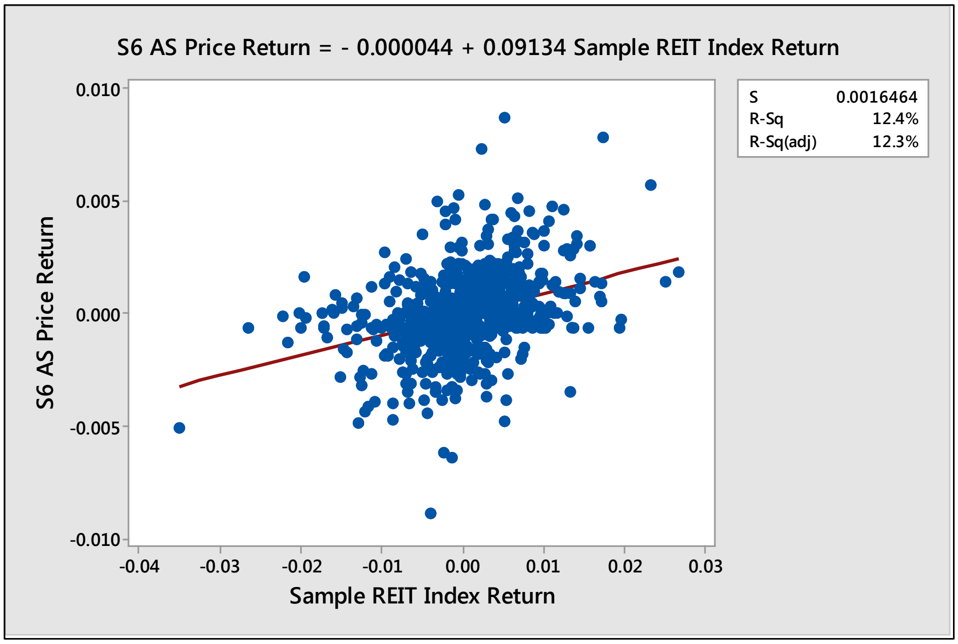
Figure 14:




```
Model Summary

        S    R-sq  R-sq(adj)  R-sq(pred)
0.0025424  12.16%     12.04%      11.58%


Coefficients

Term                            Coef   SE Coef  T-Value  P-Value   VIF
Constant                   -0.000080  0.000094    -0.86    0.393
Sample REIT Index Return      0.1394    0.0138    10.08    0.000  1.00


Regression Equation

S6 AA Price Return = -0.000080 + 0.1394 Sample REIT Index Return
```

Sample Size: 735

Figure 15:



Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.0016464	12.41%	12.29%	11.89%

Coefficients

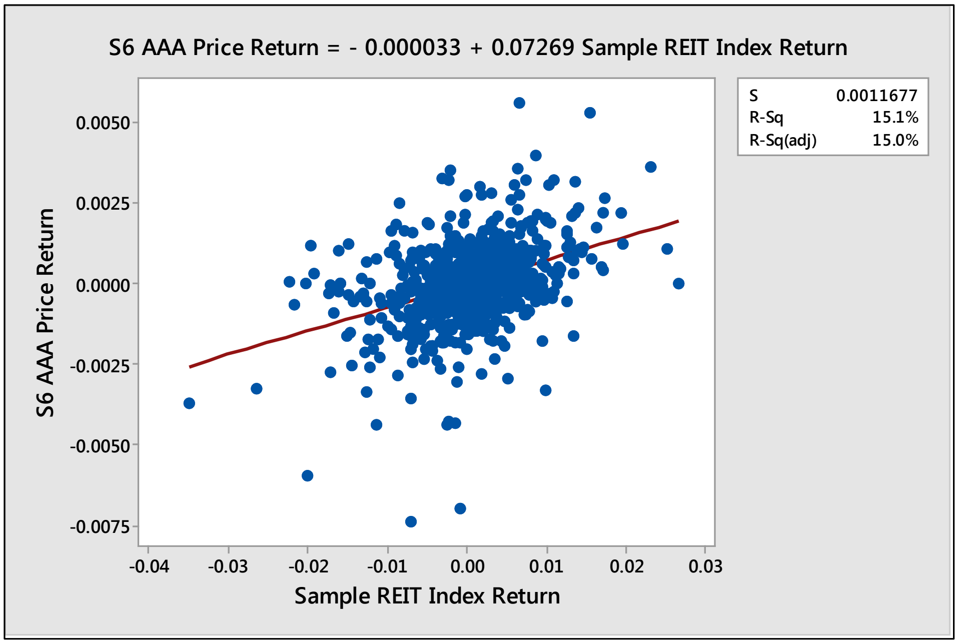
Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	-0.000044	0.000061	-0.72	0.472	
Sample REIT Index Return	0.09134	0.00896	10.19	0.000	1.00

Regression Equation

S6 AS Price Return = -0.000044 + 0.09134 Sample REIT Index Return

Sample Size: 735

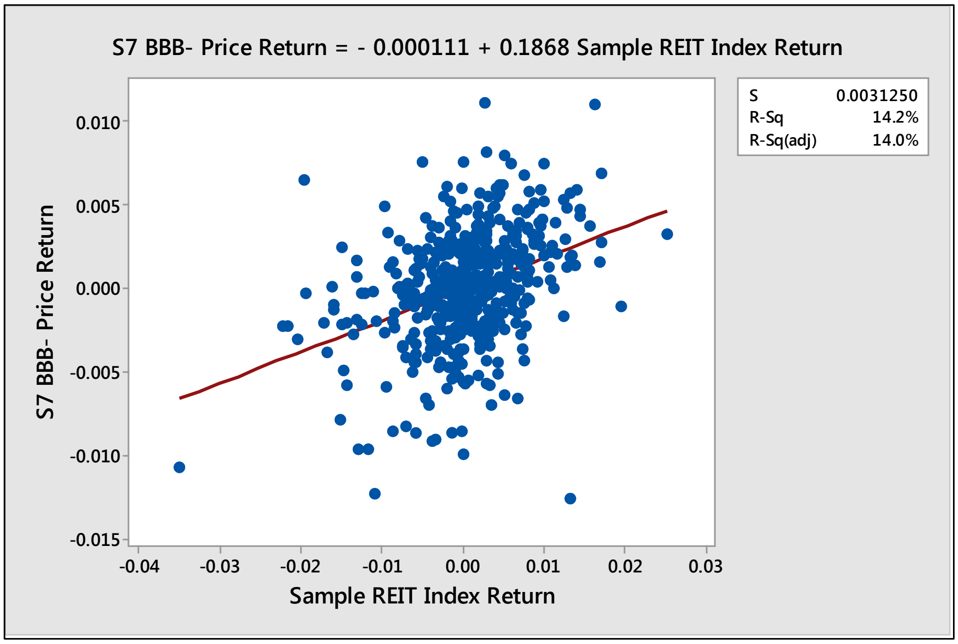
Figure 16:




```
Model Summary

        S     R-sq  R-sq(adj)  R-sq(pred)
0.0011677  15.14%     15.03%      14.57%


Coefficients

Term                            Coef   SE Coef  T-Value  P-Value   VIF
Constant                   -0.000033  0.000043    -0.77    0.442
Sample REIT Index Return     0.07269   0.00636    11.44    0.000  1.00


Regression Equation

S6 AAA Price Return = -0.000033 + 0.07269 Sample REIT Index Return
```

Sample Size: 735

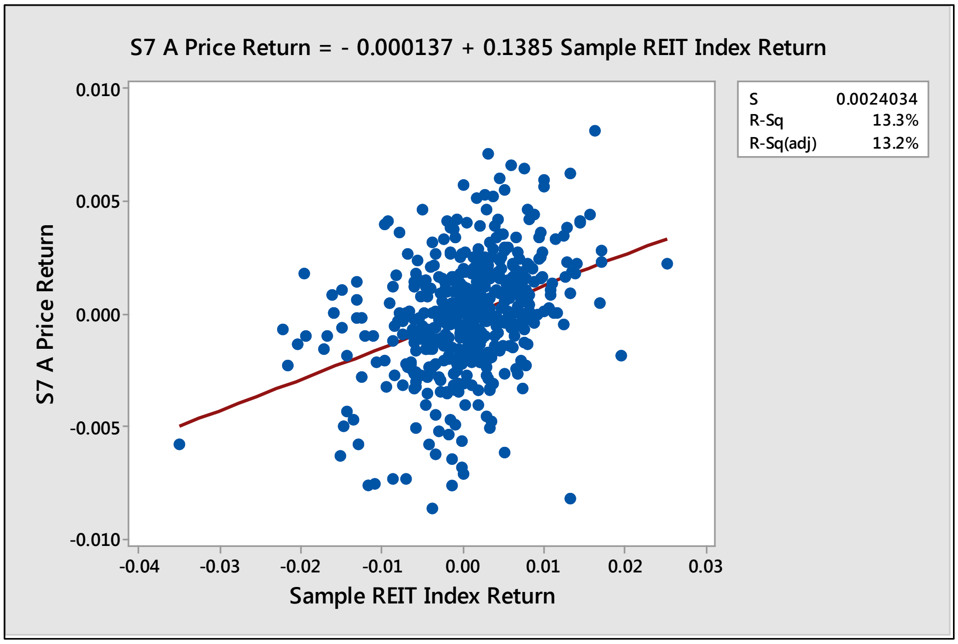
Figure 17:




```
Model Summary

        S    R-sq  R-sq(adj)  R-sq(pred)
0.0031250  14.20%     14.02%      13.36%


Coefficients

Term                            Coef   SE Coef  T-Value  P-Value   VIF
Constant                   -0.000111  0.000142    -0.78    0.436
Sample REIT Index Return      0.1868    0.0209     8.95    0.000  1.00


Regression Equation

S7 BBB- Price Return = -0.000111 + 0.1868 Sample REIT Index Return
```

Sample Size: 486

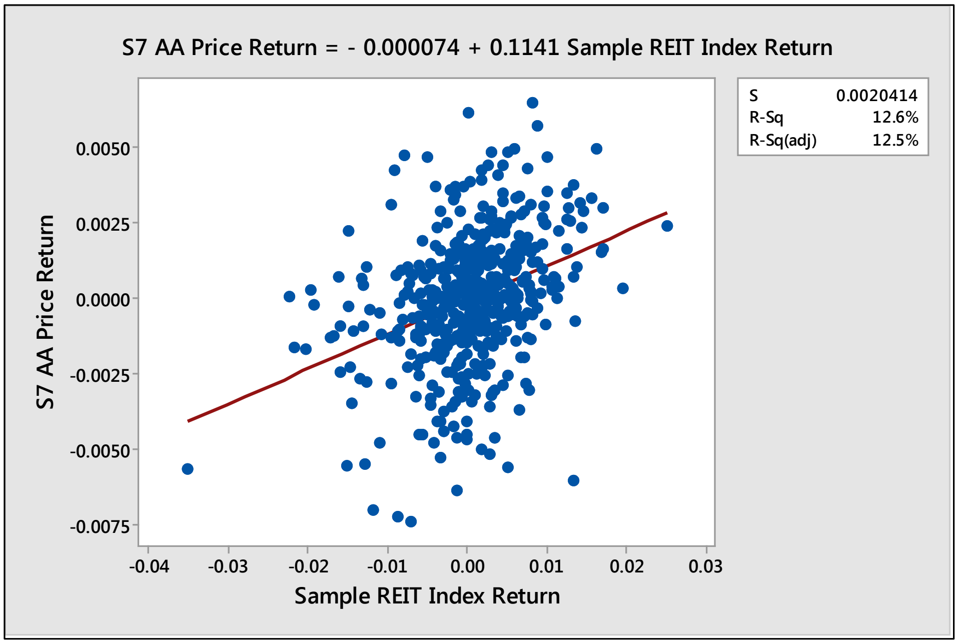
Figure 18:




```
Model Summary

        S    R-sq  R-sq(adj)  R-sq(pred)
0.0024034  13.34%     13.16%      12.57%


Coefficients

Term                          Coef   SE Coef  T-Value  P-Value   VIF
Constant                 -0.000137  0.000109    -1.25    0.212
Sample REIT Index Return    0.1385    0.0161     8.63    0.000  1.00


Regression Equation

S7 A Price Return = -0.000137 + 0.1385 Sample REIT Index Return
```

Sample Size: 486

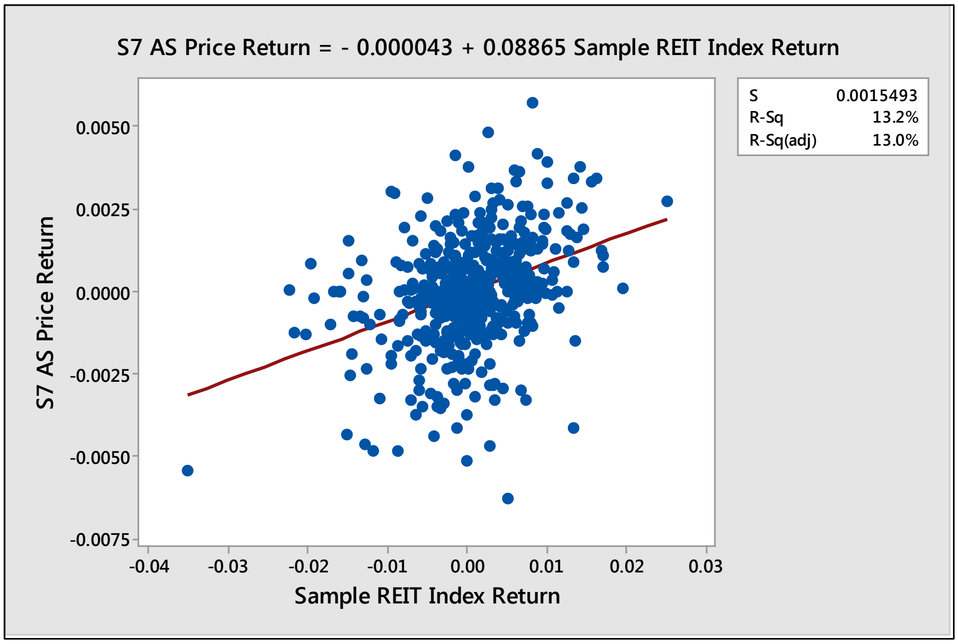
Figure 19:




```
Model Summary

        S    R-sq  R-sq(adj)  R-sq(pred)
0.0020414  12.63%     12.45%      11.89%


Coefficients

Term                           Coef   SE Coef  T-Value  P-Value   VIF
Constant                  -0.000074  0.000093    -0.79    0.428
Sample REIT Index Return     0.1141    0.0136     8.37    0.000  1.00


Regression Equation

S7 AA Price Return = -0.000074 + 0.1141 Sample REIT Index Return
```

Sample Size: 486

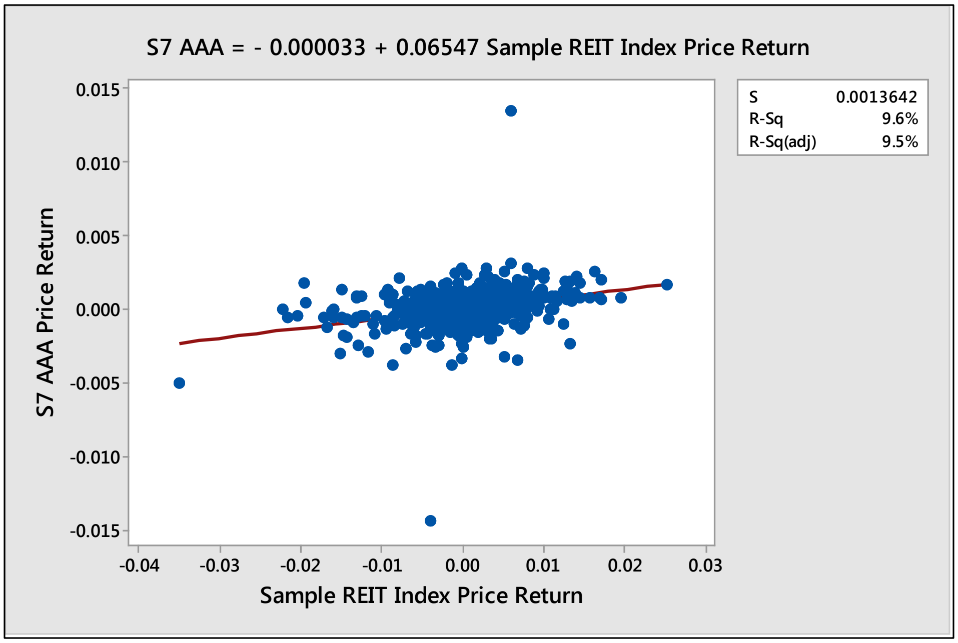
Figure 20:




```
Model Summary

        S     R-sq  R-sq(adj)  R-sq(pred)
0.0015493  13.17%     12.99%      12.37%


Coefficients

Term                          Coef   SE Coef  T-Value  P-Value   VIF
Constant                 -0.000043  0.000071    -0.61    0.539
Sample REIT Index Return    0.0887    0.0103     8.57    0.000  1.00


Regression Equation

S7 AS Price Return = -0.000043 + 0.0887 Sample REIT Index Return
```

Sample Size: 486

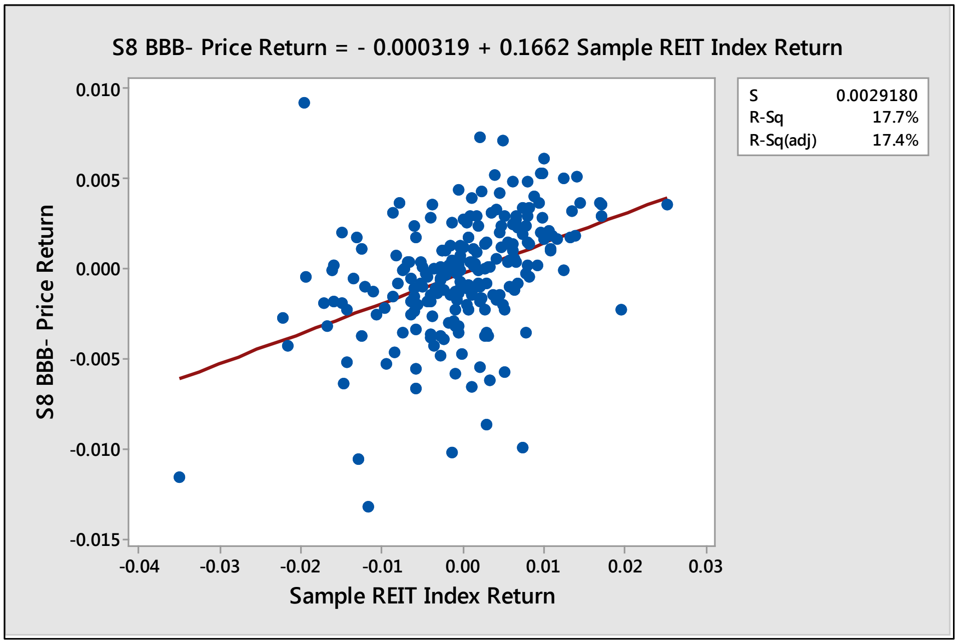
Figure 21:




```
Model Summary

        S    R-sq  R-sq(adj)  R-sq(pred)
0.0013642  9.64%      9.45%       8.84%


Coefficients

Term                            Coef   SE Coef  T-Value  P-Value   VIF
Constant                   -0.000033  0.000062    -0.54    0.591
Sample REIT Index Return     0.06547   0.00911     7.19    0.000  1.00


Regression Equation

S7 AAA Price Return = -0.000033 + 0.06547 Sample REIT Index Return
```

Sample Size: 486

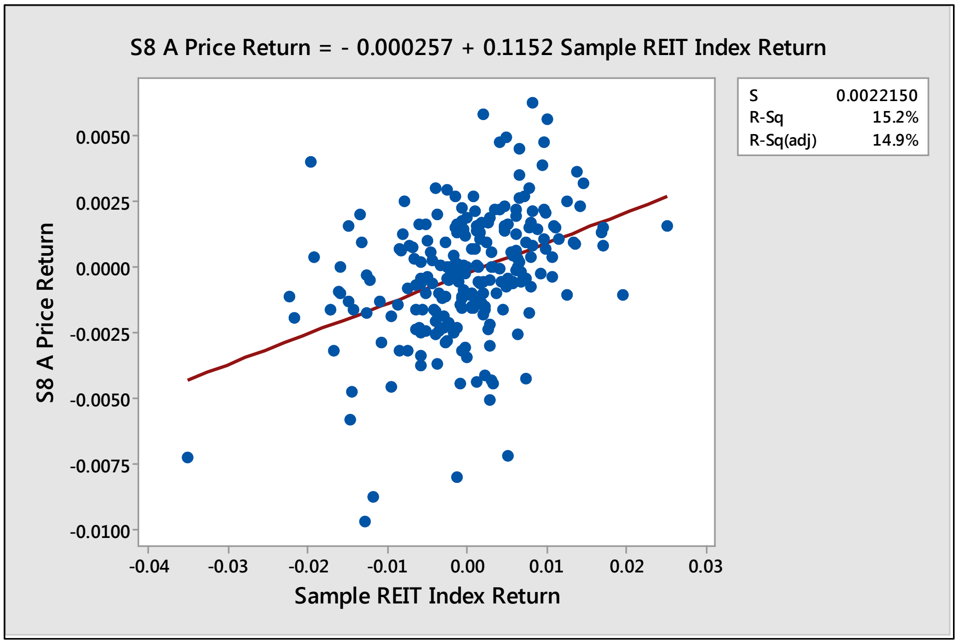
Figure 21:




```
Model Summary

        S    R-sq  R-sq(adj)  R-sq(pred)
0.0029180  17.73%     17.37%      15.81%


Coefficients

Term                           Coef   SE Coef  T-Value  P-Value   VIF
Constant                  -0.000319  0.000192    -1.66    0.098
Sample REIT Index Return     0.1662    0.0237     7.03    0.000  1.00


Regression Equation

S8 BBB- Price Return = -0.000319 + 0.1662 Sample REIT Index Return
```

Sample Size: 231

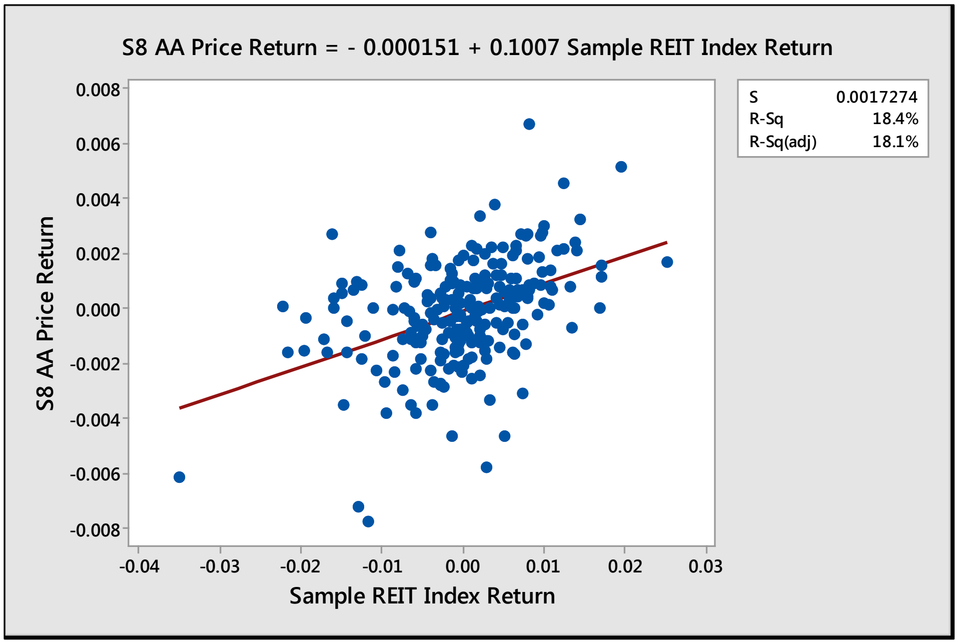
Figure 22:




```
Model Summary

        S    R-sq  R-sq(adj)  R-sq(pred)
0.0022150  15.24%     14.86%      13.52%


Coefficients

Term                           Coef   SE Coef  T-Value  P-Value   VIF
Constant                  -0.000257  0.000146    -1.76    0.079
Sample REIT Index Return     0.1152    0.0180     6.42    0.000  1.00


Regression Equation

S8 A Price Return = -0.000257 + 0.1152 Sample REIT Index Return
```

Sample Size: 231

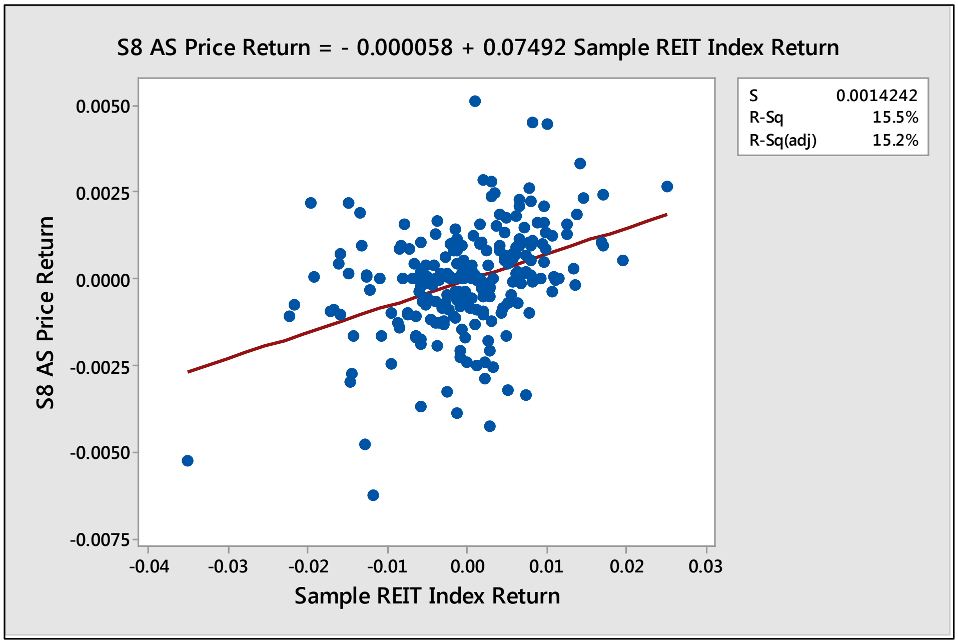
Figure 23:




```
Model Summary

        S    R-sq  R-sq(adj)  R-sq(pred)
0.0017274  18.42%     18.06%      16.72%


Coefficients

Term                            Coef   SE Coef  T-Value  P-Value   VIF
Constant                   -0.000151  0.000114    -1.33    0.184
Sample REIT Index Return      0.1007    0.0140     7.19    0.000  1.00


Regression Equation

S8 AA Price Return = -0.000151 + 0.1007 Sample REIT Index Return
```

Sample Size: 231

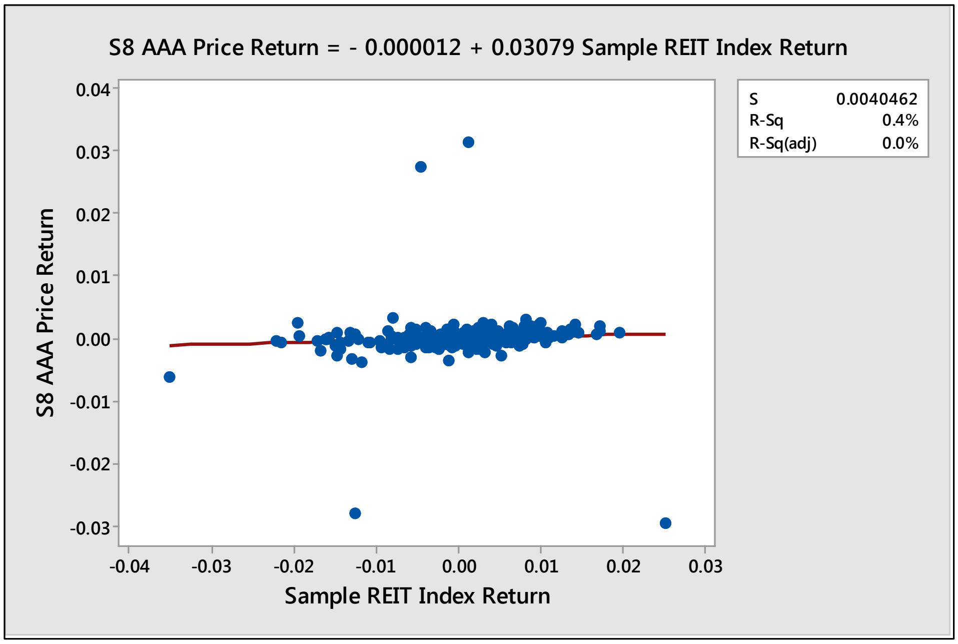
Figure 24:




```
Model Summary

        S    R-sq  R-sq(adj)  R-sq(pred)
0.0014242  15.54%     15.17%      13.73%


Coefficients

Term                          Coef   SE Coef  T-Value  P-Value   VIF
Constant                 -0.000058  0.000094    -0.62    0.534
Sample REIT Index Return    0.0749    0.0115     6.49    0.000  1.00


Regression Equation

S8 AS Price Return = -0.000058 + 0.0749 Sample REIT Index Return
```

Sample Size: 231

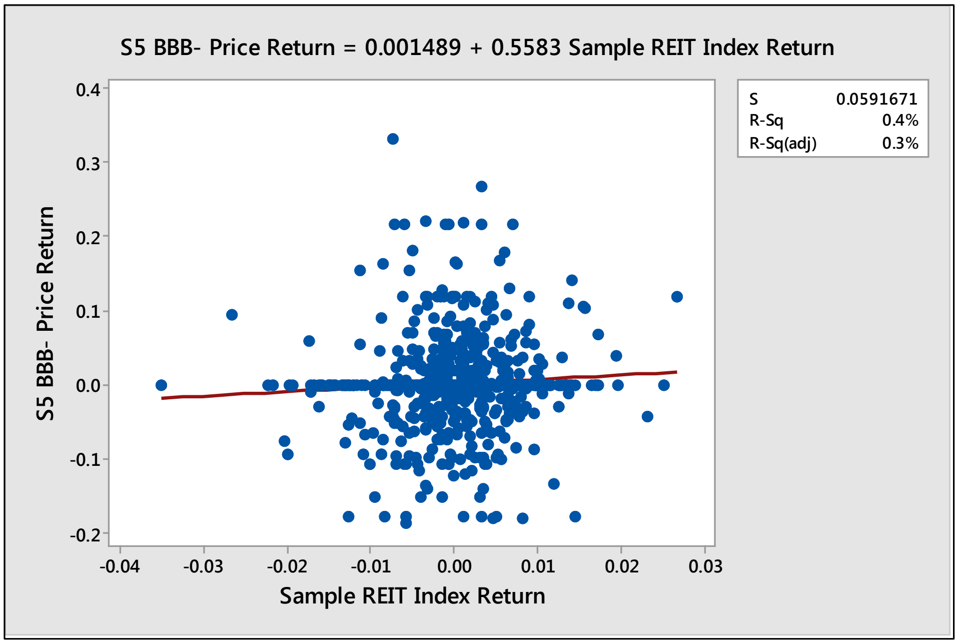
Figure 25:




```
Model Summary

        S    R-sq  R-sq(adj)  R-sq(pred)
0.0040462   0.38%      0.00%       0.00%


Coefficients

Term                             Coef    SE Coef  T-Value  P-Value   VIF
Constant                    -0.000012  0.000266    -0.05    0.963
Sample REIT Index Return      0.0308    0.0328     0.94    0.349  1.00


Regression Equation

S8 AAA Price Return = -0.000012 + 0.0308 Sample REIT Index Return
```

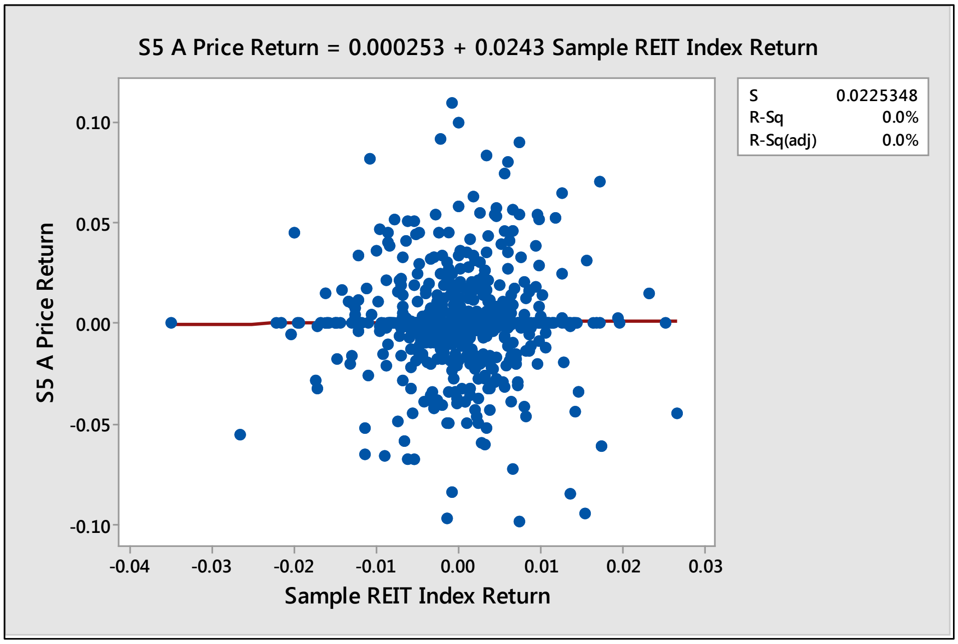
Sample Size: 231

Figure 26:



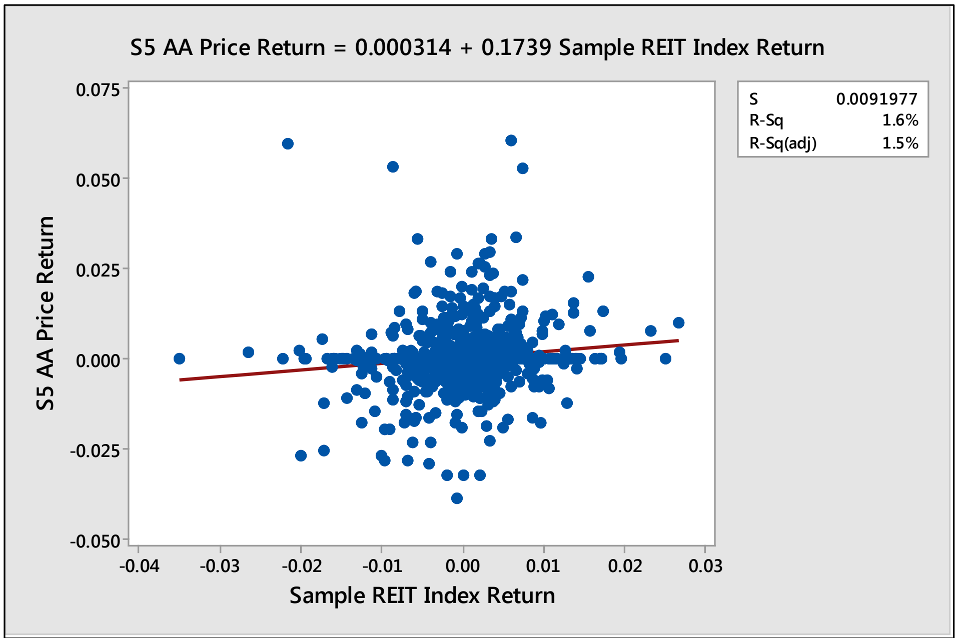

```
Model Summary

        S    R-sq  R-sq(adj)  R-sq(pred)
0.0591671  0.41%      0.27%       0.00%


Coefficients

Term                          Coef  SE Coef  T-Value  P-Value   VIF
Constant                   0.00149  0.00219     0.68    0.496
Sample REIT Index Return     0.558    0.322     1.73    0.083  1.00


Regression Equation

S5 BBB- Price Return = 0.00149 + 0.558 Sample REIT Index Return
```

Figure 27:



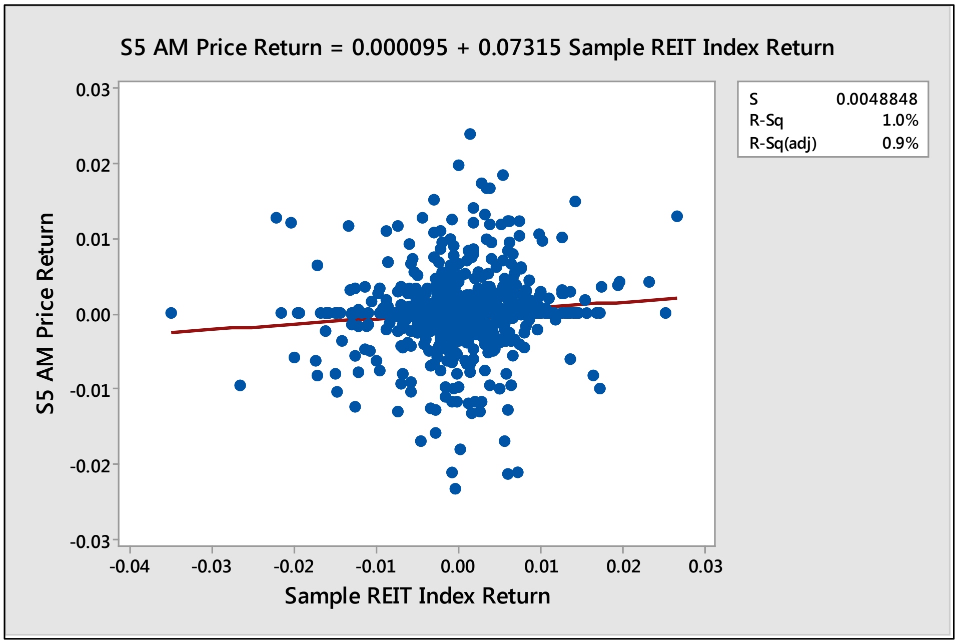

```
Model Summary

        S    R-sq  R-sq(adj)  R-sq(pred)
0.0225348  0.01%      0.00%       0.00%


Coefficients

Term                           Coef   SE Coef  T-Value  P-Value   VIF
Constant                   0.000253  0.000833     0.30    0.761
Sample REIT Index Return      0.024     0.123     0.20    0.843  1.00


Regression Equation

S5 A Price Return = 0.000253 + 0.024 Sample REIT Index Return
```

Figure 28:



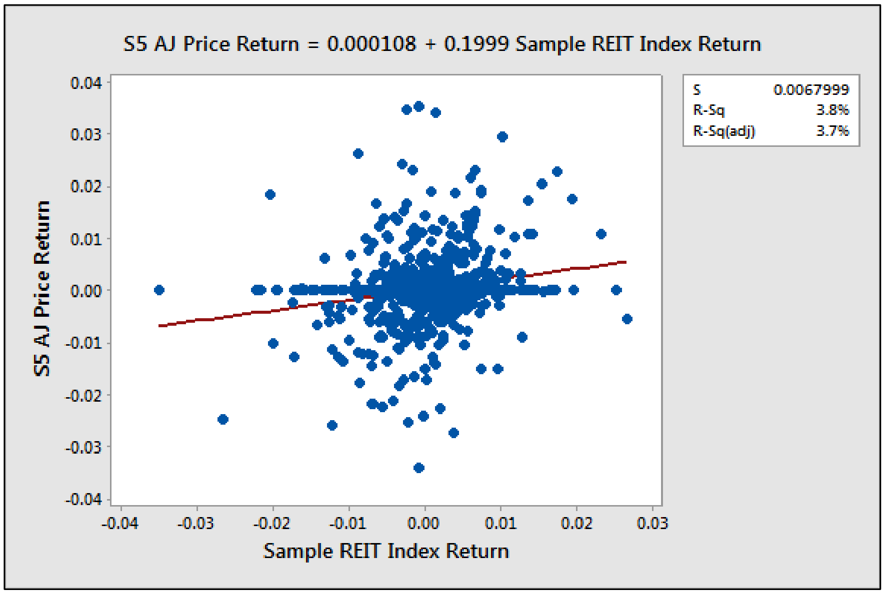

```
Model Summary

        S   R-sq  R-sq(adj)  R-sq(pred)
0.0091977  1.62%      1.48%       0.93%


Coefficients

Term                           Coef   SE Coef  T-Value  P-Value   VIF
Constant                   0.000314  0.000340     0.92    0.356
Sample REIT Index Return     0.1739    0.0501     3.47    0.001  1.00


Regression Equation

S5 AA Price Return = 0.000314 + 0.1739 Sample REIT Index Return
```

Figure 29:



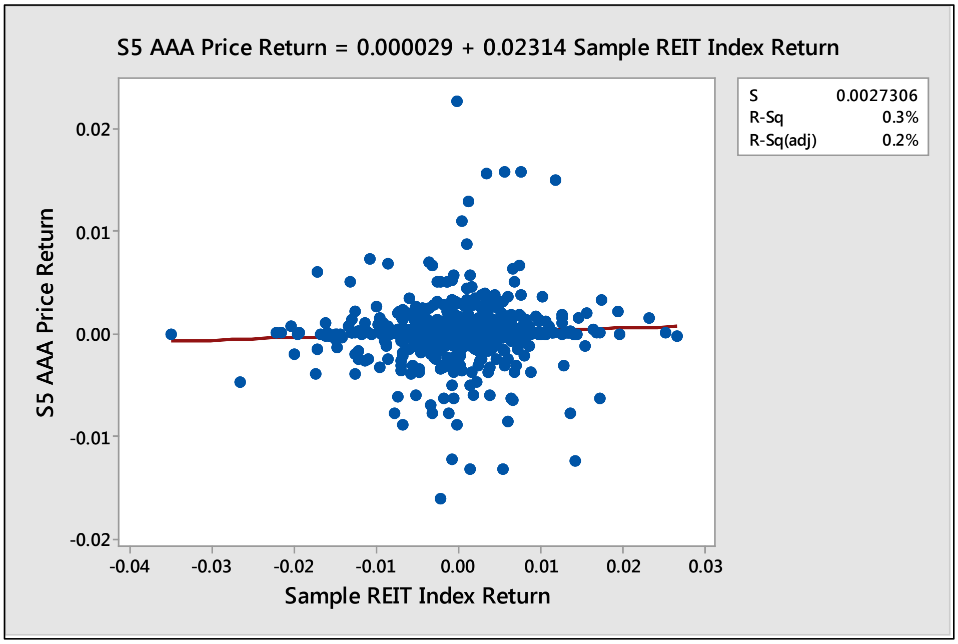

```
Model Summary

        S    R-sq  R-sq(adj)  R-sq(pred)
0.0048848   1.02%      0.89%       0.44%


Coefficients

Term                          Coef   SE Coef  T-Value  P-Value   VIF
Constant                  0.000095  0.000180     0.52    0.601
Sample REIT Index Return    0.0732    0.0266     2.75    0.006  1.00


Regression Equation

S5 AM Price Return = 0.000095 + 0.0732 Sample REIT Index Return
```

Figure 30:




```
Model Summary

        S    R-sq  R-sq(adj)  R-sq(pred)
0.0067999  3.83%      3.70%       3.22%


Coefficients

Term                          Coef  SE Coef  T-Value  P-Value   VIF
Constant                  0.000108 0.000251     0.43    0.668
Sample REIT Index Return    0.1999   0.0370     5.40    0.000  1.00


Regression Equation

S5 AJ Price Return = 0.000108 + 0.1999 Sample REIT Index Return
```

Figure 31:




```
Model Summary

        S    R-sq  R-sq(adj)  R-sq(pred)
0.0027306  0.33%      0.19%       0.00%


Coefficients

Term                          Coef   SE Coef  T-Value  P-Value   VIF
Constant                  0.000029  0.000101     0.29    0.775
Sample REIT Index Return    0.0231    0.0149     1.56    0.120  1.00


Regression Equation

S5 AAA Price Return = 0.000029 + 0.0231 Sample REIT Index Return
```

Figure 32:

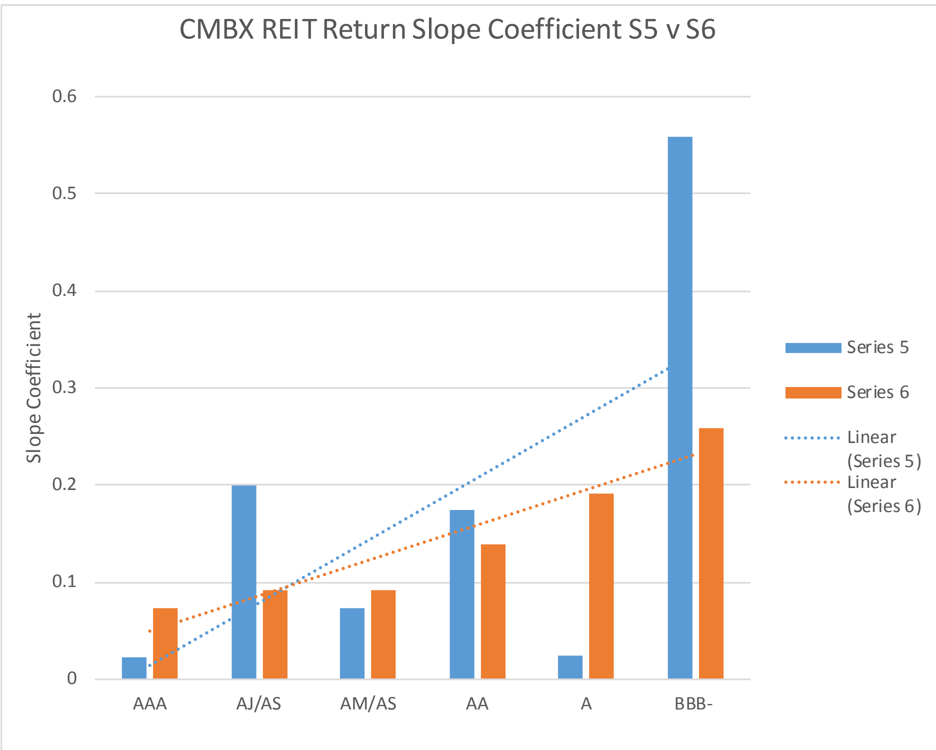
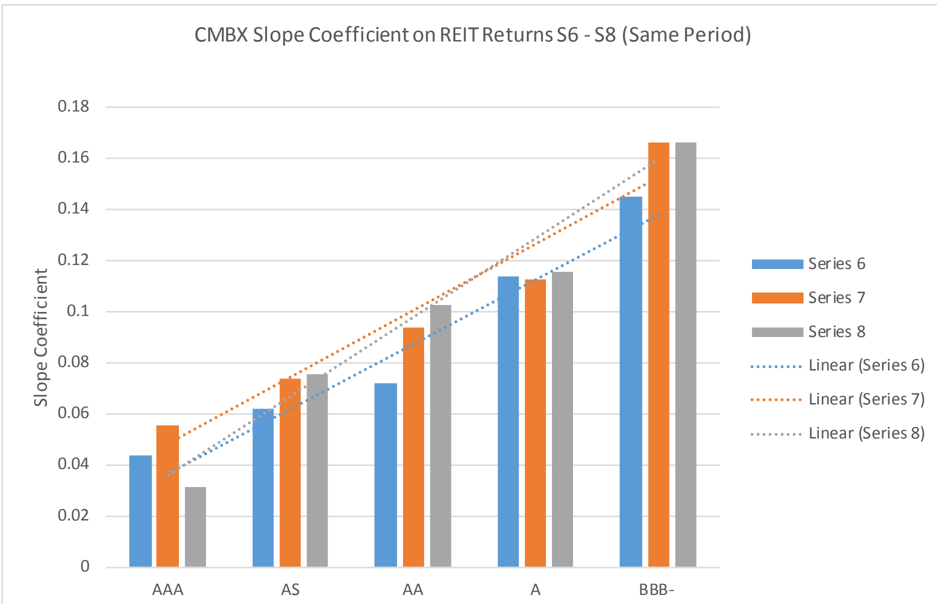

CMBX REIT Return Slope Coefficient S5 v S6
Slope Coefficient
0.6
0.5
0.4
0.3
0.2
0.1
0
AAA
AJ/AS
AM/AS
AA
A
BBB-
Series 5
Series 6
Linear (Series 5)
Linear (Series 6)

Figure 33:



CMBX Slope Coefficient on REIT Returns S6 - S8 (Same Period)
Slope Coefficient
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
AAA
AS
AA
A
BBB-
Series 6
Series 7
Series 8
Linear (Series 6)
Linear (Series 7)
Linear (Series 8)

Figure 34:

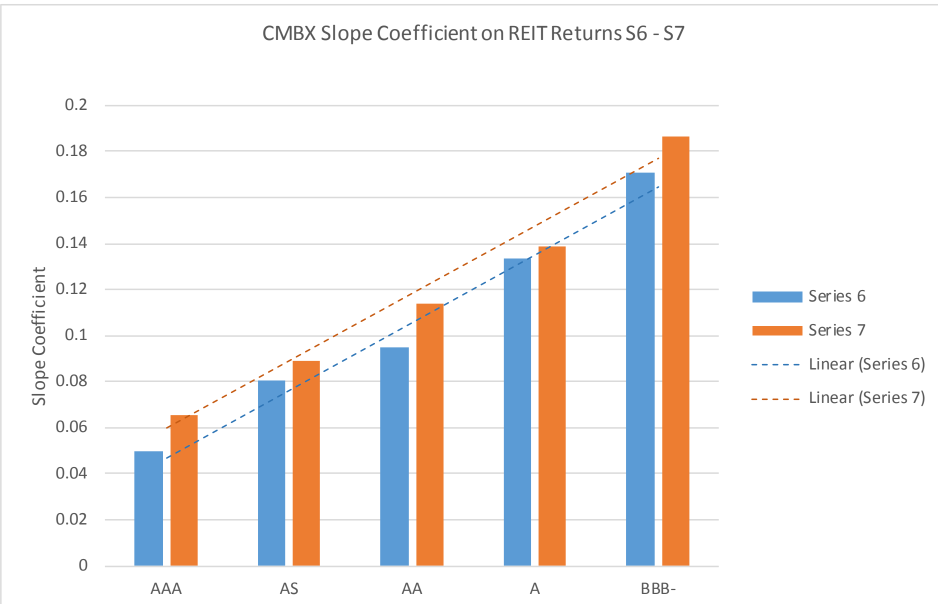

CMBX Slope Coefficient on REIT Returns S6 - S7
Slope Coefficient
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
AAA
AS
AA
A
BBB-
Series 6
Series 7
Linear (Series 6)
Linear (Series 7)

Figure 35:

Exhibit 20: Original average credit enhancement across series and ratings

Rating	CMBX.6	CMBX.7	CMBX.8	Series 6/7 Differential	Series 7/8 Differential
AAA	30.0	30.0	30.0	0.0	0.0
AS	20.8	22.1	23.5	1.3	1.4
AA	15.5	15.8	17.9	0.3	2.1
A	11.9	11.8	13.8	(0.1)	2.0
BBB-	6.8	7.1	7.6	0.2	0.5
BB	5.3	5.1	5.5	(0.1)	0.4

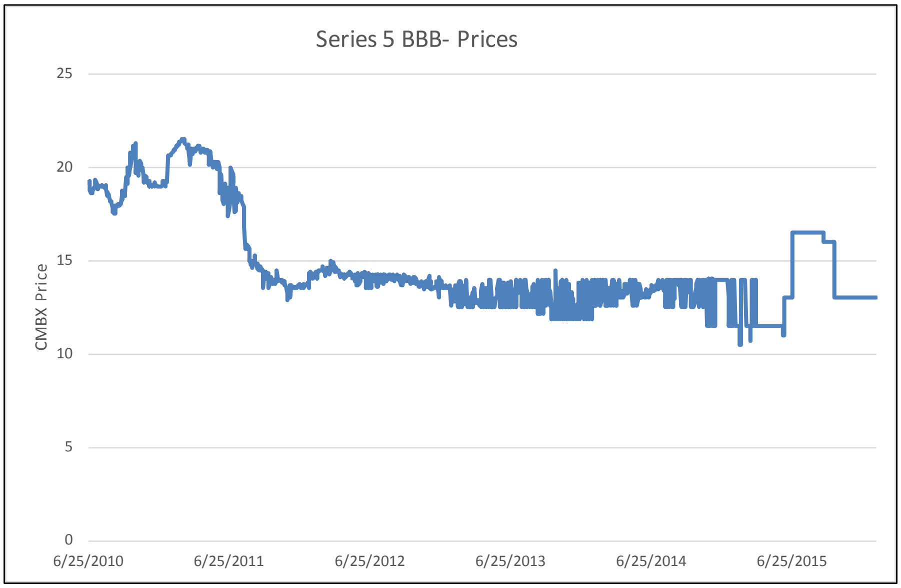
Source: Credit Suisse, deal documents, Trepp

Exhibit 21: Current credit enhancement across series and ratings

Rating	CMBX.6	CMBX.7	CMBX.8	Series 6/7 Differential	Series 7/8 Differential
AAA	31.1	30.3	30.0	(0.8)	(0.3)
AS	21.5	22.3	23.5	0.8	1.2
AA	16.0	16.0	17.9	(0.0)	2.0
A	12.3	12.0	13.8	(0.4)	1.8
BBB-	7.1	7.1	7.6	0.1	0.4
BB	5.4	5.2	5.5	(0.2)	0.3

Source: Credit Suisse, deal documents, Trepp

Figure 36:


Series 5 BBB- Prices
CMBX Price
25
20
15
10
5
0
6/25/2010
6/25/2011
6/25/2012
6/25/2013
6/25/2014
6/25/2015