The Structural Change in Mortgage–Treasury Spreads during the Credit Crunch

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Mortgage-backed securities (MBS) are assets whose cash flows are backed by the principal and interest rate payments of a pool of mortgage loans. The size of all MBS issued in the U.S. is greater than the total Treasury debt outstanding. The credit crunch starting in 2007 affected the MBS market and thus this market attracted the attention of crisis onlookers.

The prepayment and default risks are the major factors affecting the MBS price. The residential mortgagors have the option to pay off part of or the entire remaining principal at any time during the mortgage amortization term. Therefore, the mentioned cash flow can be an uncertain variable. This uncertainty in cash flow is named prepayment risk in the literature. The 10-year yield of Treasury notes has been the most important factor in explaining the prepayment behavior of the borrowers. As the rates go down, the probability of prepayment increases. As with other bonds, the market value is negatively related to the change in interest rates. The potential default of the borrower is another important factor in MBS valuation. Prior to the credit crunch this risk had been assumed to be negligible, but after the collapse of the real estate market in the U.S. this probability increased greatly and lowered MBS prices in secondary markets. Consequently financial institutions that kept MBS in their balance sheets suffered greatly, and some of them went bankrupt. Therefore, hedging portfolios of mortgages or MBS has become a vital necessity for the survival of financial institutions.

Previous studies have focused on modeling the MBS–Treasury spread. Goodman and Ho [1997] find that the slope and curvature of the yield curve and five-year cap volatility are the major explanatory variables of MBS–Treasury spreads. The increase in slope lowers the chance of prepayment and the increase in interest rate volatility makes the embedded option in mortgage loans more valuable. Kon and Polek [1998] estimate time-varying duration, slope, and par coupon sensitivities. Their time-varying empirical estimates provide superior out-of-sample hedging strategies relative to empirical option-adjusted methods. Arora, Heike, and Mattu [2000] find that a five-factor model can explain almost 60% of MBS–Treasury spreads. Koutmos [2002] looks into the dynamics of MBS spreads using a two-factor model and finds the asymmetric dynamic of spread movements. Spread is mean-reverting following spread increases and is nonstationary when spread decreases.

While research has been done on MBS–Treasury spreads, no research has compared the spread dynamics before and after a credit crunch. Modeling the spread is a crucial step in hedging mortgage portfolios, and the fall of many financial institutions during the credit crunch results from the lack of necessary changes to hedging strategies. In this article, I attempt to shed some light on the different behavior of MBS–Treasury spreads before and after a credit crunch and ultimately propose optimal hedging for a credit crunch era. Traditionally Treasury derivatives have been used as instruments for hedging mortgage portfolios. For example, Bhattacharya, Sekhar, and Fabozzi [2006] propose a GARCH model for optimal hedging of Fannie products by Treasury derivatives. But it will be shown in this study that Treasury derivatives are not sufficient for hedging mortgage portfolios during a credit crunch. The newly developed ABX derivatives will be suggested as a complementary instrument for hedging.

DATA

The dataset consists of daily 10-year Treasury rates, the 30-year par coupon conforming mortgage rate (a proxy for mortgage rates), and ABX-HE–AAA-06-01 tranche spreads. Exhibit 1 shows the daily diagram of 10-year rates and par coupon rates from January 19, 2006, to June 12, 2008.

The ABX-HE index is a kind of CDS backed with subprime residential MBS and is composed of 20 subprime deals set up in the six months prior to its launch and selected by a group of market dealers and managed by Markit Group. The administrator of the index selects the two largest transactions from each of the issuers in the subprime market. These are some of the major requirements for inclusion in the ABX index:

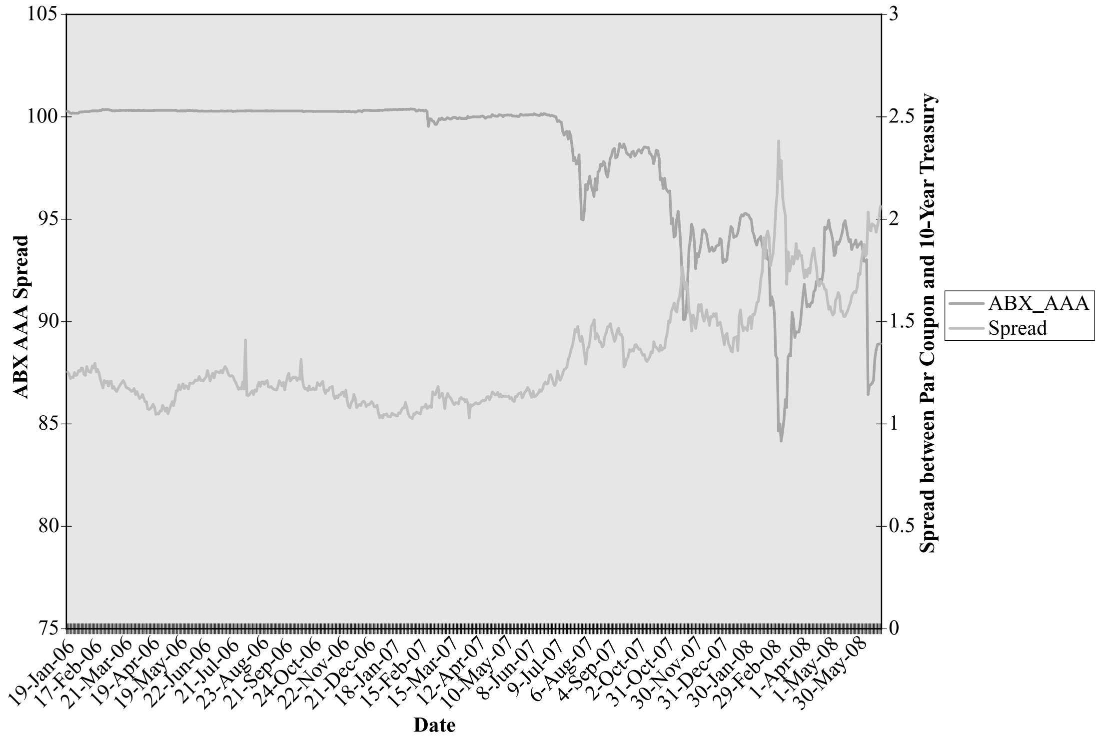
1. Tranches should have ratings from Moody's or Standard & Poor's.
2. Weighted average FICO scores should be less than 660.
3. The size should be more than $500 million.

Subindices of ABX are equally weighted tranches of each deal by credit rating (AAA, AA, A, BBB, and BBB–) and each of them will be traded in the market. ABX-HE is quoted in terms of the fixed rate, and it is the premium the protection buyer pays in exchange for the credit protection. On the first day the price is set to 100, and the dealers will quote afterwards. The difference

EXHIBIT 1
10-Year Treasury Rates and 30-Year Par Coupon Mortgage Rate

E X H I B I T 2

Spread between 10-Year Treasury Rates and 30-Year Par Coupon Mortgage Rate, ABX–AAA



between the dealer-quoted price and par will be the protection fee that the buyer should pay the seller on the notional amount. The protection buyer receives payments in the event of interest or principal shortfall on one or more of the index's constituent securities. For example, for a \$10 million notional trade on an index at a \$95 price, the protection seller receives a cash flow of \$500,000 and will compensate the protection buyer for any possible interest or principal shortfalls of the constituents of the index. Exhibit 2 shows the historical ABX-HE–AAA spread. This spread has been almost invariable before the start of the credit crunch and has increased afterwards. This index is a useful proxy for credit risk of mortgage loans.

EMPIRICAL RESULTS

Two time periods have been chosen for capturing the relationship between 10-year Treasury and 30-year mortgage rates. The first one is from January 16, 2006, to June 11, 2007, and the second one is after June 11, 2007, when the credit crunch started. It is supposed that these two time periods have different patterns.

An augmented Dickey–Fuller (ADF) test [1981] is used for the unit root test. Some studies have found that interest rates and MBS rates follow a process with unit roots. Nelson and Plosser [1982] and Koutmos [2001] find that interest rates and MBS rates have unit roots. The ADF statistic is calculated as follows:

$$\Delta y_t = \alpha_0 + \gamma y_{t-1} + \sum_{i=2}^{p} \beta_i \Delta y_{t-i+1} + \varepsilon_t$$

The null hypothesis is $\gamma = 0$; if it holds then y has a unit root.

The results of Dickey–Fuller stationary tests for 10-year Treasury rates and 30-year mortgage rates are reported in Exhibit 3. The null hypothesis of having unit root tests for both variables cannot be rejected. A principal feature of some nonstationary variables is that in the long run they may have equilibrium, and their time paths are influenced by any deviation from that equilibrium. Statistically, this process of feedback between a couple of nonstationary variables is described by Engle and Granger [1987] as cointegration modeling. Exhibit 4 shows the

EXHIBIT 3
Augmented Dickey Fuller Tests for the Pre-Credit-Crunch Period, Null Hypothesis: $\alpha = 1$ or There Is a Unit Root

Variable	Estimated Value of $\alpha - 1$	Test Statistics	p-Value
10-year rate	–0.02	–1.90	0.33
Mortgage rate	–0.011	–1.67	0.44

EXHIBIT 4
Johansen Cointegration Test Results for the Pre-Credit-Crunch Period

Rank	Eigenvalue	Trace Test	p-Value	Lmax test	p-Value
0	0.0498	20.91	0.0059	17.43	0.0134
1	0.0101	3.48	0.0621	3.48	0.0621

results of Johansen tests for cointegration between the two variables. The Lmax statistic tests the null hypothesis that the number of cointegrating vectors is r against the alternative $r + 1$. For $r = 0$, the null hypothesis, "there is no cointegration," can be rejected with less than 1% Type I error. Therefore if there is a cointegrating vector for the two variables while at 5% significance, we cannot reject the hypothesis that there are two distinct cointegrating vectors. The normalized cointegrating vector is [1, –1.04]. Therefore the long-run equilibrium for the 10-year rate and the mortgage rate is

$$\text{Deviation} = (\text{10-year rate} - 1.04 \text{ Mortgage rate})$$

The variable "Deviation" is a stationary process and shows the daily deviation from the long-run equilibrium of the two variables. The vector error correction model (VECM) will explain how the cointegrating variables react to any spontaneous disequilibrium. Exhibit 5 shows

EXHIBIT 5
VECM Model for the Pre-Credit-Crunch Period

	Variable	Coefficient	T-Stat	p-Value
Diff-Mortgage rate	Constant	0.0797	2.05	0.04
	Deviation	–0.0827	–2.01	0.04
Diff-10-Year rate	Constant	–0.0081	–0.26	0.79
	Deviation	0.0111	0.33	0.73

the VECM results. The coefficients for the 10-year rate do not show any significant reaction with respect to deviation from the equilibrium, while for the mortgage rate we observe responsiveness relative to the deviation. In other words, the mortgage rate had been correcting the deviation and was following the 10-year rate during the pre-credit-crunch period.

Exhibit 6 shows the results of ADF tests for the three variables during the credit crunch period. For all three variables, the null hypothesis of having a unit root cannot be rejected. Exhibit 7 shows the cointegration test for 10-year and mortgage rates for the credit crunch period. The null hypothesis of zero number of cointegrating vectors cannot be rejected (p-value = 0.33), and we can claim that unlike the pre-credit-crunch period the test does not show any cointegrating relationship between these two variables. However, if ABX-HE–AAA is added to the cointegrating test the result will be different. Exhibit 8 demonstrates the Johansen

EXHIBIT 6
ADF Tests for the Credit Crunch Period, Null Hypothesis: $\alpha = 1$ or There Is a Unit Root

Variable	Estimated value of $\alpha - 1$	Test Statistics	p-Value
10-year rate	–0.01	–1.76	0.39
Mortgage rate	–0.03	–1.99	0.28
ABX-HE–AAA	–0.02	–1.86	0.35

EXHIBIT 7
Johansen Cointegration Test Results for the Credit Crunch Period for the 10-Year Rate and Mortgage Rate

Rank	Eigenvalue	Trace Test	p-Value	Lmax Test	p-Value
0	0.0335	11.40	0.1904	8.49	0.3388
1	0.0116	2.91	0.0877	2.91	0.0877

EXHIBIT 8
Johansen Cointegration Test Results for the Credit Crunch Period for the 10-Year Rate, Mortgage Rate, and ABX-HE–AAA

Rank	Eigenvalue	Trace Test	p-Value	LmaxTest	p-Value
0	0.1020	42.12	0.0009	26.80	0.0056
1	0.0482	15.31	0.0517	12.31	0.0991
2	0.0119	3.00	0.0832	3.00	0.0832

EXHIBIT 9
VECM Model for the Credit Crunch Period

	Variable	Coefficient	T-stat	p-Value
Diff-Mortgage rate	Constant	0.1855	0.37	0.71
	Deviation	–0.0237	–0.37	0.71
Diff-10 year-rate	Constant	–0.0867	–0.22	0.82
	Deviation	0.0105	0.21	0.83
Diff-ABX-HE–AAA	Constant	15.86	5.59	0.00
	Deviation	–2.02	5.59	0.00

test for the three variables during the credit crunch. The null hypothesis of a zero number of cointegrating vectors can be rejected with less than 1% Type I error, while the existence of more than 1 cointegrating vector cannot be deducted from the test. The following linear relationship shows the steady state equilibrium for the three variables:

$$\text{Deviation} = (\text{10-year-rate} - 0.87 \text{ Mortgage rate} - 0.74 \text{ ABX-HE-AAA})$$

The coefficients of the VECM model for the three variables are shown in Exhibit 9. Unlike ABX-HE–AAA, the coefficients of the 10-year and mortgage rates are not significant. This means that the only variable that reacts to the deviation from the long-run equilibrium is ABX-HE–AAA.

CONCLUSION

Traditionally, mortgage portfolios have been hedged by Treasury derivatives. After the real estate meltdown started in 2007, the credit risk of mortgage borrowers played a major role in assessing the total risk of the MBS market. The comparison between before and after the start of the credit crunch shows that without using ABX-HE index instruments, it is not possible to analyze and hedge mortgage portfolios. Consequently, the cost of hedging has gone up due to the surge in default risk of mortgage loans.

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