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Assessing the Effectiveness of the Paulson “Teaser Freezer” Plan: Evidence from the ABX Index

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Abstract

How did investors holding assets backed by subprime residential mortgages react when Treasury Secretary Paulson announced the so-called “teaser freezer” plan to modify mortgages in December 2007? We apply event-study methodology to the ABX index, the only source of daily securities prices in subprime mortgage markets. Our results show that investors initially perceived that the Paulson Plan would improve conditions in subprime housing markets. Specifically, those investors who held the riskiest securities backed by subprime residential housing benefited the most from the Paulson Plan. These findings do not extend to the longer term, suggesting that any positive effects from Paulson Plan loan modifications were overwhelmed by the continued deterioration in housing markets.

Keywords: G12, G13, G14, G18, G21

JEL Classification: mortgage loan modifications, ABX index, event study

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I. Introduction

In February 2007, the U.S. economy entered a period of steep financial retrenchment caused by a correction in the market for residential housing; a correction that has not yet run its full course. A key aspect of the housing correction was the unprecedented rise in the rate of residential mortgage delinquencies and foreclosures.

Figures 1 and 2 show delinquencies and foreclosures for mortgages of different types. The rates were the highest in recent history. It is clear that subprime, adjustable-rate mortgages exhibited the worst performance and could be the greatest source of stress in the markets for residential mortgage backed securities (RMBS) market.

Figure 1
Residential Mortgage Delinquency Rates (by Credit Risk and Terms)
Data includes all U.S. Banks, 1998:Q1 - 2008:Q1

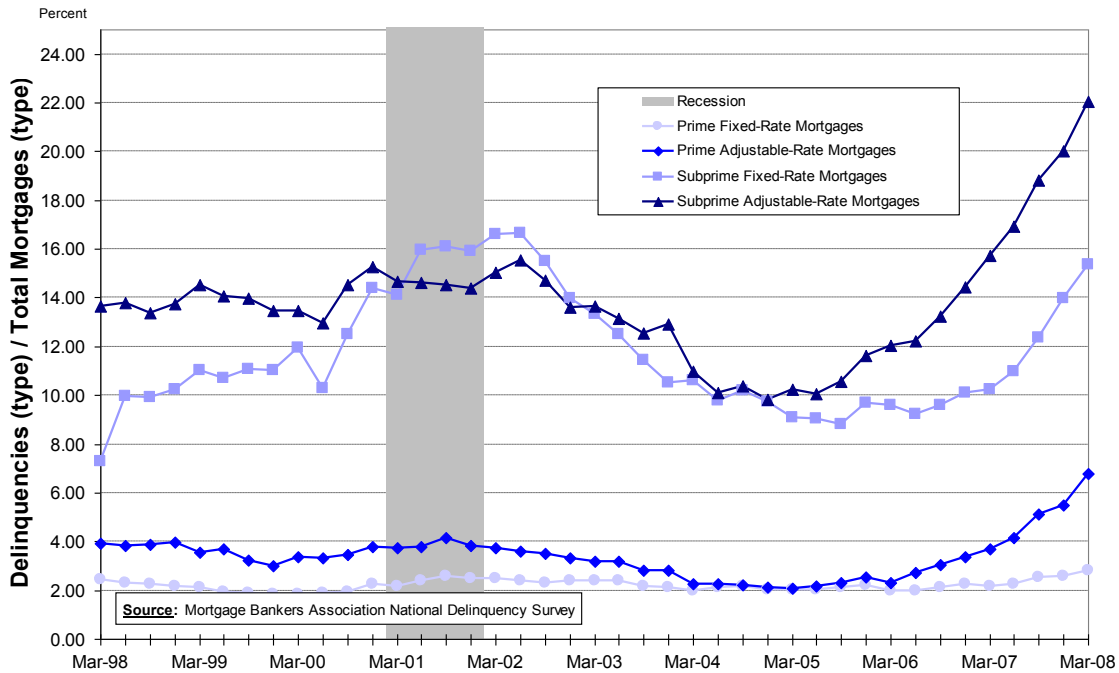
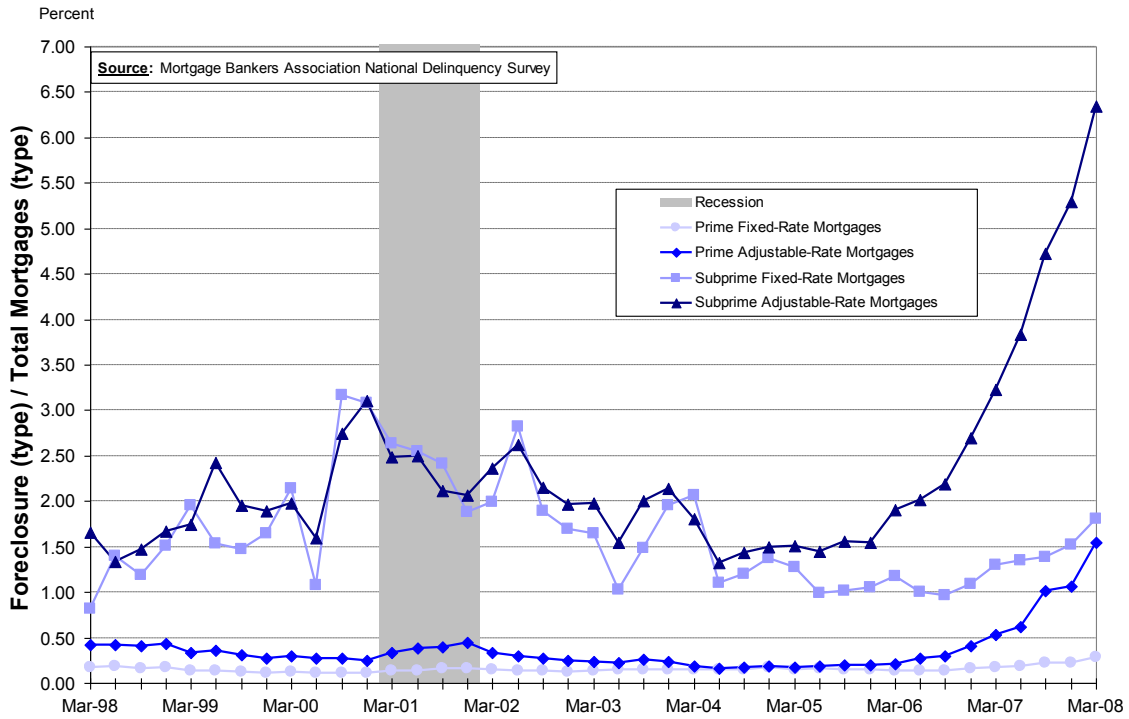


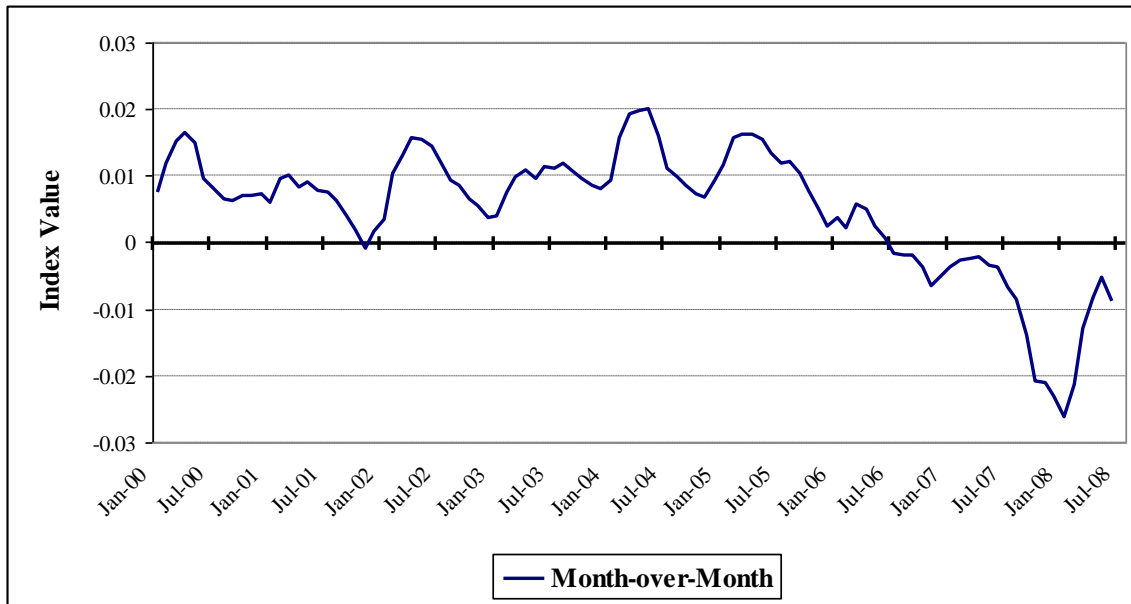
Figure 2
Residential Mortgage Foreclosure Rates (by Credit Risk and Terms)
 Data includes all U.S. Banks, 1998:Q1 - 2008:Q1



As part of the set of policies designed to limit delinquencies and foreclosures among subprime borrowers, Treasury Secretary Henry Paulson announced a plan on December 6, 2007 (“the Paulson Plan”) developed with the assistance of the Federal Reserve Board, the Federal Deposit Insurance Corporation, the Office of the Comptroller of the Currency, and the Office of Thrift Supervision, and in conjunction with the American Securitization Forum. The Paulson Plan called on lenders and servicers to voluntarily modify the mortgages of adjustable-rate subprime borrowers before they go into default. The Plan attempted to reduce defaults by encouraging lenders and servicers to contact borrowers prior to the scheduled reset of their interest rate. In addition, the Paulson Plan temporarily froze the introductory interest rate for a segment of the subprime borrowers for up to five years—leading some to label it the “teaser

freezer plan”.¹ Proponents of the Paulson Plan contended that a streamlined evaluation process for lenders and servicers would reduce transactions costs and increase the speed with which borrowers can be assisted and reduce the number of delinquencies and defaults.

Figure 3
S&P Case-Shiller Composite 20 Index
January 2000 to July 2008



The Paulson Plan had a second important objective. Many observers and key policymakers believed that the housing crisis posed a significant risk to global financial markets. This risk was the result of rapidly declining home values and their effect on RMBS and other structured finance products whose values were derived from their underlying mortgage collateral. Figure 3 shows the steep reduction in home values, the highest on record, as measured by the Standard and Poor’s Case/Shiller Index. Of the 20 metropolitan markets that are monitored, every market experienced a decline in home values. The Federal Deposit Insurance Corporation estimated that 1.54 million subprime mortgages with a notional value of

¹ Cherny and Demyanyk (2009) indicate that subprime hybrid ‘teaser’ rates were in fact not really teasers because the average subprime hybrid mortgage rate at origination was between 7.3 and 9.7% from 2001 to 2007. These numbers are considerably higher when compared to corresponding rates for prime hybrids ranging between 2% and 3%.

\$331 billion would reset by the end of 2008. By freezing resets of subprime ARMs, the Paulson Plan aimed to lower expected defaults on modified mortgages and help support the value of mortgage related assets.

Has the Paulson Plan “worked?” Was there a positive reaction by investors holding assets backed by subprime RMBS when the Paulson Plan was announced? This paper explores these questions by adapting methodology similar to an event study. We use the ABX, a price index that tracks the value of RMBS backed by subprime mortgage collateral. It is the only source of daily data tracking securities prices in subprime mortgage markets. Our hypothesis is that the ABX should exhibit positive abnormal returns when the Paulson Plan was announced if investors in those assets believed that the Plan would have an important effect on conditions in subprime mortgage markets.

Our results show that the announcement of the Paulson Plan led to a temporary positive market reaction for select tranches and vintages of the ABX. At the announcement, investors in the ABX perceived that the Plan would improve the subprime housing market. These results were strongest in the most subordinate tranches of the ABX where loan modifications would be most likely to help. When we explore movements in the ABX in the six month period following the Paulson Plan, our findings suggest that any positive effects from Paulson Plan loan modifications were overwhelmed by the continued deterioration in housing markets. Consistent with the findings of other researchers who have studied the ABX [Dungey, Dwyer and Flavin (2008) and Fender and Scheicher (2008)], we find that as the housing market deteriorates, the riskiness of all subprime securities increases, with a higher relative increase in riskiness for securities that are highly rated.

The paper is organized as follows: section two provides an overview of the types of mortgage modifications, the Paulson Plan and the benefits and costs of loan modifications. Section three discusses the data and empirical approach, section four contains our results and section five concludes.

II. Types of mortgage modifications

One of the most common loan modifications extends the maturity of the mortgage. Although the length of extension varies, it is not uncommon for borrowers to extend mortgages as many as 10 years beyond the existing maturity date. Mortgage extension can be beneficial to borrowers because it reduces their immediate financial burden by reducing monthly mortgage payments. However, many borrower advocacy groups view this type of modification unfavorably because it increases the overall financing cost of the home and lengthens the period of the borrower's indebtedness.

A more aggressive form of mortgage modification requires the lender to defer or forgive any missed payments. In the case of deferred interest payments, borrowers who have missed one or more payments would be allowed to stay in their homes, but any missed payment would be rolled into the principal of the loan. In most cases, the borrower is required to repay missed payments using a shortened amortization schedule. After the missed payments have been repaid, the payment returns to that established at origination. This form of modification is not popular among borrower advocate groups because deferring missed payments leads to an increase in mortgage payments. Increased mortgage payments to borrowers who may have had difficulty paying their mortgage under the original terms of the loan are unlikely to be an effective way to reduce mortgage defaults.

A type of modification popular with borrowers forgives missed interest and/or principal payments. Loans modified in this fashion allow borrowers to remain current on their mortgages without incurring any additional costs associated with missed payments. While this form of modification is most likely to have the greatest impact on reducing mortgage delinquency and default, this form of modification is not popular within the mortgage industry.

Another type of loan modification that is popular among borrowers forgives or reduces the principal/loan amount. Principal reduction is beneficial to the borrower because it allows the borrower to pay a lower monthly mortgage payment (both principal and interest). An additional benefit that is uniquely tied to the current housing crisis is that a principal reduction can be used to reduce the incentive of the borrowers to default on their mortgages and walk away from their homes. It has been argued that the decline in home values has encouraged many borrowers to mail in their keys when their homes become worth less than their mortgage.² A principal reduction can be used to reduce the imbalance between home values and loan amounts.

A final type of loan modification takes place when lenders reduce the interest rate charged to the borrower or extend the initial introductory interest rate beyond the pre-established period. The Paulson Plan is an example of this form of modification. The post-modification performance of mortgages varies by the type of mortgage modification. A study by Citigroup Global Markets (2009) shows that less aggressive mortgage modifications, like deferring missed interest payments or term extensions, have the highest delinquency rates post modification, while mortgage modifications that freeze the introductory interest rate in a manner similar to the “teaser freezer” plan have the best post-modification performance, when compared to other loss

² Willen et al. (2008) present a simple model that shows negative equity is a necessary, but not sufficient, condition for borrowers to “walk away” from their homes.

mitigation techniques. According to the Citigroup study, the number of modifications that freeze the introductory interest rate are just over 50,000 out of a total of 300,000 total loans modified.

The Treasury Loan Modification Plan (“The Paulson Plan”)

On December 6, 2007, Treasury Secretary Henry Paulson announced a plan in which lenders could voluntarily restructure subprime mortgages. The first step in the Paulson Plan was to encourage lenders and servicers to contact borrowers and inform them of their options prior to borrowers falling into delinquency or default. In addition to increased outreach, the Paulson Plan encouraged loan servicers to help borrowers avoid default by either modifying or refinancing existing adjustable-rate loans.

The centerpiece of the Paulson Plan allowed servicers to modify subprime ARMs without contacting individual applicants to document applicant or housing information. This streamlined or “Fast Track” process allowed servicers to restructure loans without having to individually investigate each loan in order to determine an appropriate solution. The primary method of modification available to borrowers under the “Fast Track” process froze introductory interest rates for five years.

Before the Paulson Plan could be initiated, adjustable-rate subprime borrowers had to be segmented into groups in order to identify which borrowers would be eligible for the “Fast Track” Program. Group 1 borrowers were those who held a subprime ARM and had the ability to refinance into a fixed rate mortgage product. The Paulson Plan encouraged servicers who were in negotiations with borrowers who fell into this group to apply generally accepted industry standards for loan modifications or loss mitigation. In addition, the plan encouraged servicers to waive prepayment penalties to help borrowers refinance into another mortgage product.

Group 2 borrowers were unlikely to be able to refinance into an alternative mortgage product, but met the following requirements:

1. They held ARMs, including 2/28s and 3/27s hybrid loans;
2. Their loan must have originated between January 1, 2005 and July 31, 2007;
3. Their loan must have been included in a securitized pool;
4. The loan interest rate reset must have been scheduled to occur between January 1, 2008 and July 31, 2010;
5. They must have been current, or at worst 30 days delinquent, and had no more than one 60-day delinquency over the past 12 months;
6. They must have occupied the property;
7. Their FICO score must have been less than 660 and must not have increased more than 10% from the original FICO;
8. There must have been no apparent fraud;
9. They cannot have been eligible for the FHA Secure loan program, which required:
 - a. the original loan-to-value ratio was greater than 97% on 1st lien,
 - b. or, they were otherwise ineligible because of delinquency history, a high debt-to-income ratio, or high outstanding loan balance.

Borrowers who fell into Group 2 were eligible for the rate freeze under the Paulson Plan. The plan allowed loans to be modified if the borrower agreed to the modification upon being contacted, or if the borrower made two mortgage payments under the modified terms. It was estimated that the number of borrowers who would be eligible under the Paulson Plan numbered as high as 1.2 million.³

³ Wall Street Journal, February 29, 2008

Group 3 borrowers were individuals who were having difficulty meeting their mortgage payment at the present introductory rate, and had missed two consecutive mortgage payments. This group included borrowers who used an adjustable-rate subprime loan to purchase an investment property. Borrowers who fell into this category were not eligible for assistance under the Paulson Plan. Deutsche Bank (2008) showed that roughly 35% of the subprime ARM loans could be modified based on the restrictions established under the plan. Another study published by UBS Investment Research (2007) predicted that the percentage of borrowers who could benefit from the Paulson Plan would fall by 15% after accounting for borrowers who were or would be at least 60 days delinquent (and thus became ineligible under the plan's requirements) when it is time to modify their loan.

Two criticisms were levied at the Paulson Plan when it was announced. First, because loan modifications represent a direct uncompensated cost to servicers, they might not aggressively contact, identify or modify loans to borrowers if it led to a significant increase in their costs. As a result, servicers might have fewer incentives to engage in activities that would lead to a reduction in foreclosures.⁴ A second criticism directed at the plan was that its eligibility requirements were too strict compared to the number of borrowers in need of assistance, limiting its impact on foreclosures.

⁴ Additional programs were initiated following the announcement of the Paulson Plan that attempted to address the compensation structure for mortgage servicers to modify loans. The Streamlined Modification Program, Hope For Homeowners and the Home Affordable Modification Program provided financial compensation to mortgage servicers for every mortgage that was modified. In addition, the Home Affordable Modification Program encouraged servicers to aggressively modify mortgages by providing servicers additional compensation for every year the homeowner remained current on their mortgage for up to five years.

The benefits and costs of modifying mortgages

The Paulson Plan was intended to help borrowers stay in their homes, but the support of the securitization industry was necessary to ensure that the plan would be acceptable to investors in securitized products backed by subprime mortgages. Some of the investor incentives were quite transparent and were well aligned with the incentives of the homeowner. For example, a loan modification may increase the probability that the homeowner will retain the home; maintaining homeownership preserves the cash stream that flows to investors in securitized products. In addition to those direct benefits, loan modifications potentially prevent costs associated with foreclosure. From the investor's perspective, a loan that moves into foreclosure can expect a loss severity estimated at 40%-60%. In addition to the direct cost of foreclosure, investors may also incur costs if the borrower damages or neglects the property before being evicted.

The goal for loan modification was to reduce delinquencies and foreclosures, which will benefit borrowers, lenders, and investors. It is possible, however, that loan modifications may simply delay foreclosures. Historically, 30% to 50% of previously delinquent mortgages go into default within two years of being modified.^{5,6} Since the loans targeted by the Paulson Plan were in a higher risk category, it was likely that a higher percentage of these loans would ultimately default.⁷

If loan modifications simply delay the inevitable, then investors may find themselves in a weaker financial position if they allow mortgages to be modified. One concrete example of how

⁵ Deutsche Bank, Jan. 2008.

⁶ The OCC reported that 37% of the mortgages modified in the first quarter of 2008 redefaulted after three months, and 53% did so after six months. The redefault rates for second quarter 2008 loan modifications were very similar. The speech by Comptroller Dugan citing these figures can be found at <http://www.occ.treas.gov/ftp/release/2008-142a.pdf>. The OCC report with the background data is at <http://www.occ.treas.gov/ftp/release/2008-150a.pdf>. The loan modification data is inclusive of servicers' activities (thus not limited to Paulson Plan-eligible loans.)

⁷ A Deutsche Bank study (2008) estimated that 50%-60% of the loans modified under the Paulson Plan will subsequently redefault.

this might occur concerns the release of excess spread. Excess spread is a form of credit enhancement that protects investors in the junior tranches against loss. Excess spread is a form of subordination that accumulates based on the difference between the income received from the securitized assets pool and the costs incurred by the trust (including payments to bondholders). Typically, excess spread is highest early in a trust's life when the mortgage pool experiences very few losses.

If loans are modified by lengthening the introductory rate for five years, then income from the pool may potentially fall in the short run because borrowers pay a lower, modified interest rate. Lower income will cause excess spread to grow at a slower rate. The smaller excess spread can absorb fewer losses if delinquencies and defaults are simply delayed, rather than reduced by the Paulson Plan. If defaults increase later and the excess spread is consumed, losses will increase for subordinate bondholders.

Another form of credit enhancement used to protect investors is over-collateralization (O/C). Over-collateralization occurs when the principal amount of the mortgage loans in the pool exceeds the amount necessary to support the debt issued by the trust. O/C absorbs any losses incurred by the pool beyond the protection provided by the excess spread. Typically, mortgage backed securities include performance triggers in the contract that are initiated after a certain amount of time has elapsed. These triggers often release O/C to the residual tranche holders after 36 months. If loan modifications only delay mortgage defaults, then the release of O/C may reduce the amount of protection investors in higher tranches have against losses within the pool. The release of O/C might then benefit subordinate tranche investors at the expense of mezzanine tranche investors because the cash flows to residual tranche holders are accelerated and potential losses that would have been absorbed by these investors are passed on to others.

The release of O/C can have a differential impact across investors within the structure of the RMBS. Senior tranche investors should be indifferent to loan modification plans if they are high enough up the capital ladder for the release of O/C to have a material impact upon their expected losses. However, these investors could experience an extension in the expected maturity of their investment if borrowers have an increased incentive to modify their mortgages.

Investors in the middle and lower tiers of the capital structure would have very different reactions to the Paulson Plan if the end result of the policy is simply to delay defaults. For junior tranche investors, loan modifications and the possible release of O/C puts them in a safer position, where they have received higher compensation for being at the bottom of the capital structure, but the default risk they bear has been reduced, increasing the cash flows they expect to receive.

For mezzanine tranche investors (e.g., BBB and A rated debt), loan modifications and the release of O/C may put them in a weaker credit position relative to subordinate debt holders. The release of O/C and the potential delay in defaults puts these investors at risk of having to experience losses that would have been absorbed by subordinated investors in the absence of the plan.

III. Data and Methodology

To determine if the announcement of the Paulson Plan was viewed by the market as having a credible impact on reducing delinquencies and foreclosures among subprime homeowners requires a data source with inter-day variation. Variables, like delinquency or foreclosure rates, traditionally used to monitor the health of the housing market, are reported too

infrequently for our purposes. As a result, we use data from the ABX index. The ABX, which is reported daily, is generally viewed as a barometer of the health of the subprime housing market.⁸

The value of the ABX is constructed from the spreads on a standardized portfolio of credit default swaps (CDS) on 20 equally weighted mortgage backed securities (MBS) backed by subprime home equity loans.^{9,10} CDS spreads are used to construct the index because the underlying MBSs are often privately placed and traded, and reportedly trade too thinly for use in the construction of an index.^{11, 12} The share of ARMs represented in each vintage declined slightly but consistently with each vintage from the oldest (84%) to the newest (76%). As measured by the FICO score, the borrower quality represented in each vintage is roughly the same.¹³

⁸ See Gorton (2008) for a discussion of the importance of the ABX as a market barometer of the health of the subprime housing market.

⁹ For details on the construction of the ABX, see:

<http://www.markit.com/information/products/category/indices/abx/documentation/contentParagraphs/0/document/ABX%20rules%20revised%2009-9-08.pdf> (accessed February 24, 2009).

¹⁰ The ABX index has characteristics that are similar to a bond (because its underlying assets are MBS). However, the ABX has some advantages when compared to bonds. For example, a bond's sensitivity to risk changes as the bond's maturity declines over time. When using event-study methodology, this is problematic because the appropriate benchmark index will produce a static risk factor.

¹¹ When using event-study methodology, CDS on corporate securities are viewed as a viable alternative to using corporate bonds. In fact, CDS have a number of advantages over corporate bonds for the following reasons: there is only one CDS for each company at each maturity, CDS contracts are standardized by maturity, and the CDS market is more liquid.

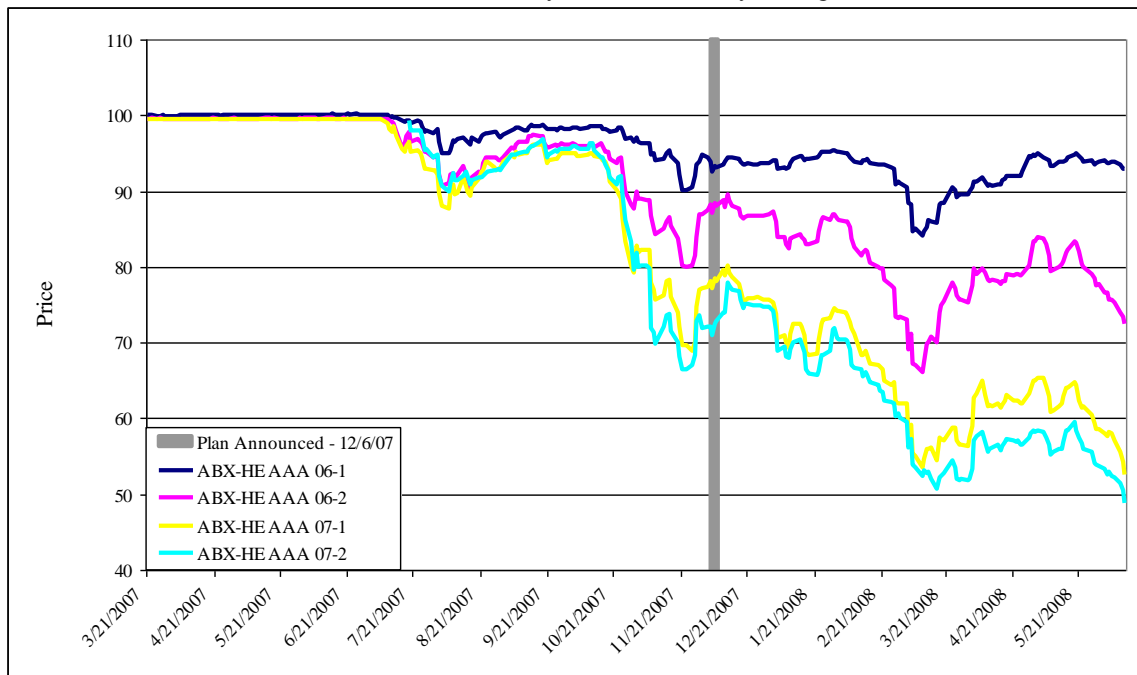
¹² The ABX index is a traded index. As such, we wondered about its relationship to the underlying MBS. The only available price data is for the AAA MBS. During the period August 2007 to February 2008, the correlations between ABX AAA and the prices of the underlying MBS were between 88 and 93 percent depending on the vintage.

¹³ These are the deal characteristics represented in the ABX. Source: Nomura Fixed Income Strategy, ABX Index-The Constituent Breakdown. July 12, 2007.

2006-1	FICO - 630.34 LTV - 81.41 % ARM - 83.99 % IO - 33.24
2006-2	FICO - 625.09 LTV - 81.17 % ARM - 82.03 % IO - 23.62
2007-1	FICO - 624.55 LTV - 80.93 % ARM - 77.74 % IO - 15.16

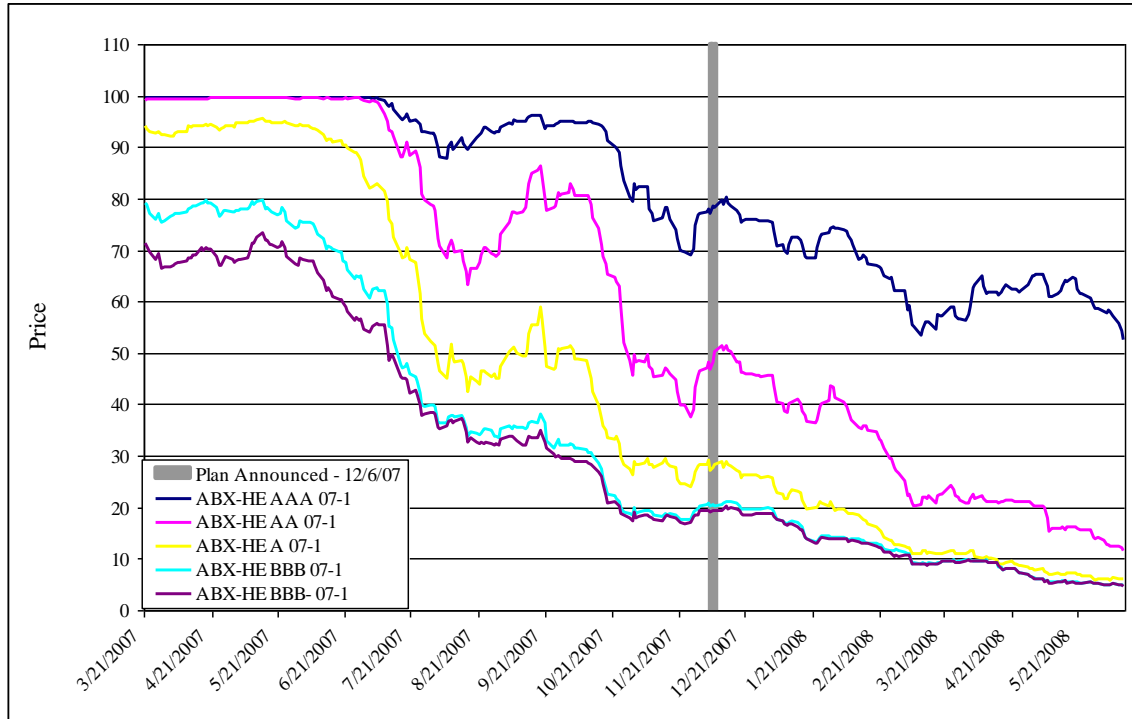
Figure 4a shows some of the price history for the four ABX vintages currently trading: the 06-1, 06-2, 07-1, and 07-2 vintages. The first two numbers for each vintage represents the reference year of the index, and the last number indicates whether the index represents the first or second half of the year. For each vintage, the ABX has five different tranches (Figure 4b is an example) that correspond to the tranches (defined by credit quality) of the underlying MBS in the index.

Figure 4a
 ABX-HE Price History – AAA Pieces by Vintage



2007-2 FICO - 624.54
 LTV - 82.06
 % ARM - 75.98
 % IO - 18.51

Figure 4b
ABX-HE 07-1 Price History



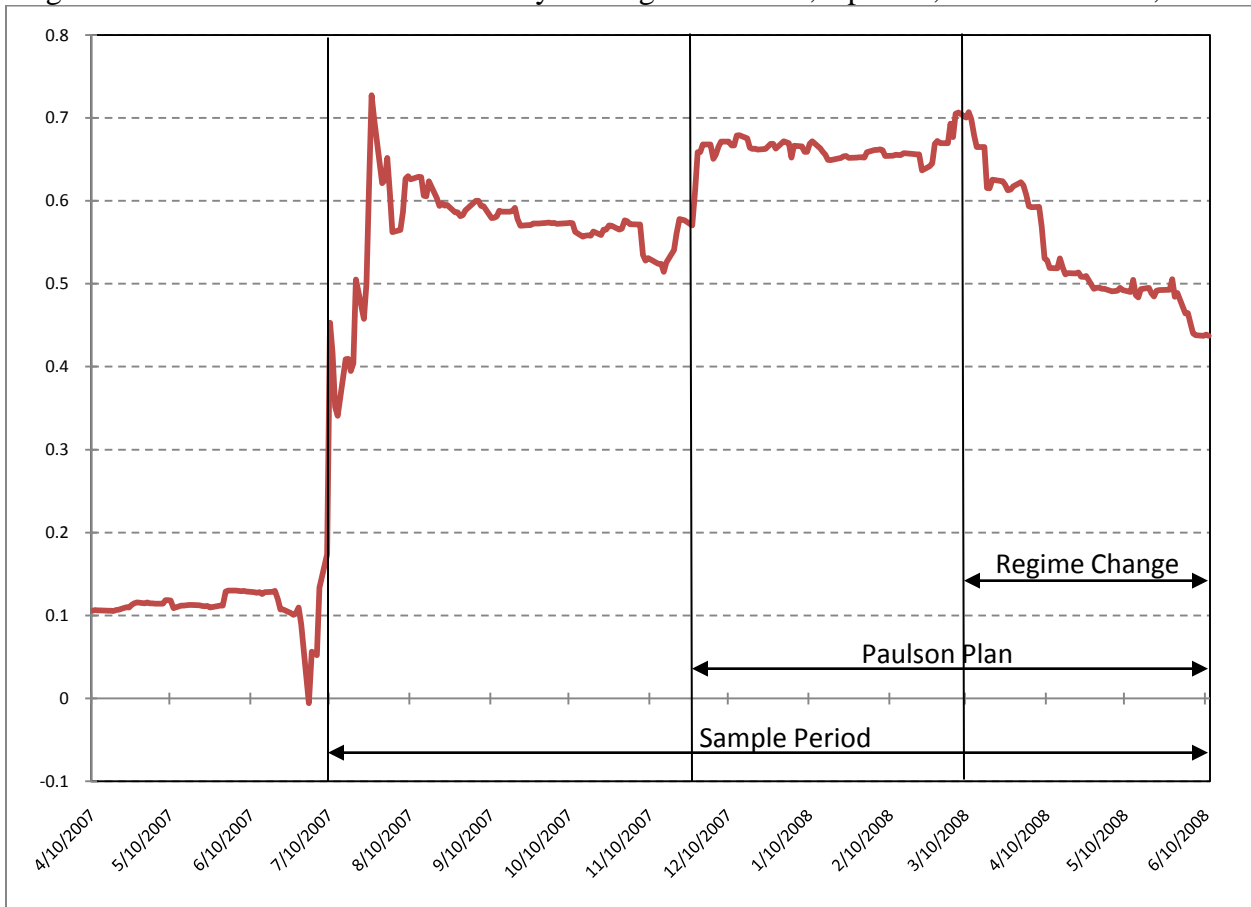
The 06-1 and 06-2 vintages of the ABX were relatively flat for year 2006. In early 2007, volatility started to appear in the ABX after it became apparent that serious weakness existed in the subprime housing market. The volatility may have been driven by investor concerns for the quality of the collateral backing mortgage related assets. For example, on July 10, 2007, the Secretary of Housing and Urban Development (HUD) stated that 20% of the subprime mortgage loans outstanding were “pretty bad”.¹⁴ On the same day, Standard and Poor’s stated that they were in the process of reviewing for possible downgrade over \$12 billion bonds backed by subprime mortgages.¹⁵ These two statements are just two examples of a consistent theme during this time period that the quality of subprime mortgages had significantly deteriorated.

¹⁴ Bernard Lo and Debra Mao. U.S. Housing and Urban Development’s Jackson Says 20% of Subprime Loans are ‘Pretty Bad.’ July 10, 2007. Bloomberg.

¹⁵ Mark Pittman. Moody’s Lowers Ratings on Subprime Bonds, S&P May Cut. July 10, 2007. Bloomberg.

It is often said that “in a crisis, all correlations go to one.” The graph presented in Figure 5 uses 90-day rolling correlations to show the relationship between the most senior and junior tranches within the ABX. These correlations indicate that the relationship between the AAA and BBB- tranches increased significantly on July 10, 2007, when the correlation more than doubled. Subsequent rolling correlations remain at or above the July 10 values for the rest of the sample period. As stated previously, the strong movement in the 90-day moving correlations corresponds with the announcements by the Secretary of Housing and Urban Development and Standard and Poor’s that the housing market had significantly deteriorated. In other words, July 2007 represents a time period where all tranches regardless of vintage were perceived by investors as being susceptible to credit loss.

Figure 5: ABX 06-1 AAA/BBB- 90-Day Rolling Correlation, April 10, 2007 to June 11, 2008



The analysis used in this study is a variation of a traditional market model event study.¹⁶ We use the market model to observe how the market perceived the potential success of the Paulson Plan. The model assumes that movements in returns on a reference portfolio that are different from the return movements in a control portfolio around a specific event can be attributed to the event. We observe the market's reaction to the Paulson Plan using daily ABX data for the time period of July 10, 2007 to June 11, 2008. To ensure that observed movements in the ABX could be attributed to the Paulson Plan, we limit the sample to the period prior to the announcement of the first in a wave of additional loan modification plans, the FDIC's Mod-in-a-Box Program to modify mortgages of the failed bank IndyMac (July 2008). By starting the sample following a structural shift in the relationship between the AAA and BBB- tranches, we bias the market model against finding statistical significance around the event of interest.

For this study, the AAA tranche of the ABX index is used as the control group. We chose the AAA tranche for the control group because it represents the highest quality securities within the ABX index (the AAA tranche is protected by the most credit enhancements). In addition, its high quality ensures that while the AAA tranche is responsive to information related to the overall health of subprime housing, its movements will be less reflective of changes in asset credit quality when compared to subordinate tranches within the ABX index.¹⁷

¹⁶ The model used for the purposes of this study is a variation of the Brown and Warner (1980) study used for equities and Asquith and Wizman (1990) and Warga and Welch (1993), among others.

¹⁷ For the time period starting in the second half of 2005, Dungey, Dwyer and Flavin (2008) showed that the standard deviation in returns is highest for those tranches that have the highest credit risk. In addition, the correlation between the AAA and BBB tranche ranges from 55.5% for the 06-1 vintage to 36.7% for the 07-2 vintage. The authors stated that during the period of increased volatility in the ABX, the correlation between the tranches within each vintage increases leading investors to realize that they under-estimated the inherent risk of the most senior tranche. For our model, we explore the relationship between the AAA and BBB tranches by vintage. A high correlation between the two tranches would indicate that the AAA tranche is a good proxy for the market index in the market model when using subordinate tranches in the ABX as the reference variable. For the sample period used in this study, correlations are higher than those reported in Dungey, Dwyer and Flavin (2008), ranging from 62.9% for the 06-1 vintage to 43.1% for the 07-2 vintage. Correlations using the Standard and Poor's 500 (S&P 500) as an alternative proxy to the AAA index of the ABX are also explored. For the sample period, the relationship between the S&P 500 and the BBB tranche of the ABX ranges from 29.3% for the 06-1 vintage to 22.3% for the 07-

To observe the market's assessment of the Paulson Plan, we must have a treatment portfolio that is influenced by information related to the health of the housing market, but more responsive to changes in credit quality than the control portfolio. The subordinated tranches to the AAA tranche in the ABX index are well suited for use as a treatment portfolio. We use the BBB-, BBB, A, and AA tranches of the ABX in our analysis.

The Paulson Plan strived to reduce the volatility in the cash flows from the subprime mortgage loans. Variations in the cash flows from these mortgages should have the greatest impact on the investors who hold securities in the subordinate and mezzanine tranches of the ABX. As a result, the price movements in the subordinate tranches within the ABX relative to the AAA tranche of the ABX can provide information about how the market perceived the Paulson Plan's ability to reduce delinquencies and foreclosures. In addition, the results from the model could inform us as to which asset risk classes were most likely to benefit from the Plan. If the Plan was viewed as being beneficial to homeowners and investors in specific risk classes, then the corresponding tranches in the ABX should experience positive price movements.

Aside from tranching based on risk levels, the ABX is also differentiated based on vintage. For each vintage of the index, the mortgage assets that make up the ABX are originated a half-year prior to the stated calendar year/portion of the year on the index. Our ability to observe differential investor responses by vintage is significant because underwriting standards were relaxed over time, thereby leading to a larger benefit from modifying loans. The data used in this study allow us to evaluate the market's perception of the potential beneficiaries of the Paulson Plan on two important dimensions: asset quality and time.

2 vintage. In every case, the correlations between the S&P 500 and the subordinate tranches of the ABX are significantly lower when compared to the AAA index of the ABX.

We also include the three-month London Interbank Offered Rate (LIBOR) as an explanatory variable in the market model. Fender and Scheicher (2008) stated that roughly half of the variation in the price movement in the ABX can be explained by the LIBOR. Based on their findings, it would seem prudent to include LIBOR in the model.

The sample period for the analysis starts 104 trading days prior to the Paulson announcement (July 10, 2007). We use the subordinated tranches of the ABX index for each vintage as the reference portfolio. The control portfolio for the model is the corresponding vintage of the AAA tranche. As a result, the model will produce four regressions for each vintage or 16 separate sets of results.¹⁸ The baseline model is defined as follows:

$$ABX_{\text{other}} = a_1 + b_1 * ABX_{\text{AAA}} + b_2 * \text{Paulson} + b_3 * \text{LIBOR} + \varepsilon,$$

where,

ABX_{other} = the percent price change in either the BBB-, BBB, A, or AA tranche for the daily ABX for either the 06-1, 06-2, 07-1, or 07-2 vintage,

ABX_{AAA} = the percent price change in the AAA tranche for the daily ABX for the 06-1, 06-2, 07-1, or 07-2 vintage and,

Paulson = corresponds to the event period surrounding the Treasury Secretary's announcement. Takes value "1" on December 5, 6, and 7 and value "0" otherwise.

LIBOR = three month London Interbank Offered Rate.

The event period analyzed is centered on the Treasury Secretary's announcement of the Plan, which occurred on December 6, 2007. It is common to use a three day event window (-1, +1) that brackets the actual event day to account for the possibility that the announcement was leaked to the market prior to the announcement and that markets may take time to process information.

¹⁸ Standard errors are White-corrected to address problems associated with heteroskedasticity.

Although there could be significant price movements in the ABX surrounding the announcement, these movements may disappear over a longer event window as investors assess the plan and its impact on the credit risk of subprime RMBS. To capture the potential longer-term impact of the Paulson Plan, we expand the event window from the day prior to the announcement to the end of the sample period. If the subprime housing market improved following the announcement of the Paulson Plan, then the coefficients in the model that correspond to the event window will have a positive sign.

IV. Results

Overall, our results provide limited evidence that investors in the ABX viewed the announcement that the Paulson Plan would initiate loan modifications for a segment of subprime borrowers who were at risk of default as a positive event. Loan modifications are beneficial for they allow investors to extend their claim to the cash flows remitted to investors by homeowners meeting the contractual terms of their mortgage. However, there appears to be a distinct investor groups that benefit from the Paulson Plan's announcement, namely those holding the most subordinate tranches of the ABX. These tranches would be most likely to have experienced significant losses associated with delinquencies and foreclosures in the residential mortgage market. The results also indicate that there is a relationship between credit quality and the size of the pool of potential homeowners who are eligible to receive mortgage modifications. This also influences which investor groups benefit from the Plan.

Table 1a: BBB-

	<i>06-1 vintage</i>	<i>06-2 vintage</i>	<i>07-1 vintage</i>	<i>07-2 vintage</i>
AAA	2.494*** (0.351)	3.382*** (0.396)	3.463*** (0.283)	1.755*** (0.108)
Paulson Event	1.101 (0.957)	2.498*** (0.849)	0.688 (0.852)	0.536** (0.244)
LIBOR	0.137 (0.146)	0.229 (0.156)	0.295** (0.129)	0.063 (0.053)
Constant	-1.391** (0.637)	-1.748** (0.685)	-1.665*** (0.561)	-0.375 (0.235)
Observations	232	232	232	232
Adjusted R ²	0.278	0.402	0.506	0.616

***, **, * significant at the 1%, 5%, and 10% level, respectively
White-corrected standard errors in parentheses

Table 1b: BBB

	<i>06-1 vintage</i>	<i>06-2 vintage</i>	<i>07-1 vintage</i>	<i>07-2 vintage</i>
AAA	0.935*** (0.158)	1.169*** (0.162)	1.935*** (0.189)	1.909*** (0.092)
Paulson Event	2.483*** (0.496)	2.220* (1.313)	2.305 (1.502)	0.061 (1.007)
LIBOR	0.034 (0.153)	0.053 (0.148)	0.199 (0.163)	0.214** (0.092)
Constant	-1.070 (0.671)	-1.168* (0.661)	-1.489** (0.735)	-1.184*** (0.408)
Observations	232	232	232	232
Adjusted R ²	0.167	0.240	0.432	0.697

***, **, * significant at the 1%, 5%, and 10% level, respectively
White-corrected standard errors in parentheses

Table 1c: A

	<i>06-1 vintage</i>	<i>06-2 vintage</i>	<i>07-1 vintage</i>	<i>07-2 vintage</i>
AAA	0.840*** (0.154)	0.803*** (0.167)	1.096*** (0.132)	1.472*** (0.110)
Paulson Event	1.204*** (0.387)	0.075 (0.605)	-0.269 (1.883)	1.806 (1.564)
LIBOR	-0.005 (0.161)	-0.016 (0.160)	0.089 (0.177)	0.203 (0.128)
Constant	-0.784 (0.731)	-0.757 (0.710)	-1.141 (0.757)	-1.332** (0.594)
Observations	232	232	232	232
Adjusted R ²	0.212	0.185	0.288	0.594

***, **, * significant at the 1%, 5%, and 10% level, respectively
White-corrected standard errors in parentheses

Table 1d: AA

	<i>06-1 vintage</i>	<i>06-2 vintage</i>	<i>07-1 vintage</i>	<i>07-2 vintage</i>
AAA	0.632*** (0.199)	0.786*** (0.200)	1.145*** (0.154)	1.397*** (0.115)
Paulson Event	1.363 (1.193)	1.600*** (0.569)	0.970 (1.044)	2.148*** (0.417)
LIBOR	0.215 (0.165)	0.153 (0.150)	0.067 (0.158)	0.168 (0.121)
Constant	-1.646** (0.746)	-1.355** (0.683)	-0.861 (0.707)	-1.170** (0.560)
Observations	224	224	224	224
Adjusted R ²	0.114	0.182	0.344	0.582

***, **, * significant at the 1%, 5%, and 10% level, respectively
White-corrected standard errors in parentheses

The main results from the market model are shown in Table 1, which lists coefficients on the Paulson event dummy variable for each tranche/vintage regression. The “Paulson” variable aims to measure the Plan’s transitory effect. When interpreting the results, it is important to remember that the coefficient on the Paulson variable represents the market’s revaluation of the return structure of the ABX for a specific tranche that is due to the announcement of the Paulson Plan. A positive coefficient on the Paulson variable signifies that investors perceived that the Paulson Plan would have a positive impact on the underlying factors that drive prices/returns, an increase in the quality cash flows and/or collateral. The results presented in Table 1 show that investors in the ABX viewed the Paulson Plan as having a positive impact on mortgage markets, which is significant for two specific tranches. In both the BBB- and BBB tranche/vintage combinations, all eight Paulson dummy variables have a positive coefficient and four are statistically significant.

One possible explanation for the significant coefficients in the BBB- and BBB tranches is that subprime mortgage related losses prior to the Paulson announcement may have eliminated any claim to principal and interest by investors, leading to a price decline in the ABX for those tranches that were at risk of non-repayment. Once the Paulson Plan was announced, it would be

expected that mortgage modifications would extend the cash flows to investors who were previously at risk of default and thereby cause the price of the securities that they hold to increase in value. If mortgage related losses were large enough in size, then loan modifications will benefit investors further up the capital structure as their cash flows and/or the value of the underlying collateral improves.

Changes in the market reaction to the Paulson announcement may vary by vintage. For example, the 06-1 vintage shows that the underlying value of the BBB and AA securities for the ABX were impacted by loan modifications associated with the Paulson Plan. A possible reason for this result is that the 06-1 vintage is the most seasoned vintage in the ABX and the poor performance of the securities acting as collateral backing the RMBS in this vintage is well known to investors. In addition, subprime mortgage related losses prior to the Paulson announcement may have eliminated any expected return of principal and interest by investors in the BBB- tranche. Mortgage modifications would extend the cash flows to investors previously at risk of default and cause investors who held securities further up the capital structure to reevaluate them.

The 07-2 vintage results show that investors holding securities in the BBB and AA tranches of the ABX tended to benefit at the time of the announcement of the Paulson Plan. The results not only identify these investors as beneficiaries of the Plan, but also provide a window into the size of loan modifications in the subprime housing market. Specifically, the positive market response in the 07-2 vintage of the ABX shows that there were more homeowners eligible for mortgage modifications and the benefits from mortgage modifications would have occurred further up the capital structure.

The results for the 06-2 and 07-1 vintages show that investors in the most subordinate tranches of the ABX benefit the most from the announcement of the Paulson Plan. One possible explanation for investors revaluing the collateral for the most subordinate tranches could be related to the relationship between default and loan modification. Specifically, the 06-2 and 07-1 vintages tend to have a higher representation of loans that would be characterized as being of poorer quality and possibly in need of modification. However, the lax underwriting standards associated with borrowers during this time period may make them ineligible for a modification under the Paulson Plan because of their repayment history. Given that loan modifications under the Paulson Plan are not available to the riskiest segment of the population of homeowners, the pool of homeowners eligible for modifications under the Plan may be relatively small, leading to an abnormal market reaction for the most subordinate tranches in the 06-2 and 07-1 vintages.

Given the first set of results, we considered the possibility that the announcement of the Paulson Plan may have caused a structural shift in the relationship between the movement in the returns of senior and subordinated tranches of the ABX. The underlying cause for the shift may well be located in the differing incentives and risks faced by investors in different tranches (which we have discussed above). If the perception of risk by investors in the ABX changed following the Paulson announcement or for some other event, the approach used in this study may only tell a portion of the story regarding the market reaction within the ABX. For example, the results presented earlier assumed that the perception of risk by investors in the ABX did not change following the Treasury Secretary's announcement. As a result, shifts in the intercept following the Paulson announcement were attributed to the event. But what if there was a change in the risk relationship between the most senior and subordinated tranches of the ABX (suggested by Figure 5)?

We tested whether the announcement of the Paulson Plan dates constituted a structural shift in the data. In unreported regressions we find that a dummy variable, taking value 1 beginning with the Paulson announcement and to the end of the sample, and 0 otherwise, is not statistically significant on its own or when interacted with the AAA tranche of the ABX, irrespective of vintage.

When exploring the impact of the Paulson Plan and the possibility that investors revalued risk, it is possible that a change in the risk relationship between the AAA and subordinate tranches may have been caused by factors unrelated to the Paulson announcement. The timeline of the financial crisis indicates that the likeliest time when risk repricing occurred began in March 2008. At this time, the Federal Reserve agreed to provide as much as \$29 billion in financing to facilitate the acquisition of a struggling Bear Stearns by JP Morgan Chase. The Term Security Lending Facility, the Primary Dealer Credit Facility, and the Treasury's proposal for a new Financial Regulatory Structure were also announced in March.

The accumulation of these events may have forced investors to reevaluate the riskiness of investing in securities that are backed by residential real estate, regardless of the credit rating of the security. A Chow test confirms March 10, 2008 as a break point.¹⁹ As a result, we attempt to account for a relative change in the risk relationship between AAA and subordinate tranches by including a dummy variable taking value 0 before March 10, 2008 and value 1 after, as well as an interaction term between this dummy variable and the AAA index.

Dungey, Dwyer and Flavin (2008) among others have suggested that the AAA securities were mispriced the most at origination and that in the time span we study, risk was transferred up the capital structure from lower- to higher-rated tranches. To explore a potential shift in the

¹⁹ We also use the Clemente et al. (1998) test that identifies March 10, 2008 as a breakpoint in half the series used in this study.

return structure of the ABX following the failure of Bear Stearns, a shift that led to a change in the relative risk relationship between the AAA and the subordinate tranches of the ABX, we need to control for the possibility that the relationship between our control index AAA and the dependent variables are not constant over our sample.

To explore this relationship, we introduce an interaction term that is created using the AAA index of the ABX and a corresponding dummy variable (labeled “Bear Stearns”) into the empirical model. The interaction term uses a dummy variable that corresponds to the time period following the structural break in the ABX. As in the previous model, the AAA index of the ABX is also used as a control variable in the model. It is important to explore this long-term relationship because during this period it became clear that housing markets continued to deteriorate. In addition to the Bear Stearns variable, the Paulson dummy variable from Table 1 is also included in the model.

Table 2a: BBB-

	<i>06-1 vintage</i>	<i>06-2 vintage</i>	<i>07-1 vintage</i>	<i>07-2 vintage</i>
AAA	3.662*** (0.407)	4.379*** (0.460)	3.573*** (0.365)	1.787*** (0.141)
Paulson Event	1.348*** (0.417)	2.696** (1.355)	0.677 (0.911)	0.520** (0.260)
Bear Stearns Event	0.025 (0.629)	0.267 (0.646)	0.647 (0.511)	0.414** (0.201)
Bear Stearns Event * AAA	-2.578*** (0.755)	-2.231** (0.872)	-0.320 (0.556)	-0.119 (0.208)
LIBOR	0.095 (0.233)	0.269 (0.244)	0.490** (0.189)	0.189*** (0.070)
Constant	-1.136 (1.133)	-1.914 (1.162)	-2.650*** (0.904)	-1.015*** (0.332)
Observations	232	232	232	232
Adjusted R ²	0.347	0.442	0.506	0.619

***, **, * significant at the 1%, 5%, and 10% level, respectively
White-corrected standard errors in parentheses

Table 2b: BBB

	<i>06-1 vintage</i>	<i>06-2 vintage</i>	<i>07-1 vintage</i>	<i>07-2 vintage</i>
AAA	1.485*** (0.156)	1.631*** (0.176)	2.112*** (0.215)	1.932*** (0.122)
Paulson Event	2.515*** (0.793)	2.259* (1.214)	2.275 (1.532)	0.075 (1.017)
Bear Stearns Event	-1.260* (0.709)	-1.283* (0.670)	0.329 (0.774)	-0.286 (0.422)
Bear Stearns Event * AAA	-1.128*** (0.309)	-0.927*** (0.344)	-0.432 (0.406)	-0.025 (0.183)
LIBOR	-0.388 (0.270)	-0.370 (0.246)	0.292 (0.283)	0.124 (0.163)
Constant	1.137 (1.315)	1.039 (1.208)	-1.934 (1.386)	-0.724 (0.806)
Observations	232	232	232	232
Adjusted R ²	0.226	0.278	0.434	0.695

***, **, * significant at the 1%, 5%, and 10% level, respectively
White-corrected standard errors in parentheses

Table 2c: A

	<i>06-1 vintage</i>	<i>06-2 vintage</i>	<i>07-1 vintage</i>	<i>07-2 vintage</i>
AAA	1.008*** (0.162)	1.000*** (0.182)	1.456*** (0.157)	1.659*** (0.110)
-				
Paulson Event	1.206*** (0.450)	0.068 (0.485)	-0.368 (1.764)	1.740 (1.577)
Bear Stearns Event	-0.883 (0.657)	-0.861 (0.669)	-0.010 (0.630)	0.239 (0.553)
Bear Stearns Event * AAA	-0.367 (0.346)	-0.438 (0.373)	-0.877*** (0.268)	-0.467** (0.223)
LIBOR	-0.270 (0.221)	-0.273 (0.235)	0.112 (0.246)	0.292 (0.198)
Constant	0.601 (1.065)	0.590 (1.126)	-1.169 (1.130)	-1.737* (0.978)
Observations	232	232	232	232
Adjusted R ²	0.220	0.195	0.329	0.606

***, **, * significant at the 1%, 5%, and 10% level, respectively
White-corrected standard errors in parentheses

Table 2d: AA

	<i>06-1 vintage</i>	<i>06-2 vintage</i>	<i>07-1 vintage</i>	<i>07-2 vintage</i>
AAA	0.915*** (0.293)	1.116*** (0.294)	1.404*** (0.193)	1.506*** (0.141)
Paulson Event	1.211 (1.404)	1.407* (0.828)	0.794 (1.249)	2.034*** (0.347)
Bear Stearns Event	-0.749 (0.727)	-0.595 (0.711)	-0.062 (0.640)	0.618 (0.598)
Bear Stearns Event * AAA	-0.859** (0.359)	-1.014*** (0.346)	-0.820*** (0.292)	-0.383 (0.245)
LIBOR	0.022 (0.265)	0.017 (0.262)	0.089 (0.232)	0.383* (0.218)
Constant	-0.592 (1.322)	-0.572 (1.324)	-0.899 (1.112)	-2.223** (1.104)
Observations	224	224	224	224
Adjusted R ²	0.153	0.241	0.378	0.592

***, **, * significant at the 1%, 5%, and 10% level, respectively
White-corrected standard errors in parentheses

Table 2 shows the results from the expanded model that includes transitory, structural shift, and interaction effects. Similar to the results presented in Table 1, the coefficient on the dummy variable that corresponds to the Paulson announcement is positive and statistically significant for the same tranche/vintage combinations. Table 2 results show that the risk relationship in the ABX changed during the time period following the Bear Stearns failure and the subsequent actions of the government to facilitate financial stability. For example, the coefficient on the interaction term for Bear Stearns always has a negative sign that is statistically significant for the BBB- and BBB tranches of the 06 vintages. For the 07-1 vintage, the interaction term has a negative sign for the A and AA tranches, and all of the tranches have a negative sign for the 07-2 vintage, except for the AA tranche. The coefficients on the interaction terms indicate that a revaluation of risk occurred for the period following the failure of Bear Stearns. This revaluation of risk can be interpreted in the model as a decrease in the risk

premium between the AAA and subordinate tranches of the ABX as investors perceive a further deterioration in the housing market.²⁰

V. Conclusion

The Paulson Plan was initiated to provide relief to the subprime housing market, with particular emphasis on adjustable-rate borrowers who were facing higher mortgage payments after the introductory interest rate on their mortgage reset. The motivation behind the Plan was the belief that subprime mortgage delinquencies and foreclosures could be reduced by outreach to eligible borrowers and by freezing the introductory interest rate on mortgages for five years.

We employ an empirical strategy similar to an event study model where data from the ABX index is used to explore possible changes in returns and risk associated with the announcement of the Paulson Plan. Overall, we find that the announcement of the Plan led to positive and significant market reaction mainly for investors in the most subordinate tranches in the ABX. When we include additional dummy variables and interaction terms in the model, the results suggest that the return structure of the ABX did not change permanently as a result of the Paulson Plan. The risk relationship between the most senior and subordinate tranches changed in March 2008 with the most senior tranche becoming riskier relative to the subordinate tranches within the structure. We take this as further evidence of the continued deterioration in the subprime securities market. It is likely that the continued deterioration in subprime markets swamped any positive impact of the Paulson Plan in the longer term.

²⁰ Coval, Jurek and Stafford (2008) argued that increasing systemic risk will result in a transfer of risk up the capital structure to more senior tranches.

References

- Asquith, P. and T.A. Wizman, 1990, "Event risk, Covenants, and Bondholder returns in Leveraged Buyouts," *Journal of Financial Economics* 27, pp 195-213.
- Brown, S.J. and J.B Warner, 1980. "Measuring Security Price Performance," *Journal of Financial Economics* 8, pp 205-258.
- Cherny, K. and Y. Demyanyk, "Subprime Mortgages: Myths and Reality," Federal Reserve Bank of Cleveland, Vox Column, October 17, 2009.
- Citigroup Global Markets, "A Brief (and Complete) History of Loan Modifications," April 16, 2009.
- Clemente, J., Montanes, A., and M. Reyes, 1998. "Testing for a Unit Root in Variables with a Double Change in the Mean," *Economics Letters* 59, pp 175-182.
- Coval J., Jurek J., and E. Stafford 2008. "The Economics of Structured Finance," Harvard Business School Working Paper 09-060. October.
- Dungey, M., Dwyer, J., & T. Flavin, 2008. "Vintage and Credit Rating: What Matters in the ABX Data During the Credit Crunch," Working Paper.
- Fender, I. and M. Scheicher, 2008. "The ABX: How Do the Markets Price Subprime Mortgage Risk?" *BIS Quarterly Review*, September 2008, pp 67-81.
- Fender, I. and M. Scheicher, 2009. "The Pricing of Subprime Mortgage Risk in Good Times and Bad: Evidence from the ABX.HE Indices," BIS Working Paper, No. 279.
- Gorton, G., 2009, "The Subprime Panic," *European Financial Management* 15, pp 10-46.
- "Henry Paulson Dismisses Mortgage Rescue Plans," *Wall Street Journal*, February 29, 2008.
- Securitization Monthly*, Deutsche Bank, January 2008.
- Securitization Monthly*, Deutsche Bank, November 2007.
- "Statement by Secretary Henry M. Paulson, Jr. at Press Conference to Announce Framework to Help Preserve Communities by Preventing Foreclosure," December 6, 2007, <http://www.treas.gov/press/releases/hp716.htm>.
- "Streamlined Foreclosure and Loss Avoidance Framework for Securitized Subprime Adjustable-rate Mortgage Loans Executive Summary," American Securitization Forum, December 6, 2007.
- "Treasury Subprime Plan Announced," UBS Investment Research, December 6, 2007.

Warga, A. and I. Welch, 1993. "Bondholder Losses in Leveraged Buyouts," *The Review of Financial Studies* 6, pp 959-981.

Willen, P., Foote, C., and K. Gerardi, 2008. "Negative Equity and Foreclosure: Theory and Evidence," *Journal of Urban Economics* 64, pp 234-245.