The Bear's Lair: Index Credit Default Swaps and the Subprime Mortgage Crisis*

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Abstract

During the recent financial crisis, ABX.HE index credit default swaps (CDS) on baskets of mortgage-backed securities were a benchmark widely used by financial institutions to mark their subprime mortgage portfolios to market. However, we find that prices for the AAA ABX.HE index CDS during the crisis were inconsistent with any reasonable assumption for mortgage default rates, and that these price changes are only weakly correlated with observed changes in the foreclosure performance of the underlying loans in the index, casting serious doubt on the suitability of these CDS as valuation benchmarks. We also find that the AAA ABX.HE index CDS price changes are related to short-sale activity for publicly traded investment banks with significant mortgage market exposure. This suggests that capital constraints, limiting the supply of mortgage-bond insurance, may be playing a role here similar to that identified by Froot (2001) in the market for catastrophe insurance.

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1 Introduction

In January 2006, a consortium of investment banks, in partnership with Markit Group Ltd. (a data vendor), launched the Markit ABX.HE index credit default swaps (CDS).[1] Each index tracks the price of a single credit default swap written on a specified basket of subprime residential mortgage-backed securities of six different credit qualities: AAA, AA, A, BBB, BBB-, and Penultimate AAA (PENAAA).[2]

While the cash flows of each ABX.HE index CDS are in principle equivalent to those from a portfolio of CDS on each of the 20 individual named tranches of a given credit rating, they allow market participants to trade the credit risk of a portfolio of pools via a single security rather than via 20 separate CDS (which may not even all exist), and without having to own, or to have borrowed, the referenced obligations. Moreover, unlike individual CDS, the ABX.HE index CDS are supported by a consortium of market makers, ensuring that their liquidity is substantially higher than that of either individual named CDS or (in the over-the-counter cash markets) the referenced obligations themselves. As a result, ABX.HE index CDS have been widely used by banks and investment banks to hedge their subprime residential mortgage pipeline risk, and by investment banks, hedge funds and other investors to make directional bets on the future performance of subprime mortgage-backed securities. In particular, trading in the ABX.HE index CDS delivered two of the largest pay-outs in the history of financial markets: the Paulson & Co. series of funds secured \$12 billion in profits from a single trade in 2007; and Goldman Sachs generated nearly \$6 billion of profits (erasing \$1.5 to \$2.0 billion of losses on their \$10 billion subprime holdings) in 2007.[3]

Perhaps most important, with the global collapse of subprime mortgage-backed security trading during the recent financial crisis, many portfolio investors in these securities began using the more liquid ABX.HE index CDS prices as a benchmark for marking-to-market their trading portfolios of subprime securities.[4] For example, the Swiss bank UBS AG wrote down its subprime mortgage investments by \$10 billion largely based on the ABX.HE index CDS (see UBS AG 6K financial statements). Both Morgan Stanley and Citigroup cited

[1]The sixteen investment banks in the consortium, CDS IndexCo LLC, are: Bank of America, BNP Paribas, Deutsche Bank, Lehman Brothers, Morgan Stanley, Barclays Capital, Citigroup, Goldman Sachs, RBS, Greenwich Capital, UBS, Bear Stearns, Credit Suisse, JP Morgan, Merrill Lynch, and Wachovia.

[2]PENAAA is a relatively new ABX.HE index CDS, written on the penultimate AAA bond in the mortgage structure. This bond has a shorter duration (and hence less interest-rate risk) than the longer-duration AAA bonds tracked by the AAA ABX.HE index CDS.

[3]For details, see Kelly (December 14, 2007), Mackintosh (January 15, 2008), Zuckerman (January 15, 2008), and Lewis (February 16, 2008).

[4]Articles discussing the use of these CDS as benchmarks for pricing include Economist (March 8, 2008), Ng, Mollenkamp, and Patterson (2007), Bank of England (2008), Senior Supervisors Group (2008), Wood (2008), Logan (2008), "More than just a technical hitch," *Credit*, Sept. 2007, "One-way fear," *Risk Magazine*, Feb. 1, 2008, "Putting a price on subprime assets," Stewart Eisenhart, *Risk Magazine*, Oct. 1, 2007.

devaluations in the ABX.HE index CDS to justify their significant write-downs of subprime securities (see Ng et al., 2007). Most recently, in August 2010 Goldman submitted a nine-page memo to the Financial Crisis Inquiry Commission (see Goldman Sachs, 2010) describing how it used ABX.HE prices in 2007 and 2008 in setting the CDO prices it quoted when demanding over $12 billion in collateral payments from the insurance firm AIG.[5] Finally, in March 2008, the Division of Corporation Finance of the Securities and Exchange Commission sent public companies an illustrative letter with preparation guidelines for the Management's Discussion and Analysis (MD&A) statements required for Form 10-K quarterly reports. The letter suggested that:

> "Regardless of how you have classified your assets and liabilities within the SFAS 157 hierarchy, if you have not already done so in your Form 10-K, consider providing the following additional information in your MD&A:
>
> - A general description of the valuation techniques or models you used with regard to your material assets or liabilities. Consider describing any material changes you made during the reporting period to those techniques or models, why you made them, and, to the extent possible, the quantitative effect of those changes.
> - To the extent material, a discussion of the extent to which, and how, you used or considered relevant market indices, for example ABX or CMBX, in applying the techniques or models you used to value your material assets or liabilities. Consider describing any material adjustments you made during the reporting period to the fair value of your assets or liabilities based on market indices and your reasons for making those adjustments ..."[6]

The large size of the ABX.HE index CDS market compared with that of the underlying securities, combined with the higher costs of trading in the underlying, makes it difficult

[5] On page 3, Goldman describes how "... it was not unusual for there to be an absence of transactions in specific RMBS [residential mortgage-backed securities], CDO [collateralized debt obligations] securities and derivatives. In addition, certain securities often had only one or a limited numbers of holders. As a result, we used observed transactions in comparable instruments (e.g., instruments having similar underlying collateral, structure, and/or risk/reward profile) to help inform our valuations." It then describes (page 4) how "Also shown are two indices referencing subprime securities issued in the second half of 2005 – the double-A rated and triple-B rated tranches of the ABX 06-1 index. These indices represented the most liquid and observable proxy for the vintage and ratings of the RMBS underlying the AIG CDO positions." Ng and Mollenkamp (2010) discuss Goldman's use of the ABX.HE index CDS, saying "Goldman also cited prices of the ABX, an index that was made up of derivatives tied to a basket of 20 subprime mortgage bonds issued in 2005, the year many of the AIG-insured CDOs were created. The index was generally regarded by market participants as a rough proxy for the values of subprime mortgage bonds that were the underlying assets of CDOs."

[6] See Sample Letter Sent to Public Companies on MD&A Disclosure Regarding the Application of SFAS 157 (Fair Value Measurements), `http://www.sec.gov/divisions/corpfin/guidance/fairvalueltr0308.htm`.

to arbitrage away any price discrepancies between the CDS market and the underlying. If such deviations do occur, using the ABX.HE CDS to mark portfolios to market may give misleading results.[7]

We collect detailed credit and prepayment histories from 2006–2010 for all of the roughly 360,000 individual loans underlying the ABX.HE index CDS, and use these data, plus prices from June 2009, to infer the market's expectations for future defaults at the height of the recent crisis. Using both a simple, "back-of-the-envelope" model (in which all defaults and insurance payments occur instantaneously) and a full CDS valuation model calibrated to historical loan-level performance data, we find that recent price levels for AAA ABX.HE index CDS are inconsistent with any reasonable forecast for the future default performance of the underlying loans. For example, assuming a prepayment rate of 25% per year (roughly consistent with historical prepayment rates on these pools), at a recovery rate of 34%, the AAA ABX.HE prices on June 30, 2009 imply default rates of 100% on the underlying loans. In other words, if recovery rates exceed 34% (a value well below anything ever observed in U.S. mortgage markets), there is *no* default rate high enough to support observed prices. We also find that changes in the credit performance of the underlying loans explain almost none of the observed price changes in the AAA ABX.HE index CDS. These results cast serious doubt on the use of the AAA ABX.HE index CDS for marking mortgage portfolios to market.

While ABX.HE price changes are unrelated to credit performance, we find that they are consistently and significantly related to short-sale activity in the equity markets of the publicly traded investment banks. These measures may be proxying for the demand for default insurance on mortgage-backed securities, suggesting that, as in the catastrophe insurance market (see Froot, 2001), shifts in the demand for default insurance provided by the ABX.HE index CDS, combined with limited capital behind the providers of this insurance, may be driving the price of such insurance well above its "fair value."

2 Prior Literature

Despite the importance of the ABX.HE index market and its links to the operation of the subprime securities market, there has been little research that focuses on the pricing dynam-

[7] While difficult, arbitrage is not impossible. In March 2009 Amherst Holdings, a Texas firm, sold credit default swaps on a pool of subprime mortgages for 80–90 cents per $1 of principal to investors (including J.P. Morgan, RBS and Bank of America) who expected the bonds to default. The total notional on the CDS was over four times that of the underlying bonds. In April 2009, Amherst bought the underlying bonds and paid them off in full. While they lost money on the bonds, this was dwarfed by the profits they made on the (now valueless) CDS (see "A daring trade has Wall Street seething," Wall Street Journal, June 12, 2009).

ics of the ABX.HE index CDS or appropriate subprime security valuation methodologies based upon the ABX.HE index prices. Early research on the operation of the ABX.HE market was produced by the research departments of investment banks (see Sinha and Chabba, 2006; Choudhry, 2006; Kazarian, Mingelgrin, Risa, Huang, Ciampini, and Brav, 2005; Dubitsky, Mellia, Bhu, Fenske, Guo, Li, Dumitrascu, and Yang, 2006), and primarily focused on the mechanics of the market and hedging strategies.

Two recent papers by Fender and Scheicher (2008) and Fender and Hoerdahl (2008) at the Bank of International Settlements have analyzed possible macro drivers of the five subindices of the ABX.HE-2006-1 vintage indices. They found that market-liquidity proxies such as price changes on the futures contract written on the Case-Shiller composite index and the Chicago Board Options Exchange Volatility Index (VIX) covaried with the returns on ABX.HE-2006-1 indices.[8] Changes in aggregate measures of loan delinquency and rating downgrades on the referenced basket of obligations affected returns on the lower rated ABX indices. Fender and Scheicher (2008) also reported the results of a simplified CDS valuation exercise that found subprime mortgage securities to be undervalued by as much as 60% based on corresponding write-downs on the ABX.HE index CDS. A Bank of England report also compared cash flow valuations of subprime mortgage-backed securities of different vintages to write-downs based on a simplified valuation model of CDS written on the ABX.HE index CDS. The report concluded that the index-based CDS valuations led to potential undervaluations of subprime obligations of about $64 billion (see Bank of England, 2008). These papers suggest the possibility of mispricings in the market, but do no formal modeling.

In another recent paper, Longstaff (2010) analyzes the pricing of subprime collateralized debt obligations, CDOs, and their contagion effects on the market. Longstaff assumes that reported ABX.HE prices are proxies for subprime CDO market prices and finds strong contagion effects from lower rated subprime CDOs to the higher rated subprime CDOs, and finally to the stock market. Gorton (2008a) concentrates on a possible correlational channel between the ABX.HE index market and the repo markets. He only analyzes the ABS.HE-2006-1 index and finds that the cash basis, the difference between the subprime CDS spread by credit rating and the spread on the underlying subprime tranches by credit rating, is highly correlated with dislocations in the repo market through July of 2007. He argues that the explosive growth in the ABX.HE cash basis reflected fear of counterparty default, especially in the repo market, where defaults would lead to the delivery of bonds that could not be sold (see Gorton, 2008a,b).

Accounting standards for valuing subprime securities have also been identified as an important source of feedback between the subprime crisis and the collapse of trading in the

[8]VIX is a measure of the implied volatility of S&P 500 index options.

mortgage credit markets. Ryan (2008) notes (p. 2), that as "firms have announced losses on subprime positions, debt markets have become more averse to holding these positions and increasingly illiquid, causing fair values of the positions to decline further and become more difficult to measure." He argues that, although FAS 157 definitions of fair value are clearer than prior GAAP measures, the FAS 157 notion of "orderly" market transactions in the current crisis has become increasingly difficult to identify and apply.

In summary, recent research has focused on only a subset of the ABX.HE index CDS and has not yet undertaken a thorough analysis of the link between the credit performance of the underlying referenced mortgage obligations and the time series of ABX.HE prices and returns. There is also a tension in the literature between a view that the ABX.HE prices can serve as direct measures of returns in the referenced subprime securities markets and results indicating that the ABX.HE prices may be highly imperfect measures of subprime security values and credit performance.

3 The ABX.HE index CDS

Each ABX.HE index CDS tracks the price of a single credit default swap (CDS) written on a fixed basket of underlying mortgage-backed securities. The first set, or vintage, of ABX.HE index CDS began trading in January of 2006, and a new vintage began trading every six months from then until July 2007.[9] The four currently outstanding vintages are labeled ABX.HE-2006-1, ABX.HE-2006-2, ABX.HE-2007-1, and ABX.HE-2007-2 respectively.

3.1 ABX.HE index CDS construction

The construction of each vintage of ABX.HE index CDS starts with the selection of 20 specified pools of subprime residential mortgage-backed securities by Markit. The subprime residential mortgages included in the ABX.HE index CDS are required to meet fixed criteria concerning pool composition and loan quality. Markit Group Ltd. and the consortium of member-dealers constrain the basket to include only four deals from the same originator, and no more than six deals can have the same servicer. The minimum deal size must be $500 million, the pools must consist of at least 90% first liens, and the average FICO score[10] of

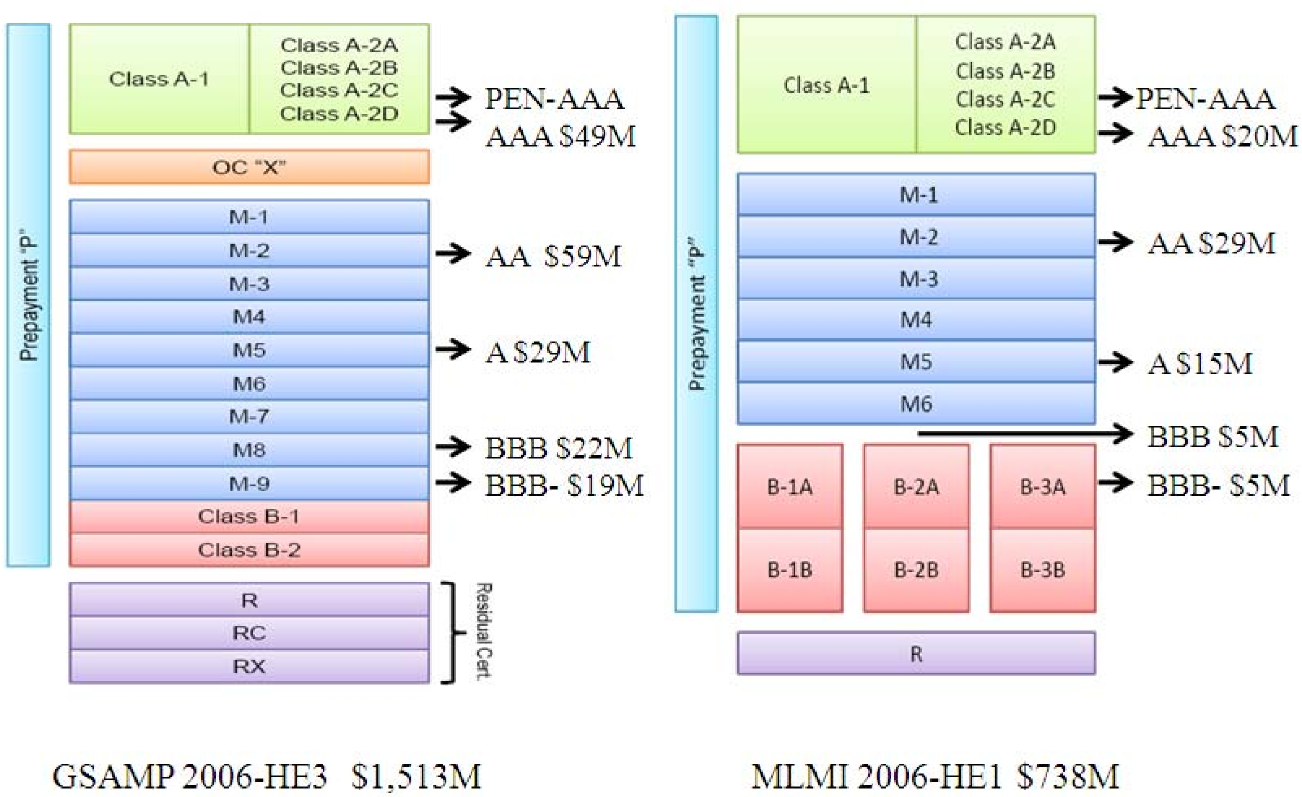
[9] The ABX.HE index CDS were originally designed to be issued every six months. However, due to the severe disruptions in the market for subprime mortgage-backed securities, the ABX.HE-2008-1 series (due to be issued in January 2008) was canceled, and no subsequent ABX.HE index CDS have been issued.

[10] FICO is an acronym for the Fair Isaac Corporation, the creators of the FICO score. The FICO score is a credit score that is based on a borrower's payment history, current level of indebtedness, types of credit used, length of credit history, and the amount of recently issued credit. FICO scores range between a low of 300 and a high of 850.

the borrowers must be at least 660. The referenced AAA tranche is the longest bond in the sequence of AAA bonds in a typical pool structure, and it must have an average life greater than five years. The average life for the referenced subordinated tranches must be four years. Although each of the ABX.HE index CDS is made up of the same twenty referenced obligations, over time the notional balances of the underlying CDS amortize following the principal pay-down structure of the respective referenced classes.

Figure 1 shows, as an illustrative example, the structure of two of the twenty pools underlying the 2006-2 ABX.HE index CDS, contributed by Goldman Sachs and Merrill Lynch respectively. The figure portrays the bond subordination structure for these two securitized mortgage pools. The bonds in these deals receive principal and interest payments by ratings priority, starting from the two classes of AAA bonds, and are exposed to losses from defaults in reverse ratings priority. Each arrow in the figure identifies the priority placement of the bond that is contributed from the deal to the similarly rated ABX.HE 2006-2 basket of twenty bonds. As is clear from the diagram, the priority placement for the lower rated bonds

Figure 1: Example of two bond structures underlying the ABX.HE 2006-2 indices



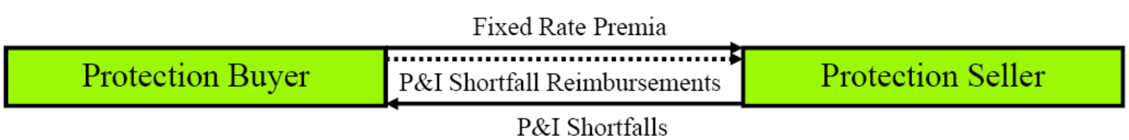
differs across the two deals. In addition, the two deals have very different sizes. The overall principal balance of the Goldman Sachs securitization, GSAMP 2006-HE3, is approximately

$1.5 billion whereas the Merrill Lynch securitization, MLMI 2006-HE1, is only $738 million, so the bonds tracked by the ABX.HE 2006-2 CDS from GSAMP are also much larger than those from MLMI 2006-HE1. Despite their different sizes, however, the initial weight on each tranche underlying one of the ABX.HE index CDS is always 5%, so small pools/tranches are over-weighted and larger pools/tranches under-weighted.[11] Moreover, note that for both of these deals, only 15–20% of the total principal in these two deals is tracked at all in the ABX.HE 2006-2 basket of pools, leaving 80–85% of the principal completely outside the index.

3.2 ABX.HE index CDS cash flows

Initially, the protection buyer (i.e., the purchaser of a newly issued ABX.HE index CDS of a given credit rating), agrees to pay the seller a monthly premium (the "fixed leg"), equal to a fixed multiple of the insured notional amount. In exchange for these payments, following the International Swaps and Derivatives Association pay-as-you-go (PAUG) structure, the protection seller pays the protection buyer amounts equal to the principal and interest shortfalls of the referenced obligations each period, called the "floating leg." Figure 2 shows these payments schematically.[12]

Figure 2: Pay-out structure on an ABX.HE index CDS



As time goes by, the composition and default risk of the underlying basket of referenced obligations change, in turn changing the value of the insurance provided by the ABX.HE index CDS. The premium rate on the fixed leg (i.e., the multiple of principal paid by the protection buyer) for an ABX.HE index of a given vintage and credit rating remains fixed until the vintage expiry date (when the notional of the referenced obligations have fully amortized, defaulted, or been prepaid). Therefore, to match the buyer's payments to the value of the insurance provided at any time after the issue date, as perceptions of default risk change, the protection buyer has to pay a one-time up-front fee to the seller in addition to the fixed leg of the CDS.

[11] Over time, the weights diverge from 5% due to prepayment, default and amortization.

[12] If credit events are subsequently reversed, the protection buyer reimburses the protection seller for previously paid principal and interest shortfalls.

The PAUG structure is different from the cash-settlement structure of CDS on corporate names, where realizations of credit events require the protection seller to pay the full notional amount of the reference obligation to the protection buyer in exchange for the protection buyer's delivery of the reference obligation. The lack of physical settlement in the CDS index market means that there may be important disparities in the size of the cash and derivative markets, since protection buyers are never required to deliver the referenced entity to the protection seller. It also means that there is no risk of short squeezes in the ABX.HE index CDS market.

Table 1 reports recently released information on the current gross and net notional outstanding interest in the ABX.HE index CDS, and compares these notionals to the current outstanding principal balances of the baskets of referenced subprime mortgage-backed securities. As of December 28, 2008, the net notional amount of ABX.HE index CDS was $33.7 billion dollars, and these swap position were written on a referenced subprime residential mortgage-backed security notional value of about $25 billion. For almost all of the indices, the net notional amount of CDS significantly exceeds the underlying principal balances, in some cases by over 6 to 1.

3.3 Subordination structure and underlying loans

Using detailed pool- and loan-level data obtained from Lewtan ABSNet, we here review the performance to date and observable characteristics of the 80 pools underlying the four vintages of ABX.HE index CDS, focusing in particular on

- Characteristics of the loans underlying the pools.
- Subordination structure of the pools.
- Loss and prepayment realizations.

Loan Characteristics Table 2 reports summary statistics at issuance for the loans in the 2006 (upper panel) and 2007 (lower panel) ABX.HE index CDS. Looking first at the 2006 pools, it can be seen that the pool size for the ABX.HE 2006-1 was slightly smaller than for the ABX.HE 2006-2 index, reflecting both a larger number of loans and larger average loan balances. The credit scores were lower in the 2006-2 pools, the coupons were higher, and the number of limited documentation loans was higher than in the 2006-1 loans. In contrast, the average loan-to-value ratio and the fraction of adjustable-rate mortgages was higher in the 2006-1 loans. The average fraction of the pools from California, Florida, and New York was roughly similar for the two indices, and the variability in most measures slightly higher in the 2006-2 index.

Table 1: Outstanding ABX.HE index CDS positions and the outstanding principal on the referenced basket of subprime residential mortgage-backed securities sorted by ABX.HE sub-indices and credit rating in January, 2008

The table presents the total outstanding U.S. dollar amount of ABX.HE index Credit Default Swaps (CDS) for gross and net notionals and the number of outstanding contracts by class. We also report the aggregate current outstanding balances for the basket of twenty bonds that make up each of the ABX.HE sub-indices and compute the percentage of CDS coverage per dollar of outstanding bond principal for the 20 component tranches. These data were obtained from the Depository Trust & Clearing Corporation (DTCC) website, `http://www.dtcc.com/products/derivserv/suite/tradeinfo_warehouse.php`

	Gross Notional ($000,000)	Net Notional ($000,000)	Contracts	Jan. 2008 Tranche Notional ($000,000)	Ratio Net ABX.CDS to Bond Notional
ABX.HE.AAA 2006	29,159	6,999	1859	2,978	2.35
ABX.HE.AA 2006	13,821	3,451	773	2,195	1.57
ABX.HE.A 2006	15,281	2,184	570	1,115	1.95
ABX.HE.BBB 2006	13,560	3,570	590	630	5.66
ABX.HE.BBB- 2006	23,545	3,237	1244	478	6.78
ABX.HE-PENAAA 2006	10,220	2,550	609	4,604	5.54
ABX.HE.AAA 2007	14,951	4,623	1045	2,867	1.61
ABX.HE.AA 2007	6,656	2,179	409	2,034	1.07
ABX.HE.A 2007	4,300	1,650	248	955	1.73
ABX.HE.BBB 2007	2,796	947	201	471	2.01
ABX.HE.BBB- 2007	4,481	947	368	472	2.00
ABX.HE-PENAAA 2007	7,639	1,389	401	6,206	.22
Totals	146,409	33,724	8,317	25,005	1.35
Total CDS	14,328,232	1,276,228	224,706		
ABX.HE % of Total	1.02%	2.64%	3.70%		

Table 2: Summary Statistics at Issuance for the Loans in the 2006 and 2007 Vintage ABX.HE index CDS

The table provides summary statistics for the loans tracked by the four vintages of the ABX.HE index CDS. The data were obtained from the 80 deal prospectuses, from Bloomberg, and from Lewtan ABSNet.

	ABX.HE 2006 1				ABX.HE 2006 2			
	Mean	Std. Dev.	Minimum	Maximum	Mean	Std. Dev.	Minimum	Maximum
Original Pool Balance ($000)	1,446	577	641	2,713	1,597	673	760	3,066
Original Loan Amount ($000)	180	126	10	2,503	188	143	10	1,575
Number of loans in Pool	7,963	3,130	3,380	13,909	8,702	3,409	3,833	15,717
Weighted Average Coupon (%)	8.30	1.63	1.00	14.25	8.71	1.69	1.00	15.50
Weighted Average Maturity	354	34	71	625	360	37	38	636
Weighted Average Loan to Value Ratio (%)	81	15	5	100	79	18	5	100
Limited Document Loans (%)	29.73	23.30	0.02	59.92	44.17	22.25	3.50	80.83
ARMs (%)	84.71	7.13	74.22	100.00	80.31	6.24	62.67	87.96
CreditScore	630	52	479	822	624	55	431	819
California Percentage (%)	29.20	11.65	14.00	55.00	28.40	8.74	13.00	44.00
Florida Percentage (%)	8.98	1.74	6.00	13.00	10.38	1.66	7.60	13.00
New York Percentage (%)	6.84	1.77	4.20	9.70	6.76	1.76	4.70	11.00
	ABX.HE 2007 1				ABX.HE 2007 2			
	Mean	Std. Dev.	Minimum	Maximum	Mean	Std. Dev.	Minimum	Maximum
Original Pool Balance ($000)	1,290	451	322	2,110	1,383	453	793	2,322
Original Loan Amount ($000)	200	147	11	1,500	213	149	10	1,445
Number of loans in Pool	6,904	2,566	1,556	11,181	6,780	2,335	2,480	10,818
Weighted Average Coupon (%)	8.97	1.51	2.00	15.95	8.40	1.54	2.50	14.88
Weighted Average Maturity	375	54	39	619	370	80	4	586
Weighted Average Loan to Value Ratio (%)	81	15	5	119	82	14	8	100
Limited Document Loans (%)	38.70	23.59	1.72	97.58	43.12	24.21	0.67	96.05
ARMs (%)	75.99	19.43	0.00	100.00	77.67	7.33	64.48	98.49
CreditScore	623	58	458	813	629	54	500	820
California Percentage (%)	25.28	7.82	12.00	41.00	28.84	8.11	16.00	49.00
Florida Percentage (%)	11.55	2.58	8.70	19.00	10.05	1.74	7.40	15.00
New York Percentage (%)	6.74	1.79	4.70	11.00	6.73	1.39	4.30	9.80

Looking at the 2007 pools, the average pool size is larger for 2007-2 than for 2007-1, and both are smaller than the 2006 pools. The proportion of limited-documentation loans is higher for 2007-1 than for either 2006 vintage, and it is higher still in 2007-2, though the average coupon rate on the 2007-2 loans is the second lowest, behind only the 2006-1 loans. The loan-to-value ratios also increased slightly over time, with the 2007-2 loans again having the highest average value. However, the average credit scores do not deteriorate significantly over time; the 629 average in the 2007-2 loans is almost the same as the 630 average in the 2006-1 loans. Overall, the 2007-2 loans appear somewhat riskier than the other vintages. All the indices, however, have exposure to risk factors such as high variance in LTV ratios, including loans with 100% LTV.

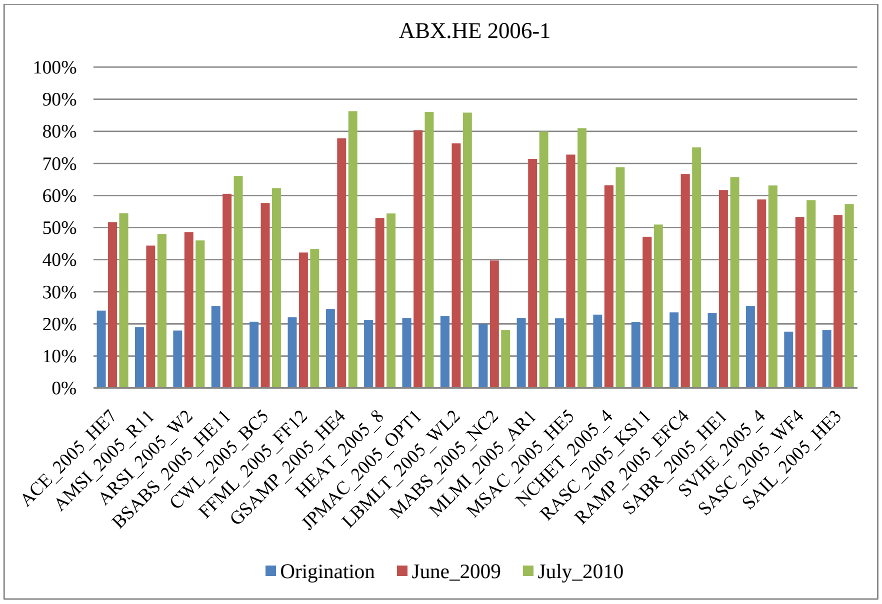
Subordination In addition to the characteristics of the underlying loans, the performance of the ABX.HE index CDS also depends on the subordination structure of the underlying pools. Figures 3 and 4 show the subordination underlying the four vintages of AAA ABX.HE index CDS at issuance and also in mid-2009 and mid-2010.[13] Figure 3 shows that the average subordination level for AAA bonds was about 21.8% at issuance for the 2006-1 AAA ABX.HE pools and 21.5% for the 2006-2 AAA ABX.HE pools. The most striking feature of this figure is the huge subsequent *increase* in subordination for most of the pools. Between the issue date and July 2010, the average subordination for 2006-1 pools experienced nearly a threefold increase, and the average subordination for 2006-2 pools experienced a 60% increase. This is primarily driven by the high prepayment levels on these pools, which we study below. When a loan is prepaid, the principal paid off is applied first to the most senior (AAA) tranches, which are senior to the tranches in the AAA ABX.HE index CDS. As a result, while prepayment causes a reduction in the total principal in the pool, it does not reduce the number of dollars of subordination under the AAA tranche. This subordination therefore becomes larger as a *fraction* of the pool's total remaining principal. Figure 3 shows that one bond in the 2006-1 AAA ABX.HE index, MABS 2005-NC2, did experience a slight decrease in subordination over the period, and two bonds in the 2006-2 index also experienced a decrease in subordination. Despite this, none of the AAA tranches has lost even $1 of principal as of July 2010.

Looking at the 2007 pools, Figure 4 shows that the average subordination below the tranches underlying the AAA ABX.HE 2007 indices was about 22.3% and 23.6% at issuance

[13]The subordination level is defined as the fraction of total pool principal, including the credit enhancement class, that must be lost before the AAA tranche would experience a $1 loss. The credit enhancement class is created from two sources: 1) at origination by selling less bond principal than the total underlying principal of the mortgage collateral; and 2) over time by accumulating the spread differential between the coupons received from the mortgages and the coupons paid to the bonds.

Figure 3: Subordination Support for the AAA ABX.HE-2006-1 and AAA ABX.HE-2006-2

The figure presents the percentage of subordination underlying the AAA bond for each of the twenty pools tracked by the index. The subordination percentages are reported as of issuance, as of June 30, 2009, and as of July 30, 2010. These data were obtained from Lewtan ABSNet.



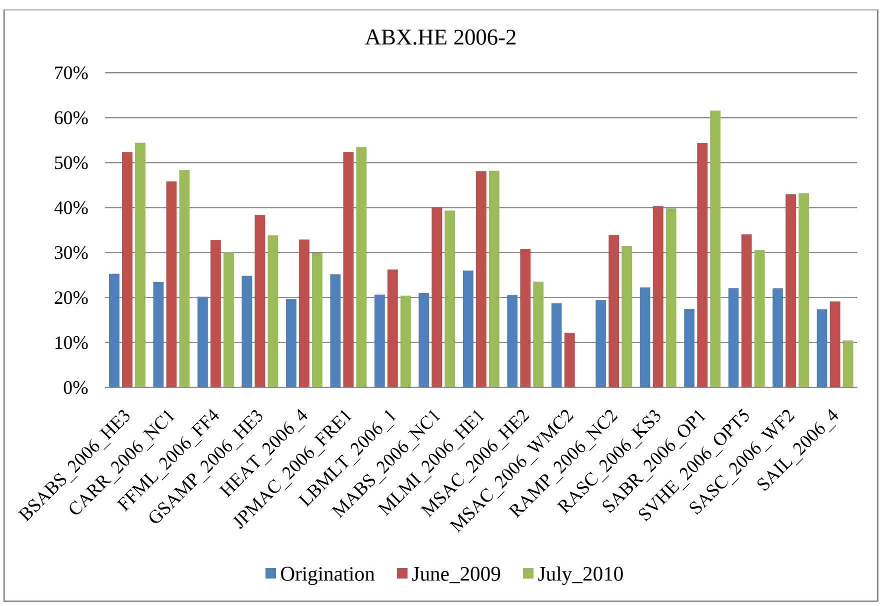
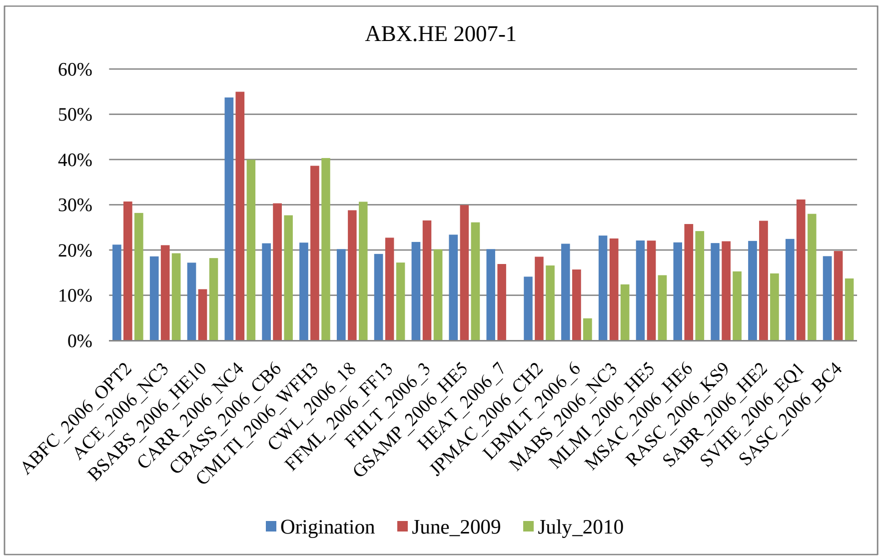
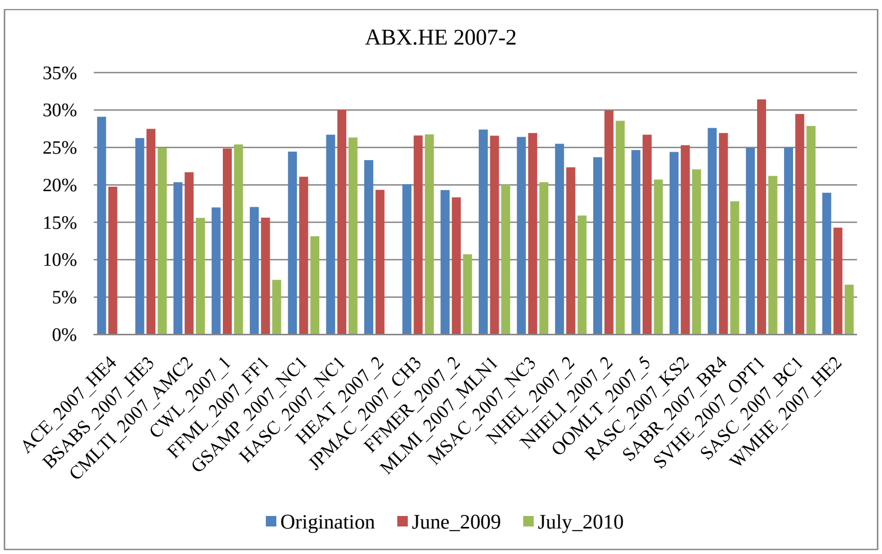


Figure 4: Subordination Support for the AAA ABX.HE-2007-1 and AAA ABX.HE-2007-2

The figure presents the percentage of subordination underlying the AAA bond for each of the twenty pools tracked by the index. The subordination percentages are reported as of issuance, as of June 30, 2009, and as of July 30, 2010. These data were obtained from Lewtan ABSNet.





for the 2007-1 and 2007-2 vintages, respectively. By July 2010, for the AAA ABX.HE 2007-1 pools, the subordination levels were on average about 88% of their issuance levels and the 2007-2 subordination levels were on average about 71% of their issuance levels. However, as of July 30, 2010, none of these tranches has experienced any losses.

Overall, it is clear from Figures 3 and 4 that the subordination underlying the four vintages of AAA ABX.HE index CDS has performed quite differently, with the pools tracked by the 2006-1 and 2006-2 indices delivering the most robust performance, and with the worst performing index being the 2007-2. However, as of July 30, 2010, none of the AAA tranches has experienced any losses.

Realized Prepayments and Losses Tables 3 and 4 summarize the realized prepayment and default performance for the eighty pools tracked by the four ABX.HE index CDS. Looking first at the performance of the pools as a whole, it is clear from Table 3 that the most important cause of principal pay-down for the 2006 vintage pools through July 30, 2010, was early return of principal, i.e., prepayment. The average cumulative amount of prepaid principal was 59.11% for the 2006-1 pools, and 54% for the 2006-2 pools. Table 4 shows that the average cumulative prepayment speed for the 2007-1 and 2007-2 ABX.HE pools was 34.55% and 23.12%, respectively.

The amount of principal lost was a fraction of these amounts. For the 2006-1 pools, the average cumulative loss percentage was 13.79%, ranging from 5.48% to about 25%. The average cumulative loss percentage for the 2006-2 pools was higher at 14.36%, ranging from 5.67% to 28.21%. Losses for the 2007 vintage were somewhat higher. The average for the 2007-1 pools was 17.62%, ranging from 4.40% to 26.07%, and was 19.61% for the 2007-2 pools, ranging from 13.39% to 33.94%.

Looking now at the performance of the AAA tranches (shown in the last two columns of the tables), we see that for the AAA ABX.HE 2006-1, the average cumulative percentage of principal prepaid through July 30, 2010 was about 20.67%, and was 1.88% for the AAA ABX.HE 2006-2. The prepayment speeds for the AAA tranches for the 2007 vintage pools were effectively 0%, with only one pool, ACE 2007-HE4, experiencing a 5% cumulative principal payoff rate. There were no principal losses on any of these AAA tranches.[14]

Overall, it is clear that accounting for the effects of prepayment is an important element in accurately capturing the expected cash flow performance of these pools. It is also clear that there are important differences between the indices and between the twenty pools that comprise them. The differences in the underlying bond subordination structures of the pools

[14] Although not shown in the table, Lewtan ABSNet data continue to show no principal losses for any AAA tranche in any vintage through December 27, 2010.

Table 3: Deal Structure, Loss Performance, and Prepayment Performance of the Pools Comprising the Markit ABX.HE 2006-1 and 2006-2 Index CDS

The table summarizes the deal structure for the twenty pools that make up the ABX.HE 2006-1 (upper panel) and ABX.HE 2006-2 (lower panel) index CDS. The table presents the name of the Depositor, the deal name, the total number of tranches in each pool, the total pool principal at issuance, and the outstanding pool principal on July 30, 2010. The table also reports the cumulative prepaid principal (measured as the percentage of initial total pool principal) and cumulative losses (measured as the percentage of initial total pool principal) for each pool as of July 30, 2010. The last two columns of the table present the cumulative prepaid principal and the cumulative losses for the AAA tranche of each pool. The reported data were obtained from Lewtan ABSNet.

Depositor Name	Deal Name	Overall Number of Tranches	Total Pool Principal at Issuance ($ M)	Total Pool Principal on 7/2010 ($ M)	Total Pool Cumulative Prepaid 7/2010 (%)	Total Pool Cumulative Loss 7/2010 (%)	AAA ABX.HE Cumulative Prepaid 7/2010 (%)	AAA ABX.HE Cumulative Loss 7/2010 (%)
ABX.HE 2006-1								
Ace Securities Corporation	ACE 2005-HE7	21	1737	377.45	59.93	18.34	0.00	0.00
Ameriquest Mortgage Securities	AMSI 2005-R11	19	1454	598.87	51.72	7.09	0.00	0.00
Argent Asset Pass-Through Cert.	ARSI 2005-W2	22	2697	713.58	61.06	12.49	0.00	0.00
Bear Stearns Asset Backed Sec. Trust	BSABS 2005-HE11	30	603	191.37	57.13	11.14	0.00	0.00
Countrywide Asset Backed Trust	CWL 2005-BC5	18	922	301.00	58.85	8.51	0.00	0.00
First Franklin Mortgage Loans	FFML 2005-FF12	16	1027	563.11	30.55	14.62	0.00	0.00
Goldman Sachs GSAMP Trust	GSAMP 2005-HE4	20	1413	311.03	56.34	21.65	63.29	0.00
Home Equity Asset Trust	HEAT 2005-8	23	1462	322.71	53.18	24.75	0.00	0.00
J.P. Morgan Mort. Acquisition Trust	JPMAC 2005-OPT1	30	1447	276.50	70.65	10.24	79.32	0.00
Long Beach Mortgage Loan Trust	LBMLT 2005-WL2	26	2651	494.28	70.84	10.52	72.34	0.00
Master Asset Backed Sec. Trust	MABS 2005-NC2	20	887	205.60	57.98	18.84	0.00	0.00
Merrill Lynch Mortgage Invest. Trust	MLMI 2005-AR1	17	1062	224.37	60.75	18.12	49.71	0.00
Morgan Stanley Capital Inc.	MSAC 2005-HE5	16	1428	281.33	69.23	11.07	66.45	0.00
New Century Home Equity Trust	NCHET 2005-4	14	2005	566.85	63.71	8.02	0.00	0.00
Residential Asset Mort. Prod. Inc.	RAMP 2005-EFC4	16	708	170.98	64.00	11.85	0.00	0.00
Residential Asset Securities Corp.	RASC 2005-KS11	19	1339	368.27	58.17	14.33	0.00	0.00
Security Asset Backed Receivables Inc.	SABR 2005-HE1	18	711	222.54	52.28	16.42	46.60	0.00
Structured Asset Invest. Loan Trust	SAIL 2005-HE3	20	2291	436.40	61.82	19.13	18.74	0.00
Structure Asset Security Corp.	SASC 2005-WF4	17	1896	514.75	67.37	5.48	2.18	0.00
Soundview Home Equity Loan Trust	SVHE 2005-4	19	834	251.82	56.70	13.11	14.80	0.00
Mean		20	1429	370	59.11	13.79	20.67	0.00
Standard Deviation		4	625	157.26	8.80	5.14	29.57	0.00
ABX.HE 2006-2								
Ace Securities Corporation	ACE 2006-NC1	16	1324	356.29	56.74	16.35	0.00	0.00
Argent Asset Pass-Through Cert.	ARSI 2006-W1	16	2275	591.97	54.34	19.64	0.00	0.00
Bear Stearns Asset Backed Sec. Trust	BSABS 2006-HE3	13	793	223.11	57.35	14.52	0.00	0.00
Carrington Mortgage Loan Trust	CARR 2006-NC1	14	1463	701.97	47.79	4.23	0.00	0.00
Countrywide Asset Backed Trust	CWL 2006-8	16	2000	969.23	41.39	10.15	0.00	0.00
First Franklin Mortgage Loans	FFML 2006-FF4	14	1534	461.54	55.62	14.29	0.00	0.00
Goldman Sachs GSAMP Trust	GSAMP 2006-HE3	17	1632	491.47	58.60	11.29	0.00	0.00
Home Equity Asset Trust	HEAT 2006-4	18	1585	473.47	51.54	18.58	0.00	0.00
J.P. Morgan Mort. Acquisition Trust	JPMAC 2006-FRE1	16	1013	285.38	65.90	5.93	0.00	0.00
Long Beach Mortgage Loan Trust	LBMLT 2006-1	17	2500	680.36	61.45	11.33	0.00	0.00
Master Asset Backed Sec. Trust	MABS 2006-NC1	16	915	264.99	55.25	15.79	0.00	0.00
Merrill Lynch Mortgage Invest. Trust	MLMI 2006-HE1	18	764	219.59	61.72	9.54	0.00	0.00
Morgan Stanley Capital Inc.	MSAC 2006-HE2	16	2266	609.61	55.16	17.94	0.00	0.00
Morgan Stanley Capital Inc.	MSAC 2006-WMC2	15	2603	557.76	50.36	28.21	6.19	0.00
Residential Asset Mort. Prod. Inc.	RAMP 2006-NC2	14	760	240.05	51.15	17.26	0.00	0.00
Residential Asset Securities Corp.	RASC 2006-KS3	17	1150	331.93	53.51	17.62	0.00	0.00
Security Asset Backed Receivables Inc.	SABR 2006-OP1	14	1260	320.54	68.89	5.67	31.43	0.00
Structured Asset Invest. Loan Trust	SAIL 2006-4	16	1699	814.51	32.65	19.41	0.00	0.00
Structure Asset Security Corp.	SASC 2006-WF2	15	1299	456.87	52.30	12.53	0.00	0.00
Soundview Home Equity Loan Trust	SVHE 2006-OPT5	18	3100	1172.16	45.25	16.94	0.00	0.00
Mean		16	1597	511	53.85	14.36	1.88	0.00
Standard Deviation		1	669	259.04	8.22	5.71	7.09	0.00

Table 4: Deal Structure, Loss Performance, and Prepayment Performance of the Pools Comprising the Markit ABX.HE 2007-1 and 2007-2 Index CDS

The table summarizes the deal structure for the twenty pools that make up the ABX.HE 2007-1 (upper panel) and ABX.HE 2007-2 (lower panel) index CDS. The table presents the name of the Depositor, the deal name, the total number of tranches in each pool, the total pool principal at issuance, and the outstanding pool principal on July 30, 2010. The table also reports the cumulative prepaid principal (measured as the percentage of initial total pool principal) and cumulative losses (measured as the percentage of initial total pool principal) for each pool as of July 30, 2010. The last two columns of the table present the cumulative prepaid principal and the cumulative losses for the AAA tranche of each pool. The reported data were obtained from Lewtan ABSNet.

Depositor Name	Deal Name	Number of Tranches	Principal at Issuance ($ M)	Principal 7/2010 ($ M)	Total Pool Cumulative Prepaid 7/2010 (%)	Total Pool Cumulative Loss 7/2010 (%)	AAA ABX.HE Cumulative Prepaid 7/2010 (%)	AAA ABX.HE Cumulative Loss 7/2010 (%)
ABX.HE 2007-1								
Asset Backed Funding Corporation	ABFC 2006-OPT2	20	1061	477.60	39.76	15.22	0.00	0.00
ACE Securities Corporation	ACE 2006-NC3	20	1461	825.60	28.23	15.26	0.00	0.00
Bear Stearns Asset Backed Sec. Trust	BSABS 2006-HE10	14	1096	638.36	25.87	15.89	0.00	0.00
Carrington Mortgage Loan Trust	CARR 2006-NC4	19	1551	1050.62	27.86	4.40	0.00	0.00
Credit Based Asset Servicing and Sec.	CBASS 2006-CB6	20	734	307.43	41.02	17.09	0.00	0.00
Citigroup Mortgage Loan Trust	CMLTI 2006-WFH3	19	1563	674.85	44.78	12.05	0.00	0.00
Countrywide Home Loans	CWL 2006-18	17	1653	969.23	31.21	10.15	0.00	0.00
First Franklin Mortgage Loans	FFML 2006-FF13	22	2055	916.69	37.68	17.71	0.00	0.00
Fremont Home Loan Trust	FHLT 2006-3	19	1574	627.23	43.32	16.83	0.00	0.00
Goldman Sachs GSAMP Trust	GSAMP 2006-HE5	21	996	408.88	38.45	20.50	0.00	0.00
Home Equity Asset Trust	HEAT 2006-7	19	1070	383.56	38.08	26.07	0.00	0.00
J.P. Morgan Mort. Acquisition Trust	JPMAC 2006-CH2	15	1964	1149.49	30.42	11.06	0.00	0.00
Long Beach Mortgage Loan Trust	LBMLT 2006-6	21	1645	629.22	36.20	25.55	0.00	0.00
Master Asset Backed Sec. Trust	MABS 2006-NC3	20	999	429.12	33.24	23.80	0.00	0.00
Merrill Lynch Mortgage Invest. Trust	MLMI 2006-HE5	15	1319	588.55	33.48	21.90	0.00	0.00
Morgan Stanley Capital Inc.	MSAC 2006-HE6	18	1429	722.30	31.10	18.35	0.00	0.00
Residential Asset Securities Corp.	RASC 2006-KS9	16	1197	552.76	31.84	21.98	0.00	0.00
Security Asset Backed Receivables Inc.	SABR 2006-HE2	17	678	352.35	24.77	23.26	0.00	0.00
Structure Asset Security Corp.	SASC 2006-BC4	18	1529	749.97	32.87	18.08	0.00	0.00
Soundview Home Equity Loan Trust	SVHE 2006-EQ1	19	1692	710.21	40.81	17.21	0.00	0.00
Mean		18	1363	658.20	34.55	17.62	0.00	0.00
Standard Deviation		2	376	236.18	5.80	5.48	0.00	0.00
ABX.HE 2007-2								
ACE Securities Corporation	ACE 2007-HE4	18	1007	223.02	43.91	33.94	5.00	0.00
Bear Stearns Asset Backed Sec. Trust	BSABS 2007-HE3	21	917	601.63	17.65	16.74	0.00	0.00
Citigroup Mortgage Loan Trust	CMLTI 2007-AMC2	20	2,204	1260.36	22.91	19.91	0.00	0.00
Countrywide Home Loans	CWL 2007-1	18	1942	1419.72	16.74	10.15	0.00	0.00
Merrill Lynch First Franklin Mortgage	FFMER 2007-2	15	1937	1123.47	25.13	16.87	0.00	0.00
First Franklin Mortgage Loans	FFML 2007-FF1	15	1987	1040.41	28.23	19.41	0.00	0.00
Goldman Sachs GSAMP Trust	GSAMP 2007-NC1	21	1734	873.29	34.37	15.27	0.00	0.00
HIS Asset Securitization Corporation	HASC 2007-NC1	17	977	600.11	13.22	25.36	0.00	0.00
Home Equity Asset Trust	HEAT 2007-2	14	1150	228.24	64.26	15.89	0.00	0.00
J.P. Morgan Mort. Acquisition Trust	JPMAC 2007-CH3	18	1130	728.98	12.15	23.34	0.00	0.00
Merrill Lynch Mortgage Invest. Trust	MLMI 2007-MLN1	17	1299	807.80	16.58	21.23	0.00	0.00
Morgan Stanley Capital Inc.	MSAC 2007 - NC3	19	1304	744.70	21.59	21.31	0.00	0.00
NovaStar Mortgage Funding Trust	NHEL 2007-2	18	1324	885.78	19.71	13.39	0.00	0.00
Nomura Home Equity Loan Inc	NHELI 2007-2	19	883	448.24	25.87	23.37	0.00	0.00
Option One Mortgage Loan Trust	OOMLT 2007-5	18	1390	885.03	19.12	17.21	0.00	0.00
Residential Asset Securities Corp.	RASC 2007-KS2	16	962	509.48	24.69	22.35	0.00	0.00
Security Asset Backed Receivables Inc.	SABR 2007-BR4	16	849	519.71	14.72	24.07	0.00	0.00
Structure Asset Security Corp.	SASC 2007-BC1	20	1162	694.47	25.11	15.12	0.00	0.00
Soundview Home Equity Loan Trust	SVHE 2007-OPT1	19	2196	1471.76	17.29	15.69	0.00	0.00
WaMu Asset Backed Securities	WMHE 2007-HE2	18	1534	905.83	20.08	20.87	0.00	0.00
Mean		18	1394	808.79	23.12	19.61	0.25	0.00
Standard Deviation		2	452	331.72	11.10	5.33	1.12	0.00

and in the quality of their underlying loans are all features that must be explicitly modeled to obtain reliable estimates of the credit default swap pay-outs.

4 ABX.HE index CDS prices and implied default rates

As described in Section 3.2 above, the buyer of an ABX.HE CDS pays a one-time up-front fee plus a monthly premium, in exchange for payments in the event of defaults. The quoted "price" is defined as par minus the up-front fee. Thus, for example, a quoted price of \$100 means the up-front fee is \$0 (as is the case on the issue date), and a quoted price of \$70 means the up-front fee is \$30.[15] When the ABX.HE index CDS trades below par, the market cost of default risk protection on subprime mortgages has increased since the issuance date of the index. For example, if the price of the ABX.HE index CDS was quoted as 80% of par, the protection buyer would pay the protection seller an up-front fee of 20% of the notional amount to be insured in addition to the monthly fixed premium on the index.

For the CDS contract to be fairly priced at date t, the present value of the fixed leg plus the single up-front payment paid by the protection buyer must equal the present value of the floating leg paid by the protection seller, i.e.,

$$\frac{B_t\left(Par - P_{ABX}\right)}{100} + E^Q\left[s\sum_{k=k_t}^{n} B_{T_{k-1}} e^{-\int_t^{T_k} r_\tau\, d\tau}\right] =$$
$$E^Q \sum_{k=k_t}^{n}\left(B_{T_{k-1}}\left[\frac{B^A_{T_k}}{B^A_{T_{k-1}}} - \text{Prepay}_{T_k}\right] - B_{T_k}\right)(1 - R + i)e^{-\int_t^{T_k} r_\tau\, d\tau}, \quad (1)$$

where all expectations are under the "risk-neutral" probability measure. The first term of the left-hand side of equation (1) is the protection buyer's up-front fee payment. It is the difference between par and the quoted market price of the ABX.HE index CDS, P_{ABX}, times the current notional amount of the insurance, B_t. The second term is the value of the protection buyer's fixed payment leg. This comprises a coupon, paid at the end of each month T_k (starting at date T_{k_t}, the end of the month containing date t) equal to a fixed coupon rate, s, times the start-of-month notional, $B_{T_{k-1}}$, of the referenced bonds. The right-hand side of equation (1) is the value of the floating leg of the ABX.HE index CDS, paid by the protection seller to the protection buyer. It includes a payment at each date T_k to compensate for any lost principal during the prior month. Here, B_{T_k} denotes the notional value at date T_k, $B^A_{T_k}$ denotes the scheduled notional (taking amortization into account),

[15] If the market price of the ABX.HE contract is at a premium, the protection seller makes a one-time payment to the protection buyer

and Prepay_{T_k} is the fraction of the start-of-month principal prepaid during the month. The difference between B_{T_k} and $B_{T_{k-1}}$, adjusted for amortization and prepayment, reflects loss of principal due to default, which is governed by the likelihood of default on the underlying mortgages and the structure of the pool underlying the ABS. The ABS pays off the lost principal, net of recovery, R, plus the interest shortfall, i. On the issue date of the new ABX.HE index CDS ($t = 0$), the fixed coupon rate is set so the market price of the ABX.HE equals par, i.e., $P_{ABX} = 0$. As expectations of default rates vary over time, the market price, P_{ABX_t}, varies to keep the values of the two sides of the swap equal.

Figure 5: Prices for the bonds with AAA credit ratings for the 2006 and 2007 Markit ABX.HE index CDS.

This Figure plots the Markit ABX.HE index CDS for the AAA ABX.HE-2006-1, AAA ABX.HE-2006-2, AAA ABX.HE-2007-1, and AAA ABX.HE–2007–1 Series from January 19, 2006 to July 30, 2010.

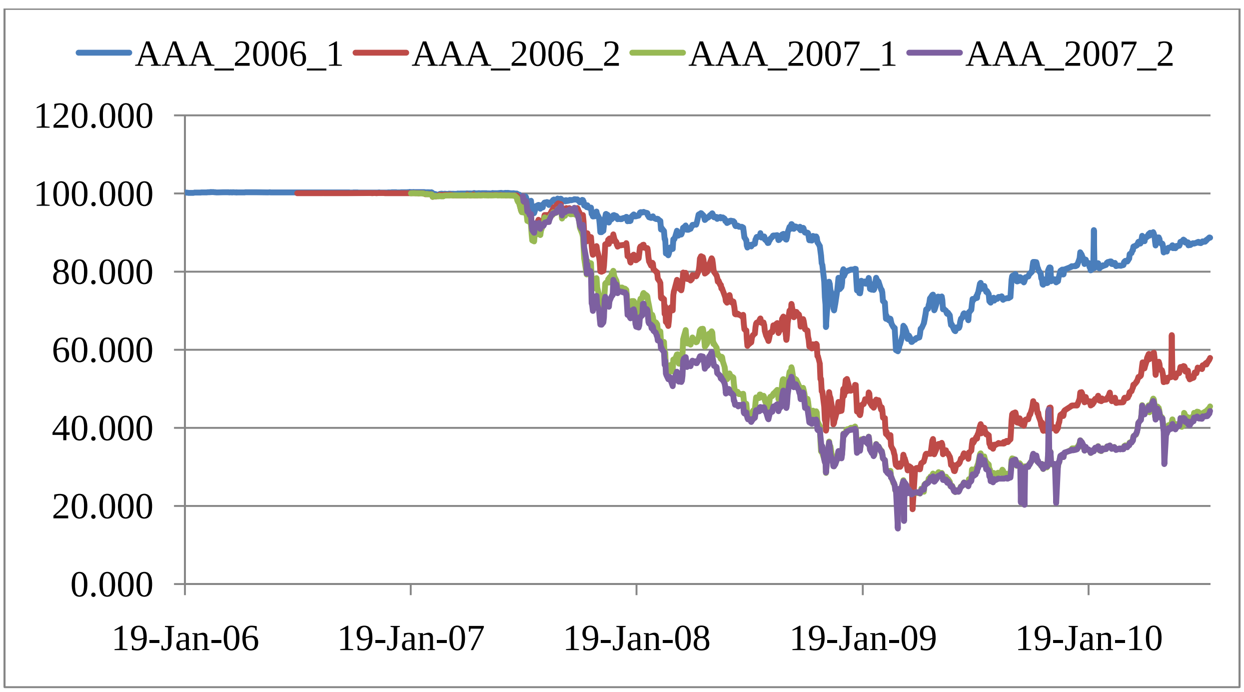


Figure 5 shows quoted market prices from January 19, 2006 to July 30, 2010 for the four vintages of the AAA ABX.HE index CDS.[16] It can be seen that there was little variation

[16]In calculating these prices, Markit collects CDS prices from the market makers, who have some discretion in reporting trades. They drop the highest and lowest of the reported prices, and average the rest. Similar patterns (not shown) exist for the lower rated securities.

in these prices until July 2007, when the poor performance of two Bear Stearns' subprime CDOs became public. After July 2007, the prices continued to trend downward through June 2009. We are focusing on the AAA bonds because the primary mark-to-market losses in the balance sheets of the commercial banks, investment banks, and structured investment vehicles (SIVs) were related to AAA residential mortgage-backed securities.

The quoted price as of June 30, 2009 for the ABX.HE 2006-2 index was \$33.165. This price means that protection buyers were paying \$66.835 per \$100 of principal for the privilege of making additional periodic payments to insure themselves against default losses on the AAA tranche. To see that something needs explaining here, consider that, as of July, 2009, the cumulative loss rate on the pools underlying all of the 2006-2 ABX.HE index CDS was under 10% and was 0% for the AAA bonds. Of course, even though the recent financial (and real estate) crisis was the worst the U.S. had seen in decades, these are only *realized* default rates, and it is possible that market expectations were for much worse to come. We therefore now infer from these prices what they imply for expected future default rates, and compare these with what we observed during the worst financial crisis this century, the Great Depression.

4.1 A "back-of-the-envelope" valuation model

Given a valuation model and assumptions about default rates, we can calculate the fair up-front payment for the ABX.HE index CDS. Conversely, given a valuation model and a market price, we can infer something about the market's expectations about default rates. Before developing a formal model, we start with a simple "back-of-the-envelope" model, which strongly suggests that expected future defaults are not going to be able to explain the prices shown in Figure 5.

Expressing all quantities per \$1 of current principal, let the subordination level on the AAA security be S,[17] and assume that a proportion H of the loans are of higher seniority than the AAA tranche,[18] so the AAA balance starts at

$$1 - H - S.$$

Now assume that a (known) fraction $Y < H$ of the underlying mortgages prepays immediately, lowering the total pool balance per initial dollar to $1 - Y$, and a fraction D of the remaining mortgages then defaults. We assume no further default or prepayment, and also

[17]In other words, a fraction S of the total principal on the loans must be completely lost before any additional losses affect the AAA tranches.

[18]The AAA tranche underlying the ABX.HE index CDS is the lowest seniority AAA tranche.

ignore the periodic fixed payment made by the protection buyer. In this case, if the recovery rate on defaulted loans is R, the defaults reduce the total principal by $D(1-R)(1-Y)$, hence reducing the AAA principal by a fraction[19]

$$\min\left(1, \max\left\{\frac{D(1-R)(1-Y)-S}{1-H-S}, 0\right\}\right). \tag{2}$$

The fair lump-sum price (per \$1 of principal) for default insurance on the AAA tranches equals the loss, and the NPV of the security is thus

$$\text{NPV} = \min\left(1, \max\left\{\frac{D(1-R)(1-Y)-S}{1-H-S}, 0\right\}\right) - (1-P). \tag{3}$$

Rearranging, we obtain the default rate implied by the quoted CDS price, P:

$$D = \frac{S + (1-P)(1-S-H+Y)}{1-R}. \tag{4}$$

Focusing on the 2006-2 AAA security, we set $S = 0.38$ and $H = 0.45$ (the observed fractions of principal junior to and senior to the AAA tranches on June 30, 2009), $P =$ \$33.165, and $Y = 25\%$ (close to the historical average for the twenty underlying pools). Table 5 shows the NPV per dollar of principal for different assumptions about the recovery rate, R, and default rate, D, calculated using Equation (3). It can clearly be seen that, except at very low recovery rates and very high default rates, the NPV of the security is always negative. To see this in more detail, note that a 100% default rate is implied when $\text{NPV} = 0$ and $D = 1$ in Equation (3), i.e., when the recovery rate is

$$R^* = 1 - \left(\frac{(1-P)(1-H-S)+S}{1-Y}\right).$$

With our parameter values, $R^* = 34.2\%$. If recovery rates exceed this value (extremely low by historical standards), even 100% default rates are not enough to support the quoted price. Similarly, a 0% recovery rate is implied when $\text{NPV} = 0$ and $R = 0$ in Equation (3), i.e., when the default rate is

$$D^* = \frac{(1-P)(1-H-S)+S}{1-Y}.$$

With our parameter values, $D^* = 65.8\%$. If the default rate is lower than this value, even a 0% recovery rate is not enough to support the quoted price.[20]

[19] The max and min in this expression account for the possibility that either all or none of the AAA principal might be lost.

[20] While extreme, our results here are actually somewhat understated. We have assumed that the senior

Table 5: Back-of-the-envelope valuation results for the AAA ABX.HE 2006-2 index CDS for June 30, 2009

The table shows the net present value (present value of insurance benefits minus cost of insurance) per dollar of principal insured for the AAA ABX.HE 2006-2 index CDS as of June 30, 2009, given the closing price that day of \$0.33165 per dollar, and assuming a 25% prepayment rate (close to the historical average for the twenty underlying pools), and various default and recovery rates.

	Default Rates					
Recovery Rates	0.0%	20.0%	50.0%	70.0%	80.0%	100.0%
100.0%	-0.6684	-0.6684	-0.6684	-0.6684	-0.6684	-0.6684
60.0%	-0.6684	-0.6684	-0.6684	-0.6684	-0.6684	-0.6684
50.0%	-0.6684	-0.6684	-0.6684	-0.6684	-0.6684	-0.6684
40.0%	-0.6684	-0.6684	-0.6684	-0.6684	-0.6684	-0.2566
20.0%	-0.6684	-0.6684	-0.6684	-0.4331	-0.0801	0.3317
0.0%	-0.6684	-0.6684	-0.6684	0.1846	0.3317	0.3317

Comparison with historical housing crises To emphasize how extreme these numbers are, we here look at historical U.S. mortgage loss rates to look for the "worst imaginable" performance, and find that default and recovery rates in the US have never been bad enough to rationalize the ABX prices we observe.

An obvious benchmark for the "worst imaginable" mortgage performance is the Great Depression, which was used as the basis for the worst-case assumptions underlying Standard and Poor's original mortgage loan-loss model from the mid-1970s, as well as Moody's original loan-loss model from the 1980s (see Standard and Poor's, 1993; Lowell, 2008).[21] Standard and Poor's (1993) report that S&P based their analysis on Saulnier (1950), who analyzes the performance of mortgages issued by 24 leading life insurance companies between 1920 and 1946. The highest lifetime foreclosure rates (see Table 22), on loans issued in 1928 and 1929, reached 28.5% and 29.6% respectively.[22] Losses on foreclosed properties varied by date of disposal, but for loans issued between 1925 and 1929 did not exceed 12% (Table 27). Combined, these foreclosure and loss rates are not sufficient to generate *any* losses in the AAA ABX tranches, given the subordination levels we see in our sample.

tranches prepay earlier and default later than the ABX.HE AAA tranche. In fact, in several of the deals, while prepayment does indeed hit the more senior tranches first, default is equally shared among all of the AAA tranches, including the more senior tranches. Thus our calculations overestimate the default rate on the ABX.HE AAA tranche. We take all of these detailed tranche-by-tranche allocation rules into account in implementing our Monte Carlo valuation model below.

[21] Excellent discussions of mortgage performance during the Great Depression can be found in Bridewell (1938), Harriss (1951), Wheelock (2008a,b) and Rose (2010).

[22] These figures are at least as high as those (from a different source) reported in Snowden (2006).

Another, more recent, "worst-case" benchmark is the performance of loans in the "Oil Patch" states in the 1980s, which was actually worse than overall loan performance during the Great Depression. By law, in evaluating the capital adequacy of Freddie Mac and Fannie Mae, OFHEO (now FHFA) was required to assume a benchmark loss experience equal to the worst cumulative losses experienced during any two-year period in contiguous states containing in total at least 5% of the U.S. population.[23] The latest benchmark was based on loans originated in Arkansas, Louisiana, Mississippi and Texas during 1983 and 1984 (representing 5.3% of the U.S. population), just before the oil price collapse of 1986. Average cumulative default rates for these loans were 14.9%, with an average 10-year loss severity across the region of 63.3%, leading to average cumulative 10-year losses of 9.4%.[24] Sorted by LTV, the losses are highest for high-LTV loans, with $> 90\%$ LTV loans experiencing 26.4% default rates and 69.0% loss rates, for a cumulative 10-year loss of 18.2%. Even if the whole country saw the same loss levels as these $> 90\%$ LTV Oil Patch loans from 1983–1984, it would not be enough to trigger losses in the AAA ABX.HE index CDS.

There are, of course, differences between the loans considered above and those underlying the ABX. In particular, these were not subprime loans. However, while default rates are probably higher on subprime than on prime loans, there are several other offsetting biases: *i.* The failure of thousands of banks and other financial institutions during the Depression meant that even many good borrowers could not refinance and therefore entered financial distress. *ii.* the 1983–1984 loans in Arkansas, Louisiana, Mississippi and Texas were the worst performing loans in the country, so country-wide default and loss rates were substantially lower. In our analysis, we conservatively consider the effect of *country-wide* losses at these same levels. *iii.* By focusing on the 1983–1984 default statistics for loans with LTV $> 90\%$, we are automatically looking at loans with default rates higher than average, which should correct for a large part of the difference between prime and subprime loans. *iv.* Although delinquency rates were extremely high during the Great Depression, eventual loss rates on these loans were relatively low, certainly compared with the Oil Patch loans during the 1980s discussed above.[25] One important reason for this is that Federal and state governments took steps to limit losses to lenders, such as the creation of the Home Owners' Loan Corporation (HOLC) in 1933 (see Rose, 2010). This agency bought huge numbers of loans from lenders at inflated prices (many lenders escaped loss entirely), then the HOLC issued new loans to the borrowers with 15 years to maturity and a 5% (later 4.5%) interest rate. Any estimate

[23] For details, see Davidson, Sanders, Wolff, and Ching (2003, pp. 310–313), Lowell (2008) or Kinsey (1998).

[24] "Default" as used here by OFHEO means that a loan completed foreclosure or otherwise resulted in a realized loss of principal. It does not include loans that were merely delinquent.

[25] According to Bridewell (1938) and Wheelock (2008b), at the beginning of 1934, roughly half of all homes with an outstanding mortgage were delinquent, with an average time of delinquency of 15–18 months.

of future expected losses during the recent crisis has to take into account the likelihood that Federal or state governments would take similar actions to mitigate lenders' losses should mortgage performance become bad enough.

4.2 A Monte Carlo valuation model

The analysis above shows that, under the simplifying assumptions given, the June 30, 2009 price of $33.165 for the AAA ABX.HE 2006-2 index CDS is inconsistent with any reasonable assumption about default and recovery rates.[26] To verify that this conclusion is not merely due to the simplicity of the model, and to account for the impact of prepayment and default over time, we here repeat the analysis using a more sophisticated Monte-Carlo-simulation-based valuation model to estimate the expectations in Equation (1) for all four vintages of the AAA ABX.HE index CDS as of June 30, 2009. This involves three steps:

1. Simulate 12,000 paths for interest rates and house prices.
2. Calculate the AAA ABX.HE cash flows along each path. These depend on
   - The prepayment, default and recovery rates of the underlying loans within each of the 20 pools.
   - The pay-out and subordination structure for all of the tranches comprising the 20 pools tracked by each index.
3. Discount each path's cash flows back to the present, and average across all paths.

Simulating the paths requires models for the dynamics of interest rates and for house-price dynamics. Estimating the cash flows along each path requires modeling every tranche in every pool to obtain the pay-outs for each of the underlying AAA tranches. This in turn requires a model for the prepayment and default behavior of the underlying loans, combined with the loan characteristics, subordination structure, and cash flow allocation rules for each of the twenty pools underlying each vintage of the ABX.HE index CDS (obtained from the relevant prospectuses).

Interest Rates We assume interest rates are described by the Hull and White (1990) model. In this extension of Vasicek (1977), the short-term riskless rate follows the risk-neutral process

$$dr = [\theta(t) - ar]\, dt + \sigma\, dZ,$$

[26]Figure 5 shows that prices for the 2007-1 and 2007-2 index CDS are even more extreme.

where the function $\theta(t)$ is fitted so that the model matches the yield curve for the U.S. Libor swap rate on June 30, 2009. Hull and White (1990) show that $\theta(t)$ is given by

$$\theta(t) = F_t(0,t) + aF(0,t) + \frac{\sigma^2}{2a}\left(1 - e^{-2at}\right),$$

where $F(0,t)$ is the continuously compounded forward rate at date 0 for an instantaneous loan at t. Parameters a and σ were fitted using maximum likelihood, yielding estimates of 0.0552 for a and 0.0107 for σ. For this analysis, we used U.S. Libor yield curve data and implied caplet volatilities as of June 30, 2009, obtained from Citigroup's Yieldbook.

House Prices We assume that house prices, H_t, follow a geometric Brownian motion,

$$dH_t = \theta_H H_t\, dt + \phi_H H_t\, dW_{H,t}, \tag{5}$$

where θ_H is the expected appreciation in house prices and ϕ_H their volatility. Denoting the flow of rents accruing to the homeowner by q_H, after risk-adjustment house prices evolve according to:

$$dH_t = (r_t - q_H)H_t\, dt + \phi_H H_t\, dW_{H,t}. \tag{6}$$

We calibrate equation (6) as follows:

$$\begin{aligned} q_H &= 0.025, \\ \phi_H &= 0.12. \end{aligned}$$

This value of q_H is consistent with estimates of owner-equivalent rents from the Bureau of Economic Activity (BEA). We estimate the annualized volatility of housing returns, ϕ_H, using a long time series of California housing transactions from 1970 to 2008 as a proxy for the segment of the housing market securitized into the private-label loans that appear in the ABX.HE pools. These estimates are based on those in Stanton and Wallace (2009), using 418,000 single-family residential transactions in the counties of San Francisco and Alameda, California, between 1970 and 2008. For simplicity, we assume that house prices and interest rates are uncorrelated.

Prepayment and Default Behavior We model the cash flows for the fixed- and adjustable-rate loans using separately estimated hazard rates for prepayment and default. We estimate these out-of-sample using a loan-level data set containing 59,290 adjustable-rate mortgages originated between 2004 and 2007 and 27,826 fixed-rate mortgages originated over the same time frame, all loans of the same type as those underlying the ABX.HE index CDS. These data were obtained from CTSlink, Bloomberg, and Lewtan ABSNet. The hazards were estimated using a time-varying-covariate hazard model with a log-logistic baseline hazard and controls for loan characteristics including the amortization structure, coupon, weighted-average life, loan-to-value ratios, the balance factor, and indexing (such as the maximum life-of-loan caps and the periodic interest-rate caps).

We estimate proportional hazard models for the prepayment and default termination rates for the ARMs and FRMs. The estimated hazard rate is the conditional probability that a mortgage will terminate given that it has survived up until a given time since origination. Hazard models comprise two components: 1) a baseline hazard that determines the termination rates simply as a function of time and 2) shift parameters for the baseline defined by the time-varying evolution of exogenous determinants of prepayment and default. We follow Schwartz and Torous (1989) and estimate log-logistic proportional hazard specifications for ARM and FRM prepayment and default rates of the form

$$\pi(t) = \pi_0(t)e^{\beta\nu}, \qquad \text{where} \tag{7}$$

$$\pi_0(t) = \frac{\gamma p(\gamma t)^{p-1}}{1+(\gamma t)^p}. \tag{8}$$

The first term on the right-hand side of Equation (7) is the log-logistic baseline hazard, which increases from zero at the origination date ($t = 0$) to a maximum at $t = \frac{(p-1)^{1/p}}{\gamma}$. This is shifted by the factor $e^{\beta\nu}$, where β is a vector of parameters and ν a vector of covariates including the end-of-month difference between the current coupon on the mortgage and LIBOR, the current loan-to-value ratio of the mortgage, the proportion of the outstanding balance remaining, and a dummy variable reflecting whether the current month is in the Spring or Summer (when most home moves occur).

The results of our hazard models are reported in Table 6. As expected, there is a statistically significant, positive coefficient on the differential between the coupon rate on the mortgage and the observed swap rate in the estimated prepayment hazard, a statistically significant, positive coefficient on the loan-to-value ratio of the loan in the default hazard, and a statistically significant negative effect of the LTV ratio on prepayment. The balance factor (the proportion of the initial pool still remaining) has a statistically significant negative effect on prepayment and a positive effect on default. The Summer and Spring indicator variable does not have a statistically significant effect in either specification.

Table 6: Loan-level Estimates of the Prepayment and Default Hazards

	Adjustable Rate Mortgages		Fixed Rate Mortgages	
	Coeff. Est.	Std. Err.	Coeff. Est.	Std. Err.
Prepayment				
γ	0.0146***	0.008	0.0154***	0.0018
p	1.0609***	0.0167	1.2446***	0.0164
Current Coupon minus LIBOR(t)	0.4027***	0.044	0.5576***	0.0436
Loan-to-Value Ratio(t)	-0.6498***	0.1276	-0.8074***	0.0304
Outstanding Balance(t)	-0.3443	0.3423	-0.928	0.4952
Summer/Spring Indicator Variable	0.2886	0.1362	0.3878***	0.0352
Default				
γ	0.0321***	0.0019	0.0086***	0.0009
p	1.002***	0.0198	1.0208***	0.0220
Current Coupon minus LIBOR(t)	0.425**	0.1931	0.5376***	0.0468
Loan-to-Value Ratio(t)	0.1193**	0.0523	0.0721	0.0347
Outstanding Balance(t)	0.1551**	0.0862	0.1316***	0.0317
Summer/Spring Indicator Variable	0.0006	0.1434	0.0312	0.0397

t statistics in parentheses

** $p < 0.05$, *** $p < 0.01$

4.2.1 Valuation Results

Constant prepayment and default rates As a first step in comparing our Monte Carlo valuation procedure with the back-of-the-envelope model above, we start by assuming constant default and prepayment rates. Based on the empirical prepayment model estimated above, we assume a prepayment rate of 2% per month. Given the interest-rate model above, we now simulate 12,000 paths for interest rates, using antithetic variates to reduce standard errors (see Glasserman, 2004).[27] Along each path, we use the assumed prepayment rate and various assumed (constant) values for default and recovery rates, together with the pay-out details for each pool from the prospectus, to determine the cash flows each month. We discount these back to the present using the simulated path of the risk-free rate, and average across paths to obtain a Monte Carlo estimate of the security's NPV, shown in Table 7. The results are similar to those from the back-of-the envelope model above, but at first sight seem seem less extreme. For example, with an annual default rate of 50%, the NPV of the CDS is positive when recovery rates are below 40%. With the back-of-the-envelope model, at a default rate of 50%, there was *no* recovery rate at which the NPV was positive. It

[27]Because we are assuming a constant rate of default, independent of the level of house prices, we do not also need to simulate the house price process.

Table 7: Valuation results for the AAA ABX 2006-2 index CDS for June 30, 2009

The table shows the net present value per dollar of principal insured for the AAA ABS.HE 2006-2 index CDS as of June 30, 2009, given the closing price that day of $0.33165 per dollar, and assuming a 2.0% constant monthly prepayment rate (the historical average for the twenty pools), and various constant default and recovery rates.

Recovery	Annual Default Rates					
Rates	0.0%	20.0%	50.0%	70.0%	80.0%	100.0%
100.0%	-0.7125	-0.6936	-0.6818	-0.6774	-0.6755	-0.6695
60.0%	-0.7125	-0.6906	-0.5345	-0.4549	-0.4089	-0.2645
50.0%	-0.7125	-0.6509	-0.3794	-0.2166	-0.1134	0.0617
40.0%	-0.7125	-0.5923	-0.1252	0.0545	0.1125	0.2438
20.0%	-0.7125	-0.4120	0.2072	0.2908	0.3056	0.3296
0.0%	-0.7125	-0.1196	0.2968	0.3127	0.3181	0.3296

is important to note, however, that a default rate of 50% here means 50% *per year*. This is much more extreme that in the prior model, where it meant a single default event of magnitude 50%. As a result, the NPV numbers in Table 7 are somewhat higher than those obtained above.

Full model Here we value all four AAA ABX.HE index CDS using the full prepayment and default models estimated above. The procedure is similar to that for the constant default and prepayment rate case above, except for *i.* using more sophisticated models for default and prepayment, *ii.* needing to simulate both interest rates and house prices.[28]

In performing the valuation as of June 30, 2009, we determine the loan composition for each of the pools on that date for each deal using data from ABSNet. We then track the prepayment and default behavior of the fixed- and adjustable- rate loans in each pool separately. The first panel (OAS=0) of Table 8 shows the net present value (present value of insurance benefits minus cost of insurance) on June 30, 2009, of the four vintages of AAA ABX.HE index CDS securities for various assumptions about recovery rates. The results are again similar to those from the back-of-the-envelope model above. In particular, the NPVs of all four AAA CDS are negative for every possible recovery rate between 40% and 100%, and are negative for all recovery rates for three of the four CDS. Before taking these results at face value, however, it is important to note that option-adjusted spreads (OAS) on many securities were widening during this period.[29] For example, Krishnamurthy (2010, Figure 9)

[28]This is because both default and prepayment vary with the level of house prices.

[29]To match model and market prices for mortgage-related securities, it is standard practice to add a fixed

Table 8: Valuation results for the AAA ABX.HE 2006-1 index CDS, AAA ABX.HE 2006-2 index CDS, AAA ABX.HE 2007-1 index CDS, and AAA ABX.HE 2007-2 index CDS

The table shows the net present value per dollar of principal insured for the AAA index for each of the ABX.HE 2006-1, ABX.HE 2006-2, ABX.HE 2007-1, and ABX.HE 2007-2 index CDS as of June 30, 2009, given the respective closing prices on that day for each of the indices. The cash flows for the simulations are based upon empirically estimated hazard rates for prepayment and default. The hazard rates were estimated using performance data from a large sample of 27,826 fixed rate mortgages and 59,290 adjustable rate mortgages both monitored between 2005 through 2009. The data were obtained from ABSnet.

	Values			
Recovery Rates	ABX.HE 2006-1	ABX.HE 2006-2	ABX.HE 2007-1	ABX.HE 2007-2
OAS = 0				
100%	-0.311	-0.670	-0.744	-0.746
60%	-0.311	-0.643	-0.724	-0.701
50%	-0.311	-0.607	-0.654	-0.534
40%	-0.296	-0.559	-0.554	-0.300
20%	-0.256	-0.383	-0.399	0.035
0%	-0.198	-0.127	-0.335	0.112
OAS = 50 bp				
100%	-0.310	-0.670	-0.743	-0.746
60%	-0.310	-0.646	-0.725	-0.696
50%	-0.310	-0.615	-0.657	-0.532
40%	-0.295	-0.572	-0.560	-0.303
20%	-0.257	-0.418	-0.410	0.026
0%	-0.202	-0.187	-0.345	0.104
OAS = 150 bp				
100%	-0.310	-0.670	-0.743	-0.746
60%	-0.310	-0.652	-0.722	-0.695
50%	-0.310	-0.626	-0.640	-0.539
40%	-0.303	-0.591	-0.489	-0.321
20%	-0.284	-0.472	-0.210	-0.001
0%	-0.257	-0.282	-0.062	0.082
Quoted Price on June 30, 2009	0.691	0.332	0.258	0.257
Premium (Basis points)	18	11	9	76

shows that OAS for plain-vanilla mortgage-backed securities were close to zero throughout 2007, but then rose steadily to almost 1.5% by early 2009, before falling again to about 0.5% by the middle of 2009. We need to rule out the possibility that our results are merely a symptom of this market-wide phenomenon.[30] In the second and third panels of Table 8, we therefore repeat the analysis in the first panel, but this time using an OAS of 0.5% and 1.5%, respectively.[31] While the numbers change slightly, the overall conclusion remains identical: the NPVs are negative for almost every possible recovery rate.

Because our estimated default model includes house prices as one of the explanatory variables, it will automatically result in higher default rates when house prices fall, as they did prior to June 2009. However, as an additional robustness check, we repeated all of our valuation results using the same model as above, but multiplying the estimated default hazard rates by two. The results are shown in Table 9, and do not materially change any of our conclusions. Overall, the Monte Carlo results support the conclusion of the back-of-the-envelope model above: all of the ABX.HE index CDS are mispriced given expected default risk, due primarily to the large up-front payments for the insurance based upon the quoted prices from Markit.

5 Empirical analysis of ABX.HE index CDS price changes

The results from Section 4 suggest that, whatever is driving AAA ABX.HE index CDS prices, it is not just expectations of future default rates on the underlying mortgages. We here investigate in more detail the empirical determinants of changes in the quoted prices for the AAA ABX.HE index CDS. The goal of this investigation is to answer two questions. First, even though we know ABX.HE index CDS prices do not *solely* reflect expectations of future default behavior, are they related at all to news about the credit performance of the referenced basket of subprime obligations? Second, given that default behavior cannot fully explain observed prices, what other variables are empirically significant?

5.1 Empirical specification and data description

To explore the determinants of AAA ABX.HE index CDS price changes, we regress the monthly percentage changes in the quoted price of the respective AAA ABX.HE index CDS for 2006-1, 2006-2, 2007-1, and 2007-2, on a selection of potential explanatory variables. The

spread, the *Option-Adjusted Spread*, to the risk-free rate when discounting projected cash flows along each path. For details, see Hayre (2001).

[30] We thank the referee for this suggestion.

[31] In other words, when doing the valuation, we discount the cash flows at $(r + \text{OAS})$ rather than just r.

Table 9: Valuation results with doubled default rates

The table shows the net present value per dollar of principal insured for the AAA ABX.HE 2006-1 index CDS, AAA ABX.HE 2006-2 index CDS, AAA ABX.HE 2007-1 index CDS, and AAA ABX.HE 2007-2 index CDS as of June 30, 2009, given the respective closing prices on that day for each of the indices. The cash flows for the simulations are based upon empirically estimated hazard rates for prepayment and default, using double the estimated default rate in the valuation. The hazard rates were estimated using performance data from a large sample of 27,826 fixed rate mortgages and 59,290 adjustable rate mortgages both monitored between 2005 through 2009. The data were obtained from ABSnet.

	Values			
Recovery Rates	ABX.HE 2006-1	ABX.HE 2006-2	ABX.HE 2007-1	ABX.HE 2007-2
OAS = 0				
100%	-0.311	-0.670	-0.743	-0.745
60%	-0.311	-0.587	-0.572	-0.439
50%	-0.286	-0.506	-0.339	-0.127
40%	-0.258	-0.365	-0.144	0.046
20%	-0.183	-0.032	0.034	0.146
0%	-0.097	0.197	0.166	0.235
OAS = 50 bp				
100%	-0.310	-0.670	-0.743	-0.745
60%	-0.310	-0.593	-0.576	-0.434
50%	-0.286	-0.520	-0.347	-0.127
40%	-0.259	-0.391	-0.156	0.042
20%	-0.185	-0.078	0.022	0.141
0%	-0.100	0.144	0.154	0.228
OAS = 150 bp				
100%	-0.310	-0.669	-0.743	-0.745
60%	-0.310	-0.604	-0.585	-0.439
50%	-0.287	-0.544	-0.365	-0.143
40%	-0.261	-0.435	-0.179	0.025
20%	-0.191	-0.158	-0.003	0.125
0%	-0.110	0.052	0.130	0.213
Quoted Price on June 30, 2009	0.691	0.332	0.258	0.257
Premium (Basis points)	18	11	9	76

regression specification is:

$$\Delta ABX_{it}^{AAA} = \beta_0^{AAA} + \beta_1^{AAA}\Delta ABX_{i,t-1} + + \sum \beta_l^{AAA}\Delta X_{i,Credit_{lt}} + \sum \beta_l^{AAA}\Delta X_{i,Short_{lt}} + \sum \beta_l^{AAA}\Delta X_{i,Control_{lt}} + \varepsilon_{it}^{AAA}, \quad (9)$$

where Δ indicates percentage changes, and the right hand side variables control for the credit performance of the underlying mortgages, the short-sales ratio of firms in mortgage-related industries, repo rates, and various controls. We now discuss the variables and the data used in more detail.

ABX.HE prices: The AAA ABX.HE index CDS prices, ABX_{it}, used in our empirical analysis are as reported to the market by Markit Group Ltd., who report daily trading prices. We compute the monthly percentage changes in the AAA ABX.HE index CDS quoted prices using the last quoted price each month. This reporting frequency matches the end-of-month reporting frequency of the mortgage performance data.

Mortgage credit and prepayment performance: To examine the significance of changes in credit behavior for the ABX.HE prices, we assemble loan performance information for each of the subprime residential mortgage-backed security pools referenced by the four trading ABX.HE index CDS. The performance data were obtained from Bloomberg and Lewtan ABSNet. We track the monthly rates of delinquency, foreclosure, Real Estate Owned,[32] and prepayment. Table 10 reports the time-series average pool-level credit and prepayment performance by vintage. As shown in the table, the average delinquency rates in the 2006-1 and 2006-2 AAA ABX.HE index CDS pools are higher than those in the 2007-1 and 2007-2 pools, but the average foreclosure rates and serious delinquency rates are lower. The maximum rates of foreclosure and loss are also higher for the later vintage pools. As is clear from the standard deviations and the minimum and maximum values of all the performance characteristics, there is considerable variability in the monthly realized credit experience across the twenty deals in each AAA ABX.HE vintage. The average monthly prepayment rate is about 2.3% for the early vintage pools and about 1.5% for the later vintage pools. The prepayment rate is also quite heterogeneous, particularly in the 2006 vintages pools, which experienced very significant decreases in interest rates followed by large decreases in house prices.

[32] This is the dollar value of housing collateral held by the trust after the foreclosure auction.

Table 10: Summary Statistics for the the Pool-level Default, Prepayment, and Loss Performance Measures in the 2006 and 2007 Vintage AAA ABX.HE index CDS, Using Performance Data from June 19, 2007 to July 30, 2010.

The table presents the summary statistics for the percentage of the overall outstanding mortgage collateral that was 30-days delinquent, 60-days delinquent, 90-days delinquent, in foreclosure, lost, or held as Real Estate Owned, and the thirty-day prepayment rate for the Markit AAA ABX.HE 2006-1 index CDS, AAA ABX.HE 2006-2 index CDS, AAA ABX.HE 2007-1 index CDS, AAA ABX.HE 2007-2 index CDS pools. We report the summary statistics for the period July, 2007 through July, 2010 (the same period tracked in the panel regressions).

	Mean	Standard Deviation	Minimum	Maximum
ABX.HE-2006-1				
30 Day Prepayment Rate (%)	2.4	0.9	1.0	5.0
30 Day Delinquency Rate (%)	4.0	1.4	0.1	5.9
60 Day Delinquency Rate (%)	2.2	1.1	0.0	3.9
90 Day Delinquency Rate (%)	5.5	4.9	0.0	15.1
Foreclosure Rate (%)	10.2	6.7	0.0	18.4
Loss Rate (%)	5.8	3.8	0.0	11.4
REO Rate (%)	4.9	3.9	0.0	11.7
ABX.HE-2006-2				
30 Day Prepayment Rate (%)	2.2	0.7	0.8	3.4
30 Day Delinquency Rate (%)	4.2	1.6	0.1	6.3
60 Day Delinquency Rate (%)	2.3	1.1	0.0	3.8
90 Day Delinquency Rate (%)	5.5	5.2	0.0	16.3
Foreclosure Rate (%)	11.3	8.0	0.0	21.6
Loss Rate (%)	7.5	5.1	0.1	15.3
REO Rate (%)	5.0	4.1	0.0	12.0
ABX.HE-2007-1				
30 Day Prepayment Rate (%)	1.6	0.5	0.3	2.5
30 Day Delinquency Rate (%)	4.7	1.4	0.0	6.9
60 Day Delinquency Rate (%)	2.9	1.1	0.0	4.7
90 Day Delinquency Rate (%)	9.1	7.9	0.0	23.2
Foreclosure Rate (%)	12.6	7.2	0.0	20.3
Loss Rate (%)	7.5	5.7	0.0	16.8
REO Rate (%)	5.0	3.3	0.0	9.6
ABX.HE-2007-1				
30 Day Prepayment Rate (%)	1.4	0.5	0.3	2.4
30 Day Delinquency Rate (%)	5.0	1.7	0.0	7.4
60 Day Delinquency Rate (%)	3.0	1.3	0.0	4.7
90 Day Delinquency Rate (%)	8.8	7.2	0.0	21.3
Foreclosure Rate (%)	12.9	7.5	0.0	21.4
Loss Rate (%)	7.5	6.5	0.0	18.6
REO Rate (%)	4.2	2.8	0.0	8.0

Short-sales data: Based on Froot (2001), who found limited capital in the reinsurance market to be the most likely explanation for the fact that prices for catastrophe insurance often exceed seven times expected losses, a candidate explanation for the pricing anomalies described above is lack of capital behind the provision of mortgage-backed-security insurance via the sale of ABX.HE index CDS. This explanation is not implausible in this market, given the size of the notional outstanding combined with the fact that, while many institutions are natural demanders of insurance against mortgage default, very few are natural suppliers of such insurance. The impact of such capital constraints will vary with shifts in the demand for insurance.

Since there was no functioning clearinghouse for CDS contracts until recently, we proxy for insurance demand by looking at measures of short selling in sectors related to subprime mortgage-backed securities. We follow prior authors (see Lamont and Stein, 2004; Fishman, Hong, and Kubik, 2007; Jones and Lamont, 2002) in the use of the value-weighted short-interest ratio (the market value of shares sold short, divided by the average daily trading volume) for banks, investment banks, and publicly traded home builders. The short-interest ratio is a measure of how long it would take short sellers, in days, to cover their entire positions if the price of a stock began to rise. A higher short-interest ratio is usually viewed by market participants as a bearish signal about a specific stock, and higher ratios have been found to be associated with other measures of demand pressure for shorting, such as high premia paid to borrow the stock.[33] We obtain monthly data for the short-interest ratio from Bloomberg and Shortsqueeze.com from January 2006 to July 2010 for each of three publicly traded types of firms with exposure to the subprime mortgage market.[34] From our monthly series, we construct a measure of the monthly percentage changes in the short-interest ratios for commercial banks, investment banks, and builders.

Repo market conditions: Gorton and Metrick (2009) argue that many of the financial problems observed during 2007–2009 were caused by failure of the repo market. We therefore include in our regression monthly percentage changes in the overnight repo rate and in the spread between three-month LIBOR and the overnight index swap (OIS) rate, downloaded from Bloomberg. Gorton and Metrick (2009) argue that the LIBOR-OIS spread is a measure

[33] See, for example, Lamont and Stein (2004), Jones and Lamont (2002), and Dechow, Hutton, Muelbroek, and Sloan (2001)

[34] The public companies that we track are: Ambac Financial Group Inc.; Bank of America Corp.; Bank of New York Company; Barclays PLC; Capital One Financial Corp.; Centex Corp.; Citigroup Inc.; Countrywide Financial Corp.; Credit Suisse Group; Deutsche Bank Aktiengesellschaft; Flagstar Bancorp Inc.; Goldman Sachs Group Inc.; HSBC Holdings PLC; JPMorgan Chase & Co.; Kaufman and Broad; KeyCorp; Lennar Corp.; Merrill Lynch & Co. Inc.; Morgan Stanley; Pulte Homes Inc.; Sovereign Bancorp Inc.; SunTrust Banks Inc.; The PNC Financial Services Group Inc.; The Ryland Group Inc.; Toll Brothers Inc.; U.S. Bancorp; UBS AG; Wachovia Corp.; Webster Financial Corp.; and Wells Fargo & Company.

of counterparty risk in the interbank lending system.[35] A higher value of this spread is an indication of a decreased willingness to lend by major banks, while a lower spread indicates lower concerns about counterparty risk. Historically, this spread has been around 10 basis points. However, on October 10, 2008, the spread spiked to all-time high of 366 basis points.

House price performance: House prices are an important factor influencing future default rates. We collect the same data that are available to market participants: the monthly repeat-sales house-price index for the United States, available from the Office of Housing Enterprise Oversight (OFHEO, now the Federal Housing Finance Agency, FHFA). Since the geographic coverage of the loans in the pools is diversified across the states, the national index is the best representation of the systemic house-price-risk exposure of the pools.

Additional market control variables: We also consider the following market controls:

- Monthly percent changes in the S&P volatility index, *VIX*, downloaded from Datastream. *VIX* is calculated from market prices of CBOE-traded options on the S&P 500 Index, and is often referred to as the market's "fear gauge" (see Whaley, 2000). Other studies (see, for example, Longstaff and Myers, 2009) have used *VIX* as a measure of the market's perception of risk. It thus serves as a measure of potential hedging demand by market participants.
- Monthly changes in the ten-year constant-maturity Treasury rate, *CMT10*, obtained from Datastream. Since the ABX.HE index CDS share the same maturity as the underlying subprime-mortgage collateral, the effects of discounting should be important to their values.
- Monthly changes in the slope of the constant-maturity yield curve, *slope*. This is calculated as the difference between the ten-year and three-month yields, obtained from Datastream. The slope of the yield curve is a measure of expected future growth in the economy, which would presumably affect the demand for housing, and thus mortgage refinancing and default rates.
- Monthly S&P 500 and REIT returns, obtained from Datastream. These measures are included following Driessen and Van Hemert (2009) and Longstaff (2010), who find a positive relation between asset-backed index CDS, such as the ABX.HE index CDS and the CMBX index CDS, and market returns.

[35] The OIS is a fixed-to-floating interest rate swap where the periodic floating rate of the swap is tied to the geometric average of an overnight index, such as the federal funds rate, over every day of the contractual loan payment period. The fixed leg of the swap is the expected average of the overnight federal funds rate over the term of the contract. Since principal does not change hands with these swaps, OIS contracts do not have significant credit risk exposure.

5.2 Results

Table 11 reports five regression specifications for the AAA ABX.HE index CDS. The first column presents the results of an OLS regression of the percent change in the indices on changes in aggregate default performance of the underlying mortgage pools, S&P return dynamics, REIT returns, fundamentals such as the change in the LIBOR minus OIS, the 10 year Treasury, the slope in the yield curve and the short interest ratios for the banks, investment banks, and builders. We use data from July 2007 to July 2010, the period for which we have data on all four pools. Column 2 of Table 11 reports an OLS specification for Equation (9) and column 3 presents a fixed-effects specification, where we cluster the standard errors by the vintage of the AAA ABX.HE index CDS. In columns 4 and 5, we replace the individual credit variables with a summed variable equal to the sum of the 60 day delinquency, 90 day delinquency, REO and foreclosure rate changes, and we replace the individual short-interest ratio variables with a single variable equal to their sum. We again run an OLS regression and a fixed-effects regression, where we cluster the standard errors by the vintage of the AAA ABX.HE index CDS.

Surprisingly, as shown in columns (1) through (3) of Table 11, of all the credit variables only the change in the foreclosure rate has the anticipated statistically significant negative coefficient, implying that the cost of the CDS per dollar of principal insured rises with increasing foreclosure. The change in the 30-day delinquency rate has a statistically significant effect of the opposite sign, suggesting that the cost of the insurance falls with more delinquency, and the other credit variables have no statistically significant effect on ABX.HE prices. In columns (4) and (5), we report specifications where we sum the 60 day delinquency effects, the 90 delinquency effects, the REO rate and the foreclosure into a measure of aggregate serious delinquency or default. We again find the expected statistically significant and negative coefficient estimate on this aggregate measure of serious credit events in these pools. Again, the change in the 30 day delinquency rate retains a statistically significant positive coefficient, which is difficult to interpret.

By contrast, the investment bank short-interest ratio has statistically significant negative effects on the AAA ABX.HE price changes in all four specifications, hence a positive relation with the cost of insurance. Changes in the bank and builder short-sales ratios are not statistically significant. The results of summing the short-interest ratios in the specification reported in column (4) and (5) of Table 11 again shows a statistically significant and negative coefficient. This result suggests that, similar to the findings of Froot (2001) in the catastrophe insurance market, the price of ABS insurance moves with supply and demand imbalances related to short selling the stocks of investment banks. Since buying AAA ABX.HE index CDS is roughly equivalent to shorting the mortgage market or firms with subprime residential

Table 11: Regressions for monthly percentage changes in the quoted prices of the 2006 and 2007 Vintage AAA ABX.HE index CDS, using data from June 19, 2007 to July 30, 2010.

	(1) % Price Change	(2) % Price Change	(3) % Price Change	(4) % Price Change	(5) % Price Change
Lag 1 % Price Change	-0.231*** (-3.23)	-0.210*** (-2.85)	-0.225*** (-3.03)	-0.202*** (-2.74)	-0.215*** (-2.89)
Δ 30 Day Delinquency	0.0948*** (2.99)	0.0925*** (2.72)	0.0949*** (2.78)	0.109*** (3.37)	0.111*** (3.41)
Δ 60 Day Delinquency	-0.0742 (-1.94)	-0.0620 (-1.66)	-0.0586 (-1.56)		
Δ 90 Day Delinquency	-0.0113 (-0.76)	-0.00870 (-0.47)	-0.00610 (-0.32)		
Δ REO Rate	-0.00809 (-0.39)	0.0155 (0.70)	0.0245 (1.06)		
Δ Foreclosure Rate	-0.0409*** (-2.72)	-0.0582*** (-3.51)	-0.0539*** (-3.19)		
Δ Principal Loss Rate	0.00292 (0.09)	0.0204 (0.69)	0.0392 (1.21)	0.0339 (1.24)	0.0434 (1.52)
Δ Prepayment	-5.243 (-1.95)	-1.131 (-0.41)	-1.218 (-0.44)	-2.431 (-0.92)	-2.367 (-0.89)
S&P Returns	3.471*** (8.67)	3.571*** (3.94)	3.483*** (3.83)	3.347*** (3.95)	3.347*** (3.94)
REIT Returns	-0.00292 (-0.16)	0.00604 (0.36)	0.00627 (0.37)	-0.00810 (-0.50)	-0.00879 (-0.54)
House Price Returns	27.25 (0.86)	0.939 (0.03)	4.982 (0.14)	-4.771 (-0.15)	-1.645 (-0.05)
Δ Bank Ratio		0.0130 (0.05)	-0.0224 (-0.08)		
Δ Builder Ratio		-0.289** (-2.15)	-0.263 (-1.94)		
Δ IV Bank Ratio		-1.178** (-2.46)	-1.151** (-2.41)		
Δ LIBOR minus OIS		-0.00954 (-0.04)	0.00144 (0.01)	0.245 (1.00)	0.272 (1.11)
Δ Repo Rate		0.00496 (0.12)	0.00745 (0.18)	0.0156 (0.39)	0.0171 (0.42)
Δ 10-year Treasury		0.209 (1.17)	0.233 (1.31)	0.294 (1.88)	0.299 (1.90)
Δ Slope (10-year CMT minus 3-month Rate)		0.0795 (1.42)	0.0790 (1.41)	0.119** (2.23)	0.122** (2.27)
Δ VIX Rate		0.145 (0.77)	0.122 (0.64)	0.0770 (0.43)	0.0648 (0.36)
Δ Sum of credit variables				-0.0272*** (-2.80)	-0.0233** (-2.23)
Δ Sum of short interest ratios				-0.288*** (-4.92)	-0.285*** (-4.84)
Constant	-0.00491 (-0.31)	-0.00880 (-0.56)	-0.0202 (-1.13)	-0.00768 (-0.49)	-0.0166 (-0.94)
Observations	158	127	127	127	127
R^2	0.4037	0.5951	0.6019	0.5535	0.5583
Standard Errors	Unclustered	Unclustered	Clustered	Unclustered	Clustered

t statistics in parentheses
** $p < 0.05$, *** $p < 0.01$

mortgage exposure, it appears that the supply and demand imbalances in the market for shorting the stocks of firms with subprime mortgage risk positively "spilled over" into the AAA ABX.HE market during this period. This spill-over effect drove up the cost of insuring AAA residential mortgage-backed securities, or alternatively, the cost of building up short positions against key mortgage market participants.

As shown in Table 11, S&P 500 returns are positively associated with shocks to the quoted ABX.HE prices, so, in line with intuition, the cost of insurance falls as the S&P rises. Changes in the slope of the yield curve have a positive coefficient, i.e., a negative effect on the cost of the insurance, probably reflecting better future economic prospects. Housing returns have little effect, appearing insignificantly in every specification. While somewhat surprising, this result may be the result of limitations with the available indices for measuring house price fluctuations, rather than an indication that shocks to housing prices did not affect the costs of insuring AAA residential mortgage-backed securities bonds through the AAA ABX.HE CDS. Different from Gorton and Metrick (2009), the changes in the repo rate and in the LIBOR-OIS spread are not significantly associated with changes in AAA ABX.HE index CDS quoted prices.[36]

As an additional robustness check, we repeat these regressions including lags of the right-hand-side credit- and default-related variables in all columns. Table 12 reports the results, which are very similar to those in Table 11. In particular, while the significance of the credit variables decreases somewhat, the short-interest variables remain highly significant.

Overall, these results suggest that the short-interest imbalance channel had a larger economic effect on ABX.HE index CDS returns than did credit events on the mortgages over this time period. Other important factors affecting the prices of the AAA ABX.HE index CDS include the slope of the yield curve and movements in the stock market.

6 Conclusions

Despite the rapid growth of the ABX.HE index CDS market, and the focus of regulators on banks using CDS market prices as the basis for marking their portfolios to market, we find that market prices for AAA ABX.HE index CDS at the peak of the financial crisis in June 2009 are inconsistent with any reasonable assumptions for future default rates. Although we find that percentage changes in CDS prices are correlated with changes in the realized foreclosure rates of the underlying loans, we also find that changes in short-sale imbalances in the equity markets of the publicly traded investment banks have a statistically significant

[36] These results are unchanged if we include only one of the LIBOR-OIS spread or the repo rate in the regressions.

Table 12: Regressions for monthly percentage changes in the quoted prices of the 2006 and 2007 Vintage AAA ABX.HE index CDS, using data from June 19, 2007 to July 30, 2010. Standard errors clustered by security.

	(1) % Price Change	(2) % Price Change	(3) % Price Change	(4) % Price Change
Lag 1 Δ ABX Quoted Price Changes	-0.286***	-0.262***	-0.208***	-0.215***
	(-4.01)	(-3.49)	(-2.70)	(-2.82)
Δ 30 Day Delinquency	0.0624	0.0820**	0.100**	0.0922**
	(1.90)	(2.04)	(2.46)	(2.48)
Δ 60 Day Delinquency	-0.0523	-0.0364		
	(-1.22)	(-0.85)		
Δ 90 Day Delinquency	0.00971	-0.0198		
	(0.37)	(-0.64)		
Δ REO Rate	0.109***	0.113***		
	(2.80)	(2.87)		
Δ Foreclosure Rate	-0.000720	-0.0434		
	(-0.03)	(-1.46)		
Δ Principal Loss Rate	0.0139	0.0307		
	(0.41)	(0.90)		
Lag1 Δ 30 Day Delinquency	0.0163	-0.0283	-0.0187	-0.000748
	(0.48)	(-0.77)	(-0.52)	(-0.02)
Lag1 Δ 60 Day Delinquency	0.0161	0.0432	0.0440	
	(0.35)	(0.92)	(1.03)	
Lag1 Δ 90 Day Delinquency	-0.0290	-0.00435	-0.00965	
	(-1.19)	(-0.14)	(-0.33)	
Lag1 Δ REO Rate	-0.130***	-0.120***	-0.0291	
	(-3.55)	(-3.06)	(-1.07)	
Lag1 Δ Foreclosure Rate	-0.0597**	-0.00881	-0.0420	
	(-2.05)	(-0.26)	(-1.34)	
Lag1 Δ Principal Loss Rate	-0.0113	0.0224	0.00300	
	(-0.31)	(0.60)	(0.08)	
Δ Prepayment	-0.0417	0.00774	-0.0180	-0.0241
	(-1.56)	(0.28)	(-0.65)	(-0.87)
S&P Returns	3.607***	3.758***	3.567***	3.141***
	(8.97)	(3.99)	(3.85)	(3.51)
REIT Returns	0.000523	0.00476	-0.00504	-0.00897
	(0.03)	(0.28)	(-0.28)	(-0.53)
House Price Returns	5.153	-22.64	-3.866	-3.577
	(0.16)	(-0.64)	(-0.11)	(-0.11)
Δ Bank Ratio		0.272		
		(0.97)		
Δ Builder Ratio		-0.255		
		(-1.92)		
Δ IV Bank Ratio		-1.475***		
		(-3.05)		
Δ LIBOR minus OIS		0.101	0.283	0.202
		(0.36)	(1.00)	(0.79)
Δ Repo Rate		-0.00422	-0.00857	0.0287
		(-0.10)	(-0.19)	(0.71)
Δ 10-year Treasury		0.0196	0.249	0.355**
		(0.10)	(1.37)	(2.10)
Δ Slope (10-year CMT minus 3-month Rate)		0.0904	0.129**	0.116**
		(1.59)	(2.23)	(2.11)
Δ VIX Rate		0.0392	0.0695	0.0968
		(0.19)	(0.35)	(0.50)
Δ Sum of credit variables			-0.000450	-0.0138
			(-0.02)	(-0.69)
Δ Sum of short interest ratios			-0.241***	-0.279***
			(-3.48)	(-4.12)
Δ Sum of Lag1 credit variables				-0.0102
				(-0.46)
Constant	0.00714	-0.0195	-0.00239	0.000960
	(0.42)	(-0.91)	(-0.11)	(0.06)
Observations	158	127	127	127
R^2	0.4783	0.6485	0.5725	0.5498

t statistics in parentheses
** $p < 0.05$, *** $p < 0.01$

and large economic impact on CDS prices. Because our short-sale activity measure is a proxy for demand imbalances in the market for mortgage default insurance, the relative importance of its correlation with CDS price dynamics suggests that the practice of using the AAA ABX.HE index CDS to value subprime mortgage portfolios is quite problematic.

Besides their immediate policy implications in the mortgage market, our findings add to a growing body of recent research documenting how limits to arbitrage (see Shleifer and Vishny, 1997) and capital constraints can allow prices in many markets to i. diverge significantly from fundamentals; and ii. move with variables unrelated to fundamentals. Other evidence for the existence of these limits include Gabaix, Krishnamurthy, and Vigneron (2007), who find that the idiosyncratic risk of homeowner prepayment (which must net to zero in aggregate) is priced in the mortgage-backed securities market. They attribute this to limits of arbitrage in the market, caused by the marginal investor being a specialized arbitrageur with limited capital, rather than a diversified representative investor. Krishnamurthy (2010) discusses mispricings between Treasury rates and 30-year fixed-for-floating (LIBOR) interest rate swap rates. Bai and Collin-Dufresne (2010) examine mispricings between corporate bonds and CDS written on the same company. Finally, Froot (2001) studies mispricings in the market for catastrophe insurance. In this market, losses due to natural disasters are both large and approximately uncorrelated with the state of the overall economy, so we should expect to see large demand for insurance, especially against catastrophic losses, and this insurance should be priced roughly at the level of expected losses. In contrast, Froot (2001) documents that protection tends to be relatively limited, and is always priced well above the level of expected losses, sometimes as much as seven times as high. He concludes, supported by statements by players in the industry such as National Indemnity,[37] that this is caused by the absence of sufficient capital in the reinsurance market. Our results suggest that similar dislocations may exist in the ABX.HE market.

Finally, our findings contribute to the growing debate concerning the wisdom of moving regulated financial institutions, especially those holding large investment portfolios of loans, to a full mark-to-market accounting system. A number of recent papers (see, for example, Brunnermeier and Pedersen, 2009; Shleifer and Vishny, 2009; Allen and Carletti, 2008; Plantin, Sapra, and Shin, 2008) have analyzed the link between the funding liquidity and market liquidity of financial institutions, and have found this to be an important source of systemic risk with the potential to generate destabilizing liquidity spirals. Although the mechanisms differ in these papers, mark-to-market accounting further exacerbates these effects by inducing potentially excessive and artificial volatility into accounting valuations, thus distorting regulatory capital requirements and the timing of liquidations (see Allen

[37]National Indemnity, a subsidiary of Berkshire Hathaway, is one of the largest reinsurance companies.

and Carletti, 2008; Plantin et al., 2008; Freixas and Tsomocos, 2004) and increasing the likelihood that rational trading will be based on irrelevant information (see Gorton, He, and Huang, 2006). Our results, showing that the ABX.HE index CDS prices appear to be only very weakly related to the performance of the underlying mortgages, strongly reinforce this concern, and suggest that the use of these CDS for the fair-market valuation of mortgage loans held in the portfolios of financial institutions, or for loans on the trading books of these institutions, is likely to lead to important distortions.[38] These distortions could lead to bank insolvency and could affect new loan origination strategies or the liquidation strategies implemented for existing mortgage loans.[39]

[38]In May, 2010, the Financial Accounting Standards Board (FASB) proposed to expand the use of mark-to-market accounting from just loans intended for sale to also include loans that financial institutions planned to hold to maturity (see *U.S. Banker*, "FASB Mark-to-Market Plan Could Have a Seismic Impact," by Heather Landy, June, 2010). As the result of these proposals, "...Lenders including Bank of America Corp., based in Charlotte, North Carolina, and San Francisco-based Wells Fargo already report the fair value of their loans in the footnotes of their quarterly reports to regulators. Reporting changes through other comprehensive income could cause swings of billions of dollars in their book values..." (see Michael J. Moore, "FASB Backs Off Fair-Value of Loans Proposal After Opposition," Bloomberg.com, January 25, 2011).

[39]Bhat, Frankel, and Martin (2010) find empirical evidence that AAA ABX.HE 2006-1 index CDS price dynamics were positively associated with sales of non-agency mortgage backed securities by regulated U.S. financial institutions and this correlation dissipated once FASB eased the mark-to-market rules temporarily on April 2, 2009.

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