Comments solicited

Jump and Cojump Risk in Subprime Home Equity Derivatives

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Abstract

I analyze the risk in the ABX index of asset backed, subprime, home equity credit default swaps and CME housing futures. Using estimators of the jump and cojump components of security prices, I determine that: (1) jump risk was rising throughout 2006, well before any problems in the mortgage market were discussed in the press or policy circles; (2) news explains up to 40% of the jump risk in the AAA rated ABX index and 24% in the BBB-; (3) The jump risk between the ABX and housing futures market is inversely related; (4) the slope of the housing futures term structure is significantly related to the jump risk.

`Keywords`: asset backed credit default swaps; housing futures; subprime; jump risk; cojumps;

`JEL Classification`: G13, G32, E44;

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1. Introduction

Asset backed securities in residential real estate are an important structured financial product that has helped to diversify credit risk among banks and lenders. They have indirectly benefited the consumer through lower financing rates. This market has grown to nearly $600 billion by the end of 2007 and helped to raise U.S. home ownership rates to a 2005 peak of 69%. Home equity loans, which are our primary focus, enable home owners to finance educational costs and make home improvements.

In the spring of 2007, these instruments came into focus with a collapse in credit markets around the world. Particular attention was paid to the so-called *subprime market*, a subset of home borrowers who failed to meet conventional mortgage qualifying criteria. These borrowers constitute an important class of the residential real estate market, particularly in recent years. Schloemer, Li, Ernst, and Keist (2006) estimate that the subprime share of mortgage originations reached 23% in 2006, up from only 10% in 1998.

As real estate prices began to fall, in some areas as early as 2005, these subprime borrowers came under particular stress. Delinquency rates began to rise. The Mortgage Bankers Association monthly survey of December 2007 showed a delinquency rate of 5.59% in the third quarter of 2007, up from 4.67% in the third quarter of 2006. While subprime fixed (6.3%) and adjustable rate (6.8%) represent only 13.1% of total loans outstanding, they represent 55% (12% and 43%) of all foreclosures.

The mortgage originators have seen the largest declines in shareholder equity, with Countrywide and First Franklin experiencing declines in their stock prices of −78.7% and −32.2% and in 2007. New Century, a California based lender specializing in the subprime market, declared bankruptcy on April 1, 2007.

Major Wall Street firms have, as of January 2008, written down more than $65 billion in assets, with the largest losses at UBS ($13.5*bn*), Citigroup ($11*bn*), Morgan Stanley ($9.4*bn*), and Merrill Lynch ($8*bn*).

This paper attempts to assess financial market anticipations of these real estate and credit market issues. I analyze two derivative securities markets that are closely linked to changes in home prices and affordability. The first of these is an index of credit default swaps on home equity loans called the ABX.HE which is compiled by an information provider called MarkIt. The securities it tracks are ground zero for the subprime market. The ABX aggregates prices on the cost of credit default swaps on subprime mortgage backed securities.

The ABX index has been used to provide long and short exposure during the credit crisis and to price illiquid mortgage backed securities. The *Wall Street Journal* reported in December 14, 2007 that Goldman Sachs' structured products trading group generated more than $4bn in profits in 2007 from shorting subprime securities using the ABX. Motivated by the new accounting rule FASB 157, banks are being prompted to mark their securities to market prices rather than models. The ABX, according to Reuters, is being used to price up to $1 trillion dollars in subprime mortgage securities.

The second part of the paper analyzes the Chicago Mercantile Exchange's futures prices on the residential real estate market. These futures contracts began trading in the Spring of 2006 and have provided a way to hedge the value of individual homes. The futures contracts track a repeat sales housing index originally constructed by Case and Shiller (1989).

Contracts trade at a variety of maturities, ranging from one month to several years. The term structure of prices is currently inverted, indicating that the market anticipates housing prices will fall further. At the end of January 2008, the composite index price for February 2008 is more than 10% above the price for November 2011.

I rely on the recent methods introduced by Barndorff-Nielsen and Shephard (2006) to extract the jump risk component from these derivative security prices. The procedure isolates the portion of security returns coming from discontinuous movements or *jumps* in the underlying stochastic process. I use Huang and Tauchen's (2005) estimator of relative jumps to assess statistical significance. In Mizrach (2009), I show that these methods, even at a daily frequency, can be useful in predicting sudden market movements.

I then extend the analysis to common movements across the two markets using a measure of *cojump* risk introduced by Bollerslev, Law and Tauchen (2007). Beine, Lahaye, Laurent, Neely and Palm (2007) examine cojump risk in foreign exchange due to central bank intervention and Lahaye, Laurent and Neely (2007) analyze the effect of macroeconomic announcements on cojumps across stock, bond, foreign exchange and commodity markets.

The key findings of the current paper are: (1) jump risk was rising throughout 2006, well before any problems in the mortgage market were discussed in the press or policy circles; (2) news explains up to 40% of the jump risk in the AAA rated ABX index and 24% in the BBB-; (3) The jump risk between the ABX and housing futures market is inversely related; (4) the slope of the housing futures term structure is significantly related to the jump risk.

Section 2 begins with details about the asset backed mortgage securities market which the ABX tracks. Section 3 develops the methodology for extracting jumps and assessing their statistical significance. Section 4 provides estimates for the jump risk across all the credit quality tranches of the ABX. Section 5 links the jump risk with the news flow in the markets about housing. Section 6 describe the real estate futures market, and in Section 7, I analyze the jump risk in the CME futures prices. In Section 8, I analyze the cojump risk between the two housing derivatives markets, and I then use, in Section 9, a simple empirical model to summarize their interactions. I conclude with a limited set of policy implications and ideas for future research in Section 10.

2. Data: ABX

2.1 Asset backed securities

Asset backed securities (ABS) are structured fixed income instruments that distribute cash flows from a designated pool of loans. By pooling across households and regions, they mitigate the idiosyncratic risk of any individual borrower.

The corporate finance motivations behind asset securitization are related to capital market imperfections. In principal, securitizing should not effect the value of the firm. As Minton, Opler and Stanton (1999) note, the firm should be indifferent between issuing asset-backed and unsecured debt.

Lang, Poulsen and Stulz (1995) emphasize agency costs of managerial discretion as one motive. The firm may find it more efficient to create a *special purpose vehicle* (SPV) to monitor the cash flows. These SPVs are typically legally distinct entities that provide no explicit recourse to the sponsoring firm's assets, eliminating the credit exposure from the firm's balance sheet. The net impact of improved monitoring and credit risk insulation is that the SPV often achieves a higher credit rating than the originator.

Research on ABS indicates that the market assumes there is some *implicit recourse* from the sponsoring firm and the SPV. Gorton and Souleles (2006) find in a sample of over 400 SPVs that poorly rated sponsors had to promise more than 50 basis points of additional yield on average, regardless of the credit rating of the SPV.

On balance, Thomas (2001) shows, the securitization process is wealth creating for the firm that sells the assets. The benefits may be even larger for firms, like banks, whose capital base is closely regulated.

The securities bundle cash flows, transforming, as Jobst (2005) notes, an illiquid set of receivables into tradable claims or *tranches*. Wighton (2005) emphasizes that the division into distinct slices of risk and maturity make the securities attractive to a wide array of potential buyers.

The market has grown incredibly over the last decade. In 1996, there was a total of $404 billion in asset backed securities, with credit card receivables ($180.7 billion) and auto loans ($71.4 billion) the two largest categories.

[Insert Table 1 Here]

Between 1996 and 2007, the market grew by 17.9% per year to reach a total of $2,477.3 billion. We now turn to the home equity loans (HEL) securities that are the focus of this paper.

2.2 Home equity loans

In 2004, as housing prices were reaching their peak and low interest rates were making refinancing a popular choice for homeowners, HEL securities surpassed credit card receivables as the largest category of asset backed securities, $454.0 versus $390.7 billion. From 1996 to 2007, they grew at a compound 24.9% annual growth rate. In 2007 alone, the Securities Industry and Financial Markets Association (SIFMA) reported issuance of $222 billion in HEL[1].

Thomas (2007) documents that the majority of HEL loans are cash out refinancing, with the cash flows used to consolidate debt, pay for education, or to make home improvements. For more than a decade, these loans have been made available to subprime borrowers. These high risk borrowers, according to Standard and Poor's[2], have Fair Isaac & Co. (FICO) credit scores in the low 600s, high loan to value (LTV) ratios, and they may lack documentation of their income or assets.

As the credit crunch unfolded in 2007, HEL securities faced growing credit spreads, deteriorating collateral, and the inevitable ratings downgrades from the credit rating agencies. According to SIFMA, "in excess of 95 percent of ABS downgrades in the 2005-2007 vintages sector were HEL."

[1] The data are from the Securities Industry and Financial Markets Assocation (SIFMA), "U.S. Market Outlook," January 2008. $1,700 billion of mortgage backed securities were issued in 2007. These securities are backed by primary mortgages though and are not incorporated into the ABX indices.

[2] Victoria Wagner, "Credit FAQ: Will Subprime Woes Spread To The Wider Mortgage Market?," March 13, 2007.

So while HEL securities face systematic risk from changes in underlying real estate prices and/or changes in the ability of homeowners to repay their mortgages, different tranches are particularly vulnerable.

2.3 Credit default swaps

One mechanism for hedging this risk was a new credit derivative known as a *credit default swap*. Credit default swaps are derivatives securities that pay security holders contingent upon a credit event. Typically, these are triggered by some failure to deliver the underlying cash flows promised to the security pool. There are now very liquid markets in credit default swaps on corporate and sovereign bonds.

Credit default swaps on ABS reference individual tranches from an SPV because they are likely to have a wide range of default probabilities. Other unique features of asset backed securities are: (1) the amortization of principal; (2) adjustment of security values in light of partial interest shortfalls or principal writedown.[3] Both considerations require a careful definition of default and settlement procedures. The market has, since 2006, begun to standardize though.

With home equity securities, credit default swaps provide a sequence of payments to the protection buyer. For this reason, the contracts are often referred to as *pay-as-you-go*. The protection seller will compensate for losses in principal and any interest shortfall. These differ from corporate credit default swaps which usually involve a single payment after a credit event. Because the maturity of the ABS contract is usually the same as the underlying mortgage securities, ABS credit default swaps can have long maturities. Corporate bond contracts typically last only 5 years.

2.4 The ABX indices

2.4.1 Entities

The ABX indices are aggregators of the performance of a variety of credit default swaps on asset backed securities. MarkIt Ltd., a London based source of credit derivatives information, collects information on individual credit default swaps and produces a series of indices that have become benchmarks for the industry. This paper studies the ABX.HE indices which track home equity loans.

The 15 issuers that make up the ABX index are in the first column of Table 2.

[3] The principal can also be written back up in the event of catchup payments by the security pool.

[Insert Table 2 Here]

Nearly every major investment bank is represented including Barclays, Goldman Sachs, JP Morgan, Merrill Lynch, Morgan Stanley and UBS. Non-bank financial intermediaries include GMAC. There are also mortgage originators like Ameriquest, Countrywide, First Franklin, and New Century.

From a list of 54 reference obligations that meet the MarkIt criteria[4] for inclusion, 20 distinct securities were chosen to form the ABX HE-061 index which was constituted on January 11, 2006. The index began trading on January 19, 2006. There have been subsequent indices formed every 6 months, with HE-062 pricing beginning on July 19, 2006, HE-071 on January 19, 2007, and HE-072 on July 19, 2007. There are 5 credit tranches to each of the underlying exposures, AAA, AA, A, BBB and BBB-. Ratings are determined by the lower of the Moody's or Standard & Poor's grades.

With the recent turmoil in the credit markets, particularly in home equity, MarkIt was unable to constitute an index for 2008. On December 19, 2007, they released a statement that they would postpone the launch of HE 08-1: "Under current index rules, only five deals qualified for inclusion in the Markit ABX.HE 08-1. Markit and the dealer community considered amending the index rules to include deals which failed to qualify initially but decided against this approach at this time."

The characteristics of the HE-061, HE-062 and HE-071 deals are summarized in Table 3.

[Insert Table 3 Here]

While the deals have progressively lower FICO scores, and less documentation, the loan to value ratio also falls slightly to offset these risks. The characteristics clearly indicate a very clean exposure to high risk borrowers. While liquidity has certainly fallen off recently, the ABX indices constitute the best available aggregate indicator of subprime borrowing and are now widely used to mark to market institutional portfolios.

[4] The MarkIt criteria for inclusion in the ABX includes: (a) deals from the largest 25 issuers (by sub-prime home equity issuance); (b) issued within the last six months (c) offering size of at least \$500M; (d) at least 90% 1st lien mortgages; (e) weighted average FICO credit score < 660; (f) Deals must pay on the 25th of the month; (g) Referenced tranches must bear interest at a floating rate benchmark of one-month LIBOR; (h) at issuance, each deal must have tranches of the required ratings with a weighted average life greater than 4 years, except the AAA which must have an average life of longer than 5 years.

2.4.2 Trades and prices

When the ABX indexes are released, they trade at or close to par. Coupon rates for the various releases and credit tranches are in Table 4.

[Insert Table 4 Here]

We will try to describe the cash flows when the index is selling at par. A purchaser of default protection will pay the coupon rate. To protect \$1 million in security value in the AAA tranche of the 06-1 index, you will pay \$1,800 per year, usually in monthly installments. For the riskier triple BBB- security from the first half of 2006, protection buyers must pay a 2.67% coupon, or \$26,700 per year. Note that for the high credit quality tranches, AAA and AA, coupon rates have actually fallen in the first half of 2007. For riskier BBB and BBB- securities, the coupon rates have risen to up to 342 basis points.

An important part of the recent credit market turmoil is that the ABX securities have fallen dramatically in price. The ABX.HE 061 AAA security has traded in a range of 100.32 and 79.97 during its life, with 100 representing par. With the index trading at a discount, purchasing credit protection becomes much more costly.[5] The buyer must not only pay the coupon, but insurance based on the distance from par. With the index at 79.97, a protection buyers would pay up-front

$$\$1mn \times (100 - 79.97)\% + \$1,800 = \$202,100.$$

The lower credit quality tranches have seen even larger declines. The ABX.HE 061 BBB- tranche has traded in a range between 100.94 and 15.15. At the low for this index, a protection buyer would pay \$848,500 up front, plus \$3,420 per month for credit protection on \$1 million dollars worth of securities.[6]

Our objective here is to describe the day to day movements in the level and volatility of ABS protection, and link to the risk of correlated assets. We turn next to the possibility of discontinuous jumps in this index.

[5] With the securities trading above par, it is possible that the protection buyer could be a net recipient of cash flows from the protection seller.

[6] According to the *Wall Street Journal* of December 17, 2007, Goldman Sachs had concentrated its short position in the ABX in the BBB- tranche.

3. Jump Processes

Consider a stochastic volatility model with jumps,

$$dp(t) = \mu(t)dt + \sigma(t)dw(t) + J(t)dq(t) \tag{1}$$

where $p(t)$ is the log price of the underlying asset, $\mu(t)$ is its drift, $\sigma(t)$ is the local volatility, $w(t)$ is a standard Brownian motion, $J(t)$ is a jump process with mean μ_J and and standard deviation σ_J, and $q(t)$ is a counting process with intensity $\lambda(t)$. Define the within day return process,

$$r_{t,j} = p(t-1+\frac{j}{M}) - p(t-1+\frac{j-1}{M}),\ j = 1, 2, \ldots M. \tag{2}$$

The *quadratic variation* for the daily return process is then

$$[r,r]_t = \int_{t-1}^{t} \sigma^2(s)ds + \sum_{t-1<s\leq t} J^2(s). \tag{3}$$

Estimation of the quadratic variation proceeds with discrete sampling from the log price process. The *realized volatility* is

$$RV_t = \sum_{j=1}^{M} r_{t,j}^2. \tag{4}$$

In the standard stochastic volatility model, $J = 0$, researchers have employed realized volatility as an estimator of the integrated volatility, $\int_{t-1}^{t} \sigma^2(s)ds$.

In the case of discontinuous price paths, Barndorff-Nielsen and Shephard (2006) show that the realized volatility will also include the jump component, and that, in the limit, realized volatility will capture the entire quadratic variation,

$$\lim_{M\longrightarrow\infty} RV_t = [r,r]_t \tag{5}$$

To extract the integrated volatility from (5), Barndorff-Nielsen and Shephard have also introduced the *realized bi-power variation*,

$$BV_t = \mu_1^{-2} \sum_{j=1}^{M} |r_{t,j}|\,|r_{t,j-1}| \tag{6}$$

where $\mu_1 = \sqrt{2/\pi}$. It is then possible to show

$$\lim_{M\longrightarrow\infty} BV_t = \int_{t-1}^{t} \sigma^2(s)ds. \tag{7}$$

By comparing (5) and (7), we have the estimate of just the jump portion of the process,

$$\lim_{M\longrightarrow\infty} (RV_t - BV_t) = \sum_{t-1<s\leq t} J^2(s). \tag{8}$$

3.1 Testing for jump risk

We follow Bollerslev, Law and Tauchen (2007) to analyze the statistical significance of the jump risk. Barndorff-Nielsen and Shephard (2006) show that the joint distribution of RV_t and BV_t is asymptotically normal,

$$M^{1/2}\left[\int_{t-1}^{t}\sigma^4(s)ds\right]^{-1/2}\begin{pmatrix} RV_t-\int_{t-1}^{t}\sigma^2(s)ds \\ BV_t-\int_{t-1}^{t}\sigma^2(s)ds \end{pmatrix} \longrightarrow N\left(0, \begin{array}{cc} v_{qq} & v_{qb} \\ v_{qb} & v_{bb} \end{array}\right) \tag{9}$$

where $v_{qq}=2$, $v_{qb}=2$, and $v_{bb}=(\pi/2)^2+\pi-3$. Computing this distribution requires an estimate of the *integrated quarticity* $\int_{t-1}^{t}\sigma^4(s)ds$. In computing our test statistics, we utilize a consistent estimator called the *tripower quarticity*,

$$TP_t = 2^{2/3}\frac{\Gamma(7/6)}{\Gamma(1/2)}\left(\frac{M}{M-2}\right)\sum_{j=3}^{M}|r_{t,j}|^{4/3}|r_{t,j-1}|^{4/3}|r_{t,j-2}|^{4/3}. \tag{10}$$

Relying on the analysis of Huang and Tauchen (2005), we utilize their relative jump measure

$$RJ_t = \frac{RV_t - BV_t}{RJ_t}, \tag{11}$$

and the test statistic,

$$z_t = \frac{RJ_t}{\left[(v_{bb}-v_{qq})\frac{1}{M}\max(1,\frac{TP_t}{BV_t^2}\right]}, \tag{12}$$

which has a standard normal distribution as $M \longrightarrow \infty$ if $J(t)=0$. Monte Carlo evidence in Huang and Tauchen shows that this statistic has good size and power properties.

3.2 Daily return analysis

I will now take the sampling interval to be daily changes, $j = M = 1$, and compute 50-period rolling sample estimates of realized volatility,

$$RV_t = \sum_{j=1}^{50} r_{t-j}^2 \tag{13}$$

and bipower variation,

$$BV_t = (\pi/2)\sum_{j=1}^{50}|r_{t-j}|\left|r_{t-j-1)}\right|. \tag{14}$$

We constrain the jump risk to be positive,

$$J_t^2 = (\max[RV_t - BV_t, 0]) \tag{15}$$

Then we compute what Andersen, Diebold and Bollerslev (2006) call the *significant jumps* using an $\alpha\%$ confidence level,

$$ZJ_t^2 = J_t^2 I(z_t > \Phi_\alpha^{-1}), \tag{16}$$

where Φ is the cumulative normal distribution.

4. Jump Risk Estimates for the ABX

I report estimates of $J^2(t)$ using (15)for the 5 credit tranches of the 2006-1 version of the ABX. The A rated tranches are in Figure 3 and the BBB tranches in Figure 4.

[Insert Figure 3 Here]

[Insert Figure 4 Here]

I also assess the statistical significance of these jumps by looking at ZJ_t^2 using a significance level of 1% in (16). On average, this level estimates about 57 jump risks to be significant in the 315 day sample. I graph the statistically significant jumps in Figures 5 and 6.

[Insert Figure 5 Here]

[Insert Figure 6 Here]

The ABX indices, regardless of credit quality, were all trading within 5% of par until February 2007. It is very interesting that there are small but significant jumps in several indices in November 2006 well before the BBB index loses par.

The first sizable jump risk emerges in early February. On February 9, 2007, the jump risk in the BBB- tranche of rises to 0.0914. By the end of the month, the largest jump risk spike appears. On February 27, 2007, the BBB- tranche has a spike to 0.8917. This increase occurs in all the credit quality tranches. The BBB rises to 0.3009, the A rises to 0.1019, and the AAA rises to 0.0029. All of these changes are statistically significant.

The jump risk quiets down to zero by March 2, 2007, and remains insignificant until July 10, 2007. There is another large spike at that point in the BBB- of 0.3294. There are jumps in the AA and AAA indices on that date but of much smaller magnitude. July 10, interestingly, is the first date that the AAA index trades below par.

The jump risk in the BBB- index remains high, reaching 0.4806 on July 25, 2007. The risk however is not statistically significant though. In fact, the BBB- has no other statistically significant jumps after July 10. After that point, the risk appears to shift into the higher credit quality tranches. The A tranches have jump risk increases in October 2007. The AA tranche has a statistically significant jump of 0.2707 on October 26, 2007. This does, however, fall back to zero by the end of our sample in November 2, 2007.

It is tempting to begin matching these risks to particular news events, but I will propose in the next section a more formal approach.

5. Events

Despite mentions from prominent observers like Edward Gramlich[7] of the Federal Reserve, the subprime lending market was not on policy makers' or Wall Street's radar screen. *The Wall Street Journal* noted in January 8, 2008, that in the newspaper, there were 75 mentions of the word subprime in the second half of 2006. In the second half of 2007, there were $1,561$. The question before us here is whether jump risk did any better anticipating it.

5.1 Measuring news flow

To try to provide an objective measure of the effect of news on the jump risk, I utilized three time lines that have been published since the subprime crisis hit. The first of these was from the British Broadcasting Company (BBC). Britain, apart from the US, has been the country most strongly impacted. The second timeline was from the U.S. Senate Joint Economic Committee. The committee chair, Senator Charles Schumer of New York, has been a leading proponent of relief for subprime borrowers. The third timeline was from the largest U.S. bond mutual fund, Pacific Investment Management, PIMCO.

I gathered news stories from the three timelines about (1) Federal Reserve actions; (2) Materials news from subprime lenders like Countrywide and investment banks like Merrill Lynch; (3) I excluded macroeconomic news unless it appeared on at least 2 of 3 timelines.

I consider two measures of news. The first is simply the message count which I denote $\#M_t$. This variable counts stories that appeared in any of the three timelines on a given event day. For example, on August 9, 2007, there was; (1) a coordinated intervention by ECB, Fed and Bank of Japan; (2) the French bank BNP Paribas suspended redemption in three hedge funds; and (3) AIG warned that defaults were spreading beyond subprime. This would set the count variable to 3. There are several other days with three stories including June 14, 2007 and August 13, 2007.

My second measure was one of intensity. If a story appeared in all three timelines, this variable, which I denote $\#nM_t$, would be set to 3. For example, the Bear Stearns' announcement on August

[7] In testimonry before the House Committee on Banking and Financial Services on May 24, 2000, Gramlich wrote: "Most predatory lending seems to occur in the subprime mortgage market, a market that has grown recently. In this market, the premiums paid by borrowers typically range from about 1 percentage point to about 6 percentage points over the rate charged for prime mortgage loans, depending on the credit risk involved."

18, 2007 that it would be returning little or nothing to investors in two of its' mortgage backed hedge funds appears in the BBC, JEC and PIMCO timelines, so $\#nM_t = 3$. If there are multiple stories for a given day, the story that appears the most determines the counter for this variable.

5.2 News flow regressions

To smooth over possible difficulties in timing with stories being released in Europe and the U.S. and the possibility that action might take effect with some lag, I construct a 5-day sum of both variables,

$$D_{1,t} = \sum_{j=1}^{5} \#M_{t+1-j},\ D_{2,t} = \sum_{j=1}^{5} \#M_{t+1-j} \tag{17}$$

I then regress the jump risk at time t on the lagged valued of the two moving sums,

$$ZJ_t^2 = b_0 + b_1 D_{i,t-1},\ i = 1, 2. \tag{18}$$

I look across all days, days with non-zero jump risk, $I(J_t^2 > 0)$, and days in which jump risk is statistically significant, $I(ZJ_t^2 > 0)$. Regressions results for all 5 credit quality tranches are in Table 6.

[Insert Table 6 Here]

In the full sample, news explains between 0% and 10% of the jump risk. The A and AA tranches have insignificant coefficients on the D_2 news variable in these cases. The model, with either D_1 or D_2 fits the AAA, BBB, and BBB- jump risk better. The news dummies are significant at the 1% level for all but the D_2 variable in the BBB-.

On days with positive jump risk, the model fit improves substantially. News explains between 4% and 53% of the variation. Again the A tranche is the most difficult to fit, with 4% explained by the D_2 variable and 10% by D_1. The best fit is with the BBB, where the D_2 explains 53% of the jump risk variation. News is significant at the 1% level in all 10 regressions.

If we confine our focus to days on which the jump risk is statistically significant, we begin to zero in on the days in which certain trances make their most extreme moves. There are only 15 days, for example where the jump risk in the BBB- tranche is statistically significant. In that small sample, news count explains 44% of the jump risk variation. In the AAA tranche, there are many more significant jumps, 96 in the 313 day sample. The model still fits quite well though, with D_1 capturing 32% of the daily variation, and D_2 40%. The model is almost as successful in the BBB tranche. Apart from the A and AA tranches, news is again statistically significant at the 1% level in the other six cases.

We now turn to the index that in some respects is the underlying for the ABX, the value of single family residences.

6. Data: CME

In the late 1980s, economists Karl Case and Robert Shiller (1989) began to study housing in a modern portfolio theory context. Both were concerned that the dramatic declines in the stock market that took place in 1987 might also extend to real estate. They noted that unlike the stock market, there was no low transaction cost method to short real estate prices. This was surprising given the size of the sector ($23.2 trillion in the third quarter 2007 Federal Reserve flow of funds accounts), and apparent frequency of boom and bust cycles in real estate.

Case, Shiller and Allan Weiss (1993) proposed the creation of futures and options markets in real estate to "allow diversification and hedging." The first step in creating such a market though was the production of real estate indices for the U.S. and important geographical markets. Case, Shiller and Weiss founded a firm in 1991 to produce the indices which was sold to the publicly traded information provider Fiserv in 2002. Standard and Poor's began "co-branding" the indices in March 2006.

The key method to the Case-Shiller indices (CSI) is the use of repeat sale methodology. The index computes a three-month moving average of the repeat sales of single family houses in 20 metropolitan areas. The use of repeat sales is preferable to using a hedonic index to compensate for changes in quality, but obviously does not avoid it due to home improvements (or lack thereof). The method produces a cap-weighted index for residential real estate in a particular region. A national composite in then produced from the regional indices using census weights..

In May 2006, the Chicago Mercantile exchange began trading futures on the CSI indices for 10 metropolitan areas: Boston; Chicago; Denver; Las Vegas; Los Angeles; Miami; New York; San Diego; San Francisco; and Washington, D.C. There are also options on the futures.

The contracts trade at $250 per index point and are cash settled. For example on January 25, 2008, the February 26, 2008 expiry of the composite index closed at 203. The November 2010 expiry was trading at 178.80. If the February 2008 contract were to fall to the November 2010 level, an investor who was long the contract would lose $\$250 \times (178.80 - 203.00) = -\$6,050.00$. The contracts trade in ticks of 0.20.

We have the full history of the indices from inception and will analyze the sample that coincides with the ABX index.

7. Jump Risk Modeling of Housing Futures

In the first section, I extract the jump risk component from the returns on the CME futures using the Barndorff-Nielsen and Shephard approach. I then try to explain movements in the jump risk using our news timelines.

7.1 Jump risk estimates

I report estimates of J_t^2 for the near month, f^1, and one-year ahead, f^{12}, housing futures composite index in Figure 7.

[Insert Figure 7 Here]

Jump risk is positive much more often for the CME futures. For the near-month contract, the jump risk is positive on 303 of 313 trading days in the sample, and for the year ahead contract, it is positive on 289. There are again substantial increases in jump risk in 2006. Beginning in late November 2006, the jump risk for both contracts rises from essentially zero and continues to rise through the end of the year. f^1 reaches 0.0400 on the last trading day of 2006 and f^{12} peaks at 0.0705.

The risk remains high through the end of February. Neither contract substantially exceeds their December 2006 risk level until September 2007. At that point, both contracts make new highs. f^1 spikes above 0.06 in September and above 0.07 in October. f^{12} reaches 0.07 in September and 0.10 in October. Judging from the record high jump risk achieved near the end of the sample, there may still be substantial volatility ahead for the real estate sector.

I also assess the statistical significance of these jumps by looking at ZJ_t^2 using a significance level of 1% in (16). On average, this level estimates about 69 jump risks to be significant in the 315 day sample. This graph is very noisy due to low volume trading days, and I omit it here.

7.2 The impact of news

I repeat the exercise with the news regressions for the two futures contracts. Results are reported in Table 7.

[Insert Table 7 Here]

The news about subprime mortgages does not, as we had anticipated, explain as much of the variation in the housing futures jump risk. Between 0% and 21% of the variation is explained by news compared to the cases for the ABX in which the $\overline{R}^2$ exceeds 0.50.

Since nearly every day has some positive jump risk, I consider first the case where $J^2 > 0$. The housing futures respond more closely to the news intensity variable $D_{2,t-1}$, but still only 4% for the near month and 5% for the one year.

On the 70 or so days where we have statistically significant returns at the 1% level, I can successfully explain only the jumps in f^1 from the news timeline. My best model is $D_{2,t-1}$with f^1 where 21% of the jump risk variation is captured by widely covered news stories.

My next exercise is to see how the jump risks in the ABX and the CME housing futures move together.

8. Cojumps

8.1 Theory

Bollerslev, Law and Tauchen (BLT, 2007) have proposed a measure of the cross correlation of markets to look at jumps occurring simultaneously in more than one market, called *cojumps*. They develop the cross-product statistic

$$cp_{t,j} = \frac{1}{2n(n-1)} \sum_{i=1}^{n-1} \sum_{l=i+1}^{n} r_{i,t,j}. \tag{19}$$

We then sum the daily measures of (19),

$$cp_t = \sum_{j=1}^{M} cp_{t,j} \tag{20}$$

There is, as of this writing, no formal asymptotic theory for cojumps, so we follow BLT and use the studentized statistic,

$$z_{cp,t,j} = \frac{cp_{t,j} - \overline{cp}_t}{s_{cp,t}} \tag{21}$$

where

$$\overline{cp}_t = \frac{1}{M} \sum_{j=1}^{M} cp_{t,j}, \tag{22}$$

and

$$s_{cp,t} = \left[\frac{1}{M-1} \sum_{j=1}^{M} (cp_{t,j} - \overline{cp}_t)^2 \right]^{1/2}. \tag{23}$$

I implement the test on our housing derivatives in the next section.

8.2 Estimates

I compute the cojump statistic for our two markets. I set market 1 to be the ABX index for the BBB- tranche and set market 2 to be the 12 month futures. I graph the cojump risk in Figure 8.

[Insert Figure 8 Here]

There are two significant episodes of positive co-movement. On February 27, 2007, the day that jump risk spikes in the BBB- ABX tranche, the cojump risk rises strongly as well. Both the housing futures and the ABX are falling strongly during this period contributing to a positive cojump risk.

There are some positive moves in the ABX index in late July and early August. These are matched by small, but negative movements in the futures. Cojump risk is negative in this period.

A handful of larger negative moves in housing prices coincide with the further deterioration of the ABX in September and October. This creates the second segment of positive cojump risk in last 6 weeks of the sample.

9. An Empirical Model of Jump Risk

I have two sets of evidence that a common set of factors are driving the jump risk in these two markets. I begin with some empirical modeling of the their interactions to provide the building blocks for a future structural model.

Jump risk, like a lot of other volatility measures, is clearly persistent. It is clear from Figures 3 and 4 that jump risk is autoregressive, so we will include lagged jump risk $J^2_{1,t-1}$ in our empirical model. On the other hand, extreme events are quite rare and seem to stand out in the figures. This is seen especially clearly in the figures with only the large, statistically significant jumps in Figure 5 and 6. To model these large jumps, I include a lagged squared value of the ABX jump risk, $J^4_{1,t-2}$.

The jump risk from the housing market should be feeding information to the mortgage securities in the ABX index. We include the lagged jump risk from the housing futures in our specification as well.

Finally, there may be risks to the ABX index from rapid changes in home prices in the near future. We include the slope of the housing futures yield curve as our last explanatory variable.

I summarize the model with

$$J^2_{1,t} = b_0 + b_1 J^2_{1,t-1} + b_2 J^4_{1,t-1} + b_3 J^2_{2,t-1} + b_4 (f^{12}_t - f^1_{t-1}), \tag{24}$$

and estimate it for the 5 ABX credit tranches in Table 8.

[Insert Table 8 Here]

The model fits the data quite well, explaining 16% and 64% of the jump risk. Goodness of fit may be of relatively limited value though. The single A tranche, for example, fits well because there is very little variation overall.

Lagged jump risk b_1 is statistically significant and in each specification. This is simply confirming the persistence in our jump risk volatility measure. The extreme jumps appear to be climatic for the market and lower the jump risk the next day, $b_2 < 0$. It is also significant for all 5 tranches.

Jump risk from the housing futures appears to matter only for the lowest rated tranche. It lowers the risk in the ABX market though, $b_3 < 0$, with a magnitude similar to the size of the squared jumps, -0.4694 versus -0.2942.

The slope of the housing futures yield curve matters for jump. A steeply sloping yield curve like we had in the early part of the sample raises the jump risk, $b_4 > 0$. A possibly hopeful sign is that the recent inversion of the yield curve may be lowering jump risk. This is certainly true in the BBB and BBB- tranches which have not had statistically significant jump risks since the summer of 2007.

10. Conclusion

This is the first paper to show a linkage between discontinuous movements in two housing derivatives markets, the ABX.HE index and the CME housing futures. My estimates of realized volatility and jump risk can be directly translated into value-at-risk estimates for firms with exposure in either of these markets. Cojump risk reveals that the interaction between these markets can vary substantially, making the hedge value of exposure to both more complex.

An empirical model of jump risks indicates that some of the changes in risk profile can be anticipated. These results should help regulators diagnose potential problems before they reach crisis levels.

The literature awaits a formal asymptotic theory for multivariate jump risks. In the mean time, bootstrap estimators will probably be useful for most purposes. A structural framework that incorporates the term structure of housing futures prices and the impact of interest rates on housing affordability is the most important step on the modeling side. In the interim, empirical models of high frequency risks remain a useful way for economists and policy makers to clarify the messages in derivatives prices.

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Table 1
Asset Backed Securities Outstanding ($bn)

	Automobile Loans	Credit Card Receivables	Home Equity Loans	Student Loans	Other	Total
1996	71.4	180.7	51.6	10.1	90.6	404.4
1997	77.0	214.5	90.2	18.3	135.8	535.8
1998	86.9	236.7	124.2	25.0	258.7	731.5
1999	114.1	257.9	141.9	36.4	350.5	900.8
2000	133.1	306.3	151.5	41.1	439.8	1,071.8
2001	187.9	361.9	185.1	60.2	486.1	1,281.2
2002	221.7	397.9	286.5	74.4	562.7	1,543.2
2003	234.5	401.9	346.0	99.2	612.1	1,693.7
2004	232.1	390.7	454.0	115.2	635.8	1,827.8
2005	219.7	356.7	551.1	153.2	674.5	1,955.2
2006	202.4	339.9	581.2	183.6	823.3	2,130.4
2007	199.1	342.7	596.0	236.0	1,103.5	2,477.3

Notes: The data were compiled by SIFMA, the Securities Industry and Financial Markets Association. The 2007 figures are for the end of the third quarter.

Table 2
Issuers and Entities in the ABX Index

	Issuer	**Entities**
1	ACE Securities Corp. (DeutscheBank)	2005-HE7
2	Ameriquest Mortgage Securities	2005-R11
3	Argent Securities Inc.	2005-W2
4	Bear Stearns Asset Backed Securities, Inc.	2005-HE11
5	Countrywide Asset-backed Certificates	2005-BC5
6	First Franklin MTG Loan Asset Backed	2005-FF12
7	GSAMP Trust (GoldmanSachs)	2005-HE4
8	Home Equity Asset Trust (CSFB)	2005-8
9	JP Morgan Mortgage Acquisition Corp.	2005-OPT1
10	Long Beach Mortgage Loan Trust	2005-WL2
11	MASTR Asset Backed Securities Trust (UBS)	2005-NC2
12	Merrill Lynch Mortgage Investors Trust	2005-AR1
13	Morgan Stanley ABS Capital	2005-HE5
14	New Century Home Equity Loan Trust	2005-4
15	Residential Asset Mortgage Product Series (RFC/GMAC)	2005-EFC4
16	Residential Asset Securities Corp. (RFC/GMAC)	2005-KS11
17	Securitized Asset Backed Receivables (Barclays)	2005-HE1
18	Soundview Home Equity Loan Trust (Greenwich)	2005-4
19	Structured Asset Investment Loan Trust (Lehman)	2005-HE3
20	Structured Asset Securities Corp. (Lehman)	2005-WF4

Notes: The data are from MarkIt and the securities represent the constituents of the ABX.HE 06-1 index. Ownership of the securities was confirmed from the 8-K filings of the registrants.

Table 3
Weighted Average Deal Characteristics

ABX	60+	FICO	LTV	ARM	IO	Full Doc
2006-01	11.94	634	80.36	81.75	32.13	58.71
2006-02	11.94	627	77.76	80.78	22.52	56.90
2007-01	5.48	626	79.21	76.84	15.64	57.57

Notes: The data were compiled by Nomura Fixed Income Research in April 18, 2007. All numbers are percentages based on a weighted average of deals in the ABX indices. 60+ Delq. is the percentage of mortgage holders who are 60 days or more delinquent. FICO is their credit score, CLTV is the loan to value ratio, ARM is the percentage of floating rate mortgages, IO is interest only mortgages, Full Doc refers to the whether full income documentation was provided by the borrower.

Table 4
Coupon Rates on ABX Indices

Index	AAA	AA	A	BBB	BBB-
ABX.HE-061	18	32	54	154	267
ABX.HE-062	11	17	44	133	242
ABX.HE-071	9	15	64	224	389

Notes: The figures are in basis points. For example, A buyer of an ABX AAA security from the first half of 2006, HE-061, will pay protection of 18 basis points per annum, or $1,800 per year on $1 million dollars of bonds.

Table 5(a)
Subprime News Flow: Dec. 2006-August 2007

Date	News	BBC	JEC	PIMCO
20061228	OwnIt Mortgage Solutions files for bankruptcy		X	
20070207	Senate has hearings on subprime lending		X	
20070212	ResMae Mortgage files for bankruptcy		X	
20070220	Nova Star has surprise loss		X	
20070222	HSBC fires head of US mortgage business after $10.5bn loss	X		
20070302	Fed announces draft regulations for subprime		X	
20070308	DR Horton warns of huge losses	X		
20070308	New Century stops making loans		X	X
20070312	New Century shares halted	X		
20070316	Accredited Home Lenders sells $2.7bn in loans	X		
20070320	People's Choice files for bankruptcy		X	
20070327	Bernanke "likely to be contained"		X	X
20070402	New Century files for bankruptcy	X	X	X
20070406	American Home Mortgage writes down risky mortgages		X	
20070418	Freddie announces plans to refinance $20bn in subprime		X	
20070424	Sales of existing homes fall 8.4%, sharpest in 18 years		X	X
20070503	GMAC loses heavily in subprime	X		
20070503	UBS closes subprime lending arm	X		
20070509	Fed does not change rates		X	
20070517	Fed does not see broader economic impact		X	
20070612	Foreclosure filings surge 90% year over year.		X	X
20070614	Frank says Fed could lose mortgage regulatory authority	X		
20070614	News emerges about large liquidations at Bear			X
20070614	Goldman reports flat profit		X	
20070622	Bear Stearns announces $3.2bn bail out of two hedge funds	X	X	X
20070629	Bear fires head of asset management	X		
20070710	S&P and Moody's negative ratings $12bn in subprime		X	X
20070713	GE decides to sell WMC subprime business	X		
20070718	Bear says investors will get little in any money back	X	X	X
20070719	Fed comments shake global shares	X	X	
20070720	Bernanke warns subprime crisis could cost up to $100bn	X		
20070724	Rising default hit profits at CFC	X		
20070726	Bear Stearns seizes assets. Shares fall 4.2%, largest in five year.	X		
20070727	Worries about subprime hammer global stock markets	X		
20070730	Germany's IKB bailed out		X	
20070731	Bear Stearns stops withdrawls from third fund	X	X	
20070731	Home prices show 18th consecutive decline in growth rate		X	
20070803	Shares fall heavily on fears of credit crunch	X		
20070806	American Home Mortgage files for bankruptcy	X	X	
20070807	Fed leaves rates at %5.25		X	

BBC is the British Broadcasting Company, JEC is the Joint Economic Committee of U.S. House of Representatives, and PIMCO is from the Pacific Investment Management Co.

Table 5(b)
Subprime News Flow: Aug.-November 2007

Date	News	BBC	JEC	PIMCO
20070809	Coordinated intervention by ECB, Fed and Bank of Japan	X	X	
20070809	AIG warns defaults spreading beyond subprime			X
20070809	BNP Paribas suspends 3 funds	X	X	
20070810	ECB provides extra 61bn in Euros. Fed pledges overnight money	X		
20070810	Global markets pressure. Worst day on FTSE in 4 years	X		
20070813	ECB pumps 47.7bn in Euros into money markets	X		
20070813	Goldman provides $3bn support for hedge fund	X		
20070813	Aegis Mortgage files for bankruptcy		X	
20070816	CFC draws entire 11.5bn credit line	X	X	X
20070817	Fed cuts discount rate by 50 basis points	X	X	X
20070820	CFC cuts jobs	X		
20070823	CFC get $2bn cash infusion from BAC	X		
20070828	German Sachsen Landesbank sold under threat of collapse	X		
20070831	Bernanke at Jackson Hole says US will act as needed		X	
20070903	German IKB records $1bn loss	X		
20070904	Bank of China reveals $9bn in subprime losses	X		
20070904	Overnight bank lending dries up	X		
20070906	ECB injects fresh cash into market	X		
20070911	Trichet says EU economy sound	X		
20070914	Northern Rock shares plummet after BofE rescue plan announced.	X		
20070914	Merrill signals mortgages will hurt 3Q earnings		X	
20070917	NovaStar eliminates its REIT			
20070917	Merill Lynch job cuts at First Franklin		X	
20070918	Fed cuts interest rates to 4.75%	X		X
20070918	Impac Mortgages closes			
20070920	Bernanke says subprime losses higher than expected	X		
20070920	Goldman makes profits betting MBS will fall	X		
20070921	HSBC closes Decision One		X	
20071001	UBS reveals $3.4bn loss	X	X	
20071001	Greenspan says housing crisis far from over			
20071005	Merrill reveals $5.6bn subprime loss	X		
20071010	Bush administration Hope Now		X	
20071015	Citi writes down additional $5.9bn	X		X
20071016	Bernake: subprime crisis and housing slump will be drag	X	X	
20071018	S&P cuts grades on 23.3bn of loans		X	
20071024	Merrill Lynch announces $7.9bn writedown		X	X
20071030	Merrill O'Neal resigns	X		
20071031	Deutsche Bank reveals $3bn writedown	X		
20071031	Fed delivers second rate cut	X	X	X
20071101	CFSB writes down $1bn	X		

BBC is the British Broadcasting Company, JEC is the Joint Economic Committee of U.S. House of Representatives, and PIMCO is from the Pacific Investment Management Co.

Table 6
ABX Index News Regressions

	All		$J^2 > 0$		$ZJ_t > 0$		
Tranche	$D_{1,t-1}$	$D_{2,t-1}$	$D_{1,t-1}$	$D_{2,t-1}$	$D_{1,t-1}$	$D_{2,t-1}$	**Stat.**
AAA	0.0004	0.0003	0.0009	0.0008	0.0016	0.0023	Coeff
	(4.98)	(3.46)	(8.22)	(6.95)	(9.26)	(11.03)	(t-ratio)
	0.07	0.03	0.21	0.16	0.32	0.40	$\overline{R}^2$
	313		255		96		N
AA	0.0018	0.0008	0.0043	0.0047	0.0006	-0.00048	Coeff
	(2.82)	(1.27)	(4.08)	(3.40)	(0.35)	(-0.33)	(t-ratio)
	0.02	0.00	0.07	0.05	-0.01	-0.01	$\overline{R}^2$
	313		216		76		N
A	0.0024	0.0003	0.0239	0.0202	0.0016	0.0004	Coeff
	(1.26)	(0.16)	(4.23)	(2.90)	(1.14)	(0.41)	(t-ratio)
	0.00	0.00	0.10	0.04	0.00	-0.01	$\overline{R}^2$
	313		158		73		N
BBB	0.0095	0.0098	0.0307	0.0369	0.0492	0.038934	Coeff
	(5.52)	(6.05)	(9.33)	(12.37)	(2.95)	(2.48)	(t-ratio)
	0.09	0.10	0.39	0.53	0.24	0.18	$\overline{R}^2$
	313		135		23		N
BBB-	0.0090	0.0051	0.0415	0.0363	0.2667	0.1751	Coeff
	(3.28)	(1.93)	(8.72)	(6.83)	(3.48)	(2.34)	(t-ratio)
	0.03	0.01	0.29	0.20	0.44	0.24	$\overline{R}^2$
	313		182		15		N

These are estimates the effect of news on ABX index jump risk using the specification (18) in the text. $D_{1,t}$ is a 5-day moving sum of the number of news stories in the BBC, JEC, and PIMCO timelines in Table 5. $D_{2,t}$ is the number of news timelines that carried a particular story on that day. We estimate the model over the full sample, on days when jump risk is non-zero, and when jump risk is statistically significant. N indicates the number of days in each estimation.

Table 7
CME Housing Futures News Regressions

	All		$J^2 > 0$		$ZJ_t > 0$		
Contract	$D_{1,t-1}$	$D_{2,t-1}$	$D_{1,t-1}$	$D_{2,t-1}$	$D_{1,t-1}$	$D_{2,t-1}$	**Stat.**
f^1	0.0032	0.0026	0.0028	0.0023	0.0049	0.0056	Coeff.
	(4.79)	(4.16)	(4.27)	(3.72)	(3.26)	(4.37)	(t-ratio)
	0.07	0.05	0.05	0.04	0.12	0.21	$\overline{R}^2$
	313		303		70		N
f^{12}	0.0029	0.0043	0.0017	0.0034	-0.0013	0.0014	Coeff.
	(3.11)	(5.06)	(1.76)	(3.90)	(0.64)	(0.87)	(t-ratio)
	0.03	0.07	0.01	0.05	-0.01	0.00	$\overline{R}^2$
	313		289		69		N

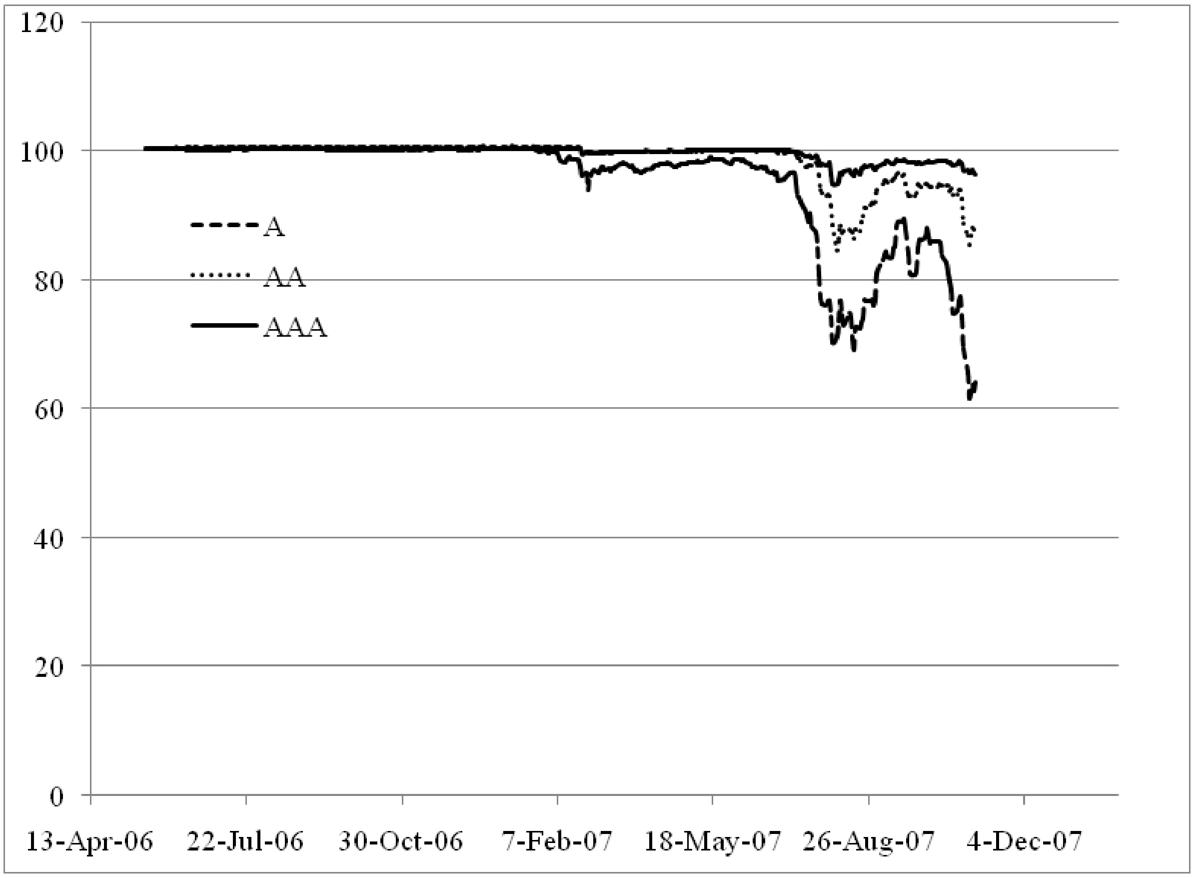
These are estimates the effect of news on housing futures jump risk using the specification (18) in the text. $D_{1,t}$ is a 5-day moving sum of the number of news stories in the BBC, JEC, and PIMCO timelines in Table 5. $D_{2,t}$ is the number of news timelines that carried a particular story on that day. We estimate the model over the full sample, on days when jump risk is non-zero, and when jump risk is statistically significant. N indicates the number of days in each estimation.

Table 8
Empirical Model of ABX Jump Risk

Tranche	Constant	$J^2_{1,t-1}$	$J^4_{1,t-1}$	$J^2_{2,t-1}$	$(f^{12}_{t-1} - f^1_{t-1})$	$\overline{R}^2$
AAA	0.0011	0.7127	-20.2800	-0.0036	0.0001	0.16
	(2.29)	(6.69)	-(5.70)	-(0.74)	(1.34)	
AA	-0.0018	1.4735	-4.4247	0.0133	-0.0002	0.50
	-(0.79)	(15.40)	-(10.38)	(0.49)	-(0.76)	
A	-0.0039	1.3560	-1.0939	0.0172	-0.0004	0.64
	-(0.69)	(14.58)	-(6.74)	(0.46)	-(0.65)	
BBB	0.0326	0.5000	-0.9598	0.0038	0.0025	0.09
	(3.26)	(3.86)	-(3.15)	(0.04)	(2.67)	
BBB-	0.0520	0.7332	-0.4694	-0.2942	0.0033	0.37
	(3.49)	(7.17)	-(3.02)	-(2.08)	(2.60)	

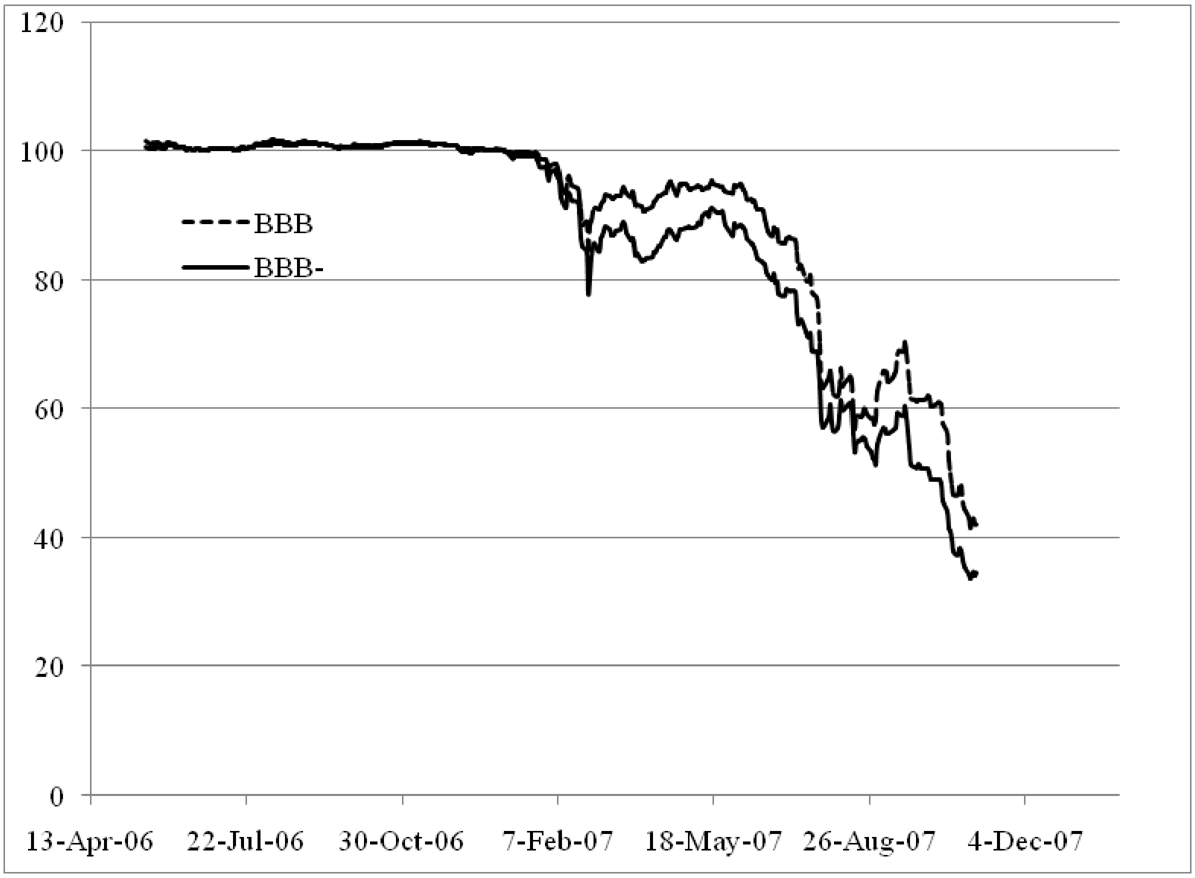
The table contains estimates of the empirical ABX jump risk model (24). $J^2_{1,t-1}$ is the lagged ABX jump risk, $J^2_{1,t-1}$ is the lagged jump risk from the CME housing futures, and $(f^{12}_{t-1} - f^1_{t-1})$ is the slope of the housing futures yield curve out one year. t-ratios are in parentheses. The sample period is August 2006 to November 2007.

Figure 1
Prices on A Rated Tranches of ABX Indices 2006-1
May 2006-November 2007



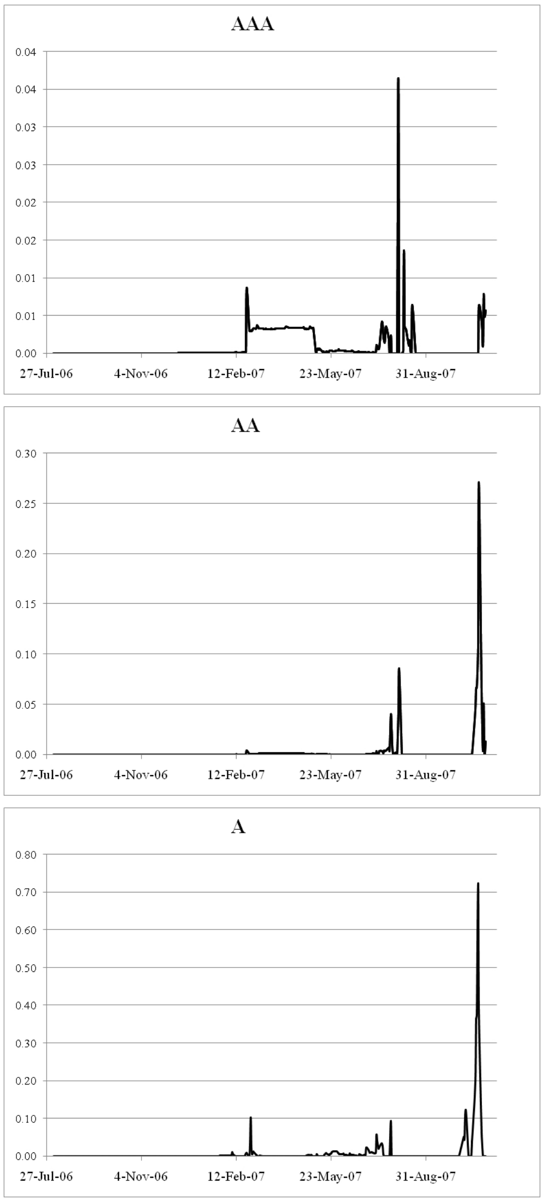
The data are daily closing prices on the ABX.HE indices for the first half roll of 2006.

Figure 2
Prices on B Rated Tranches of ABX Indices 2006-1
May 2006-November 2007



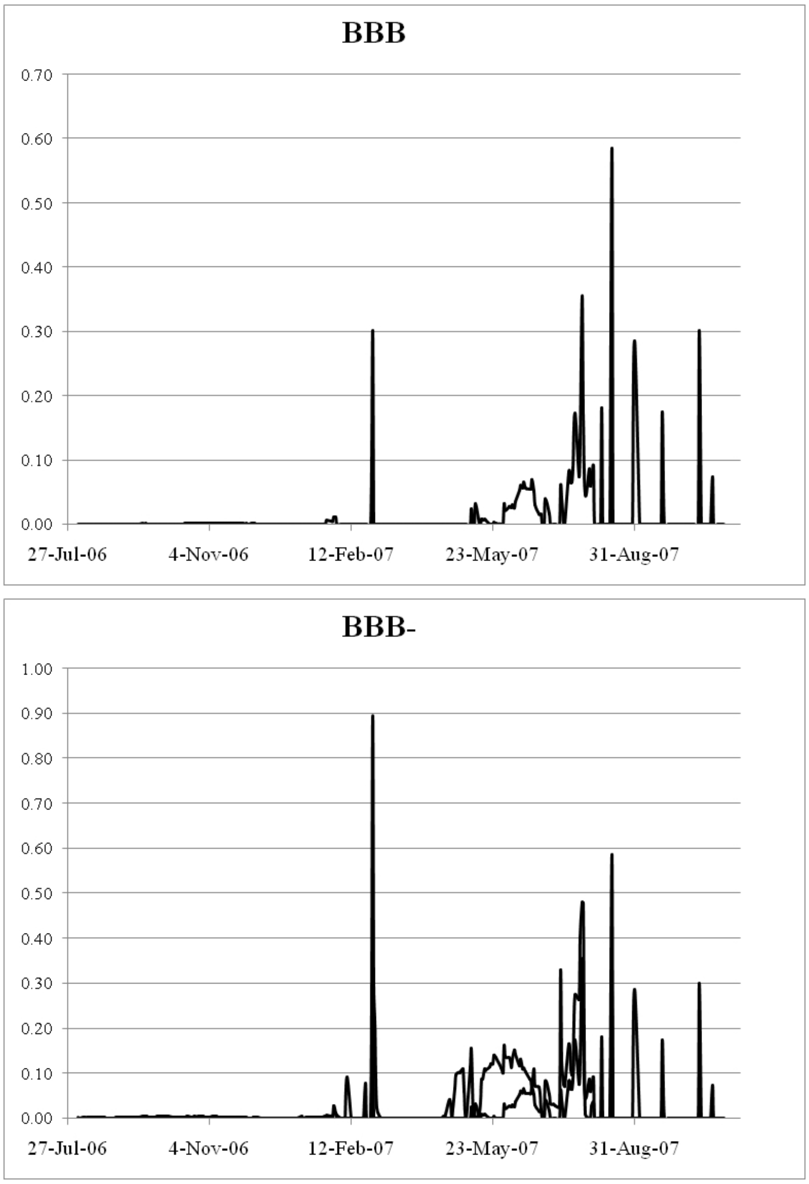
The data are daily closing prices on the ABX.HE indices for the first half roll of 2006.

Figure 3
Jump Risk Of A Rated Tranches of ABX Indices 2006-1
August 2006-November 2007



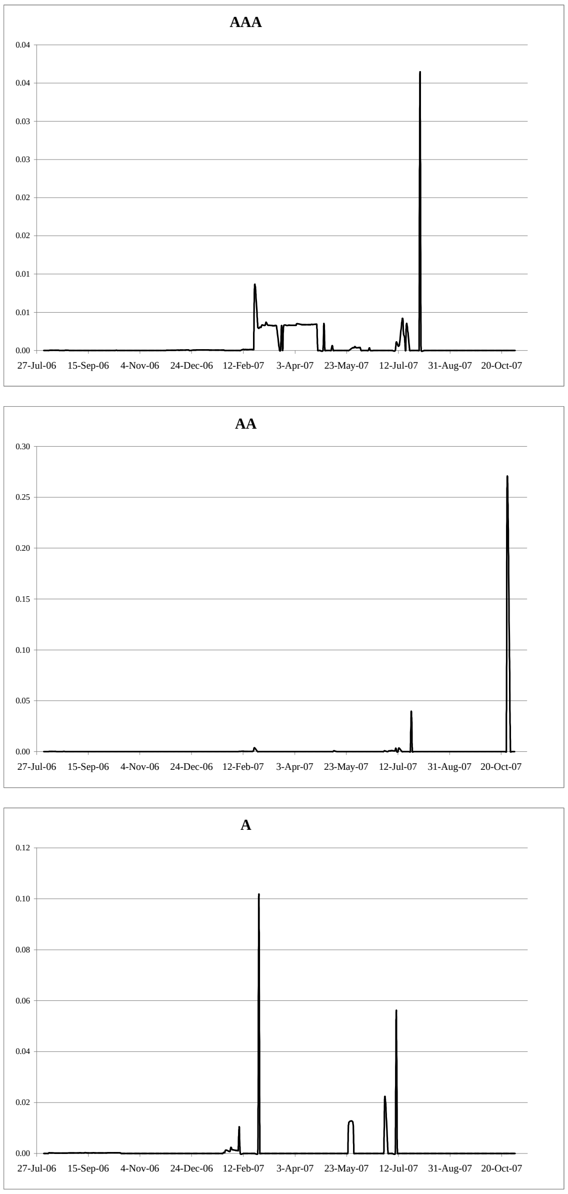
The data are estimates of jump risk using (15) of the ABX.HE indices for the first half roll of 2006.

Figure 4
Jump Risk Of BBB Rated Tranches of ABX Indices 2006-1
August 2006-November 2007



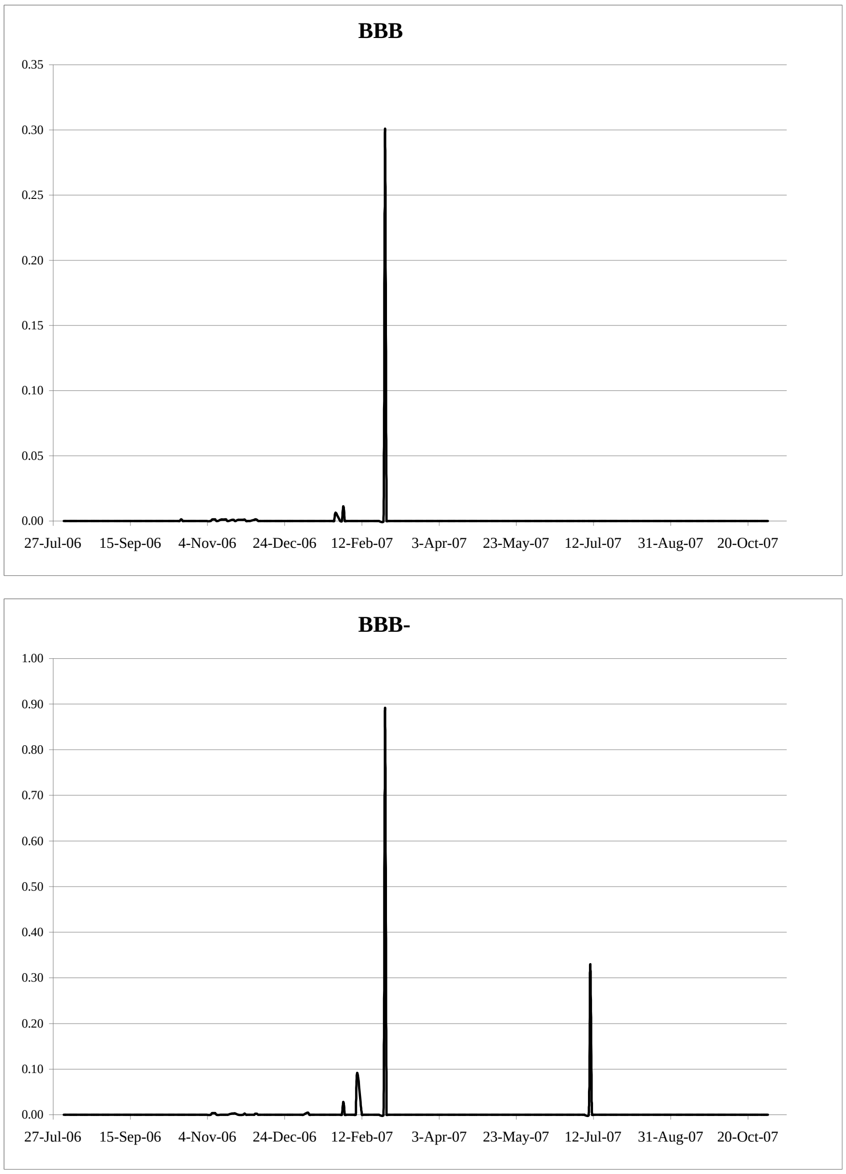
The data are estimates of jump risk using (15) of the ABX.HE indices for the first half roll of 2006.

Figure 5
Statistically Significant Jump Risk Of A Rated Tranches of ABX Indices 2006-1
August 2006-November 2007



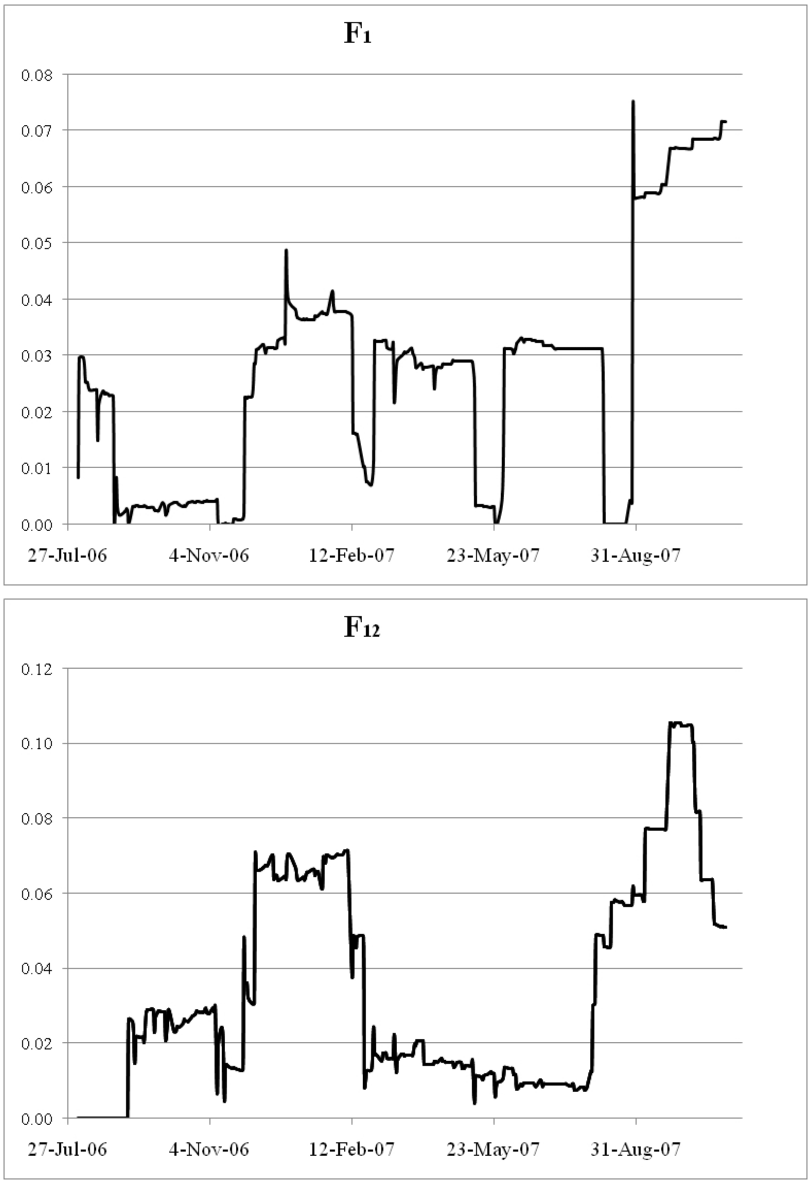
The data are statistically significant estimates of jump risk (15) for the ABX.HE indices from the first half roll of 2006 using the 1% significance level in (16).

Figure 6
Jump Risk Of BBB Rated Tranches of ABX Indices 2006-1
August 2006-November 2007



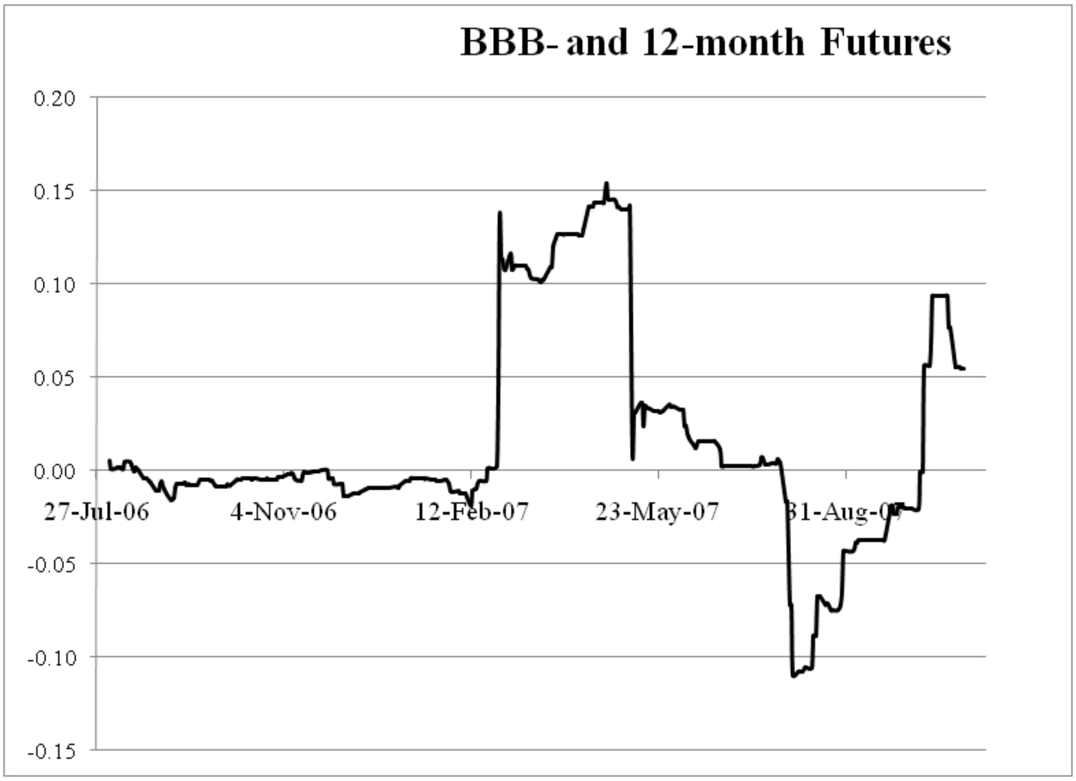
The data are statistically significant estimates of jump risk (15) for the ABX.HE indices from the first half roll of 2006 using the 1% significance level in (16).

Figure 7
Jump Risk Of CME Composite CSI Housing Futures
August 2006-November 2007



The data are estimates of jump risk (15) for the CME CSI composite housing futures for the near month f_1 and one year f_{12} expirations,

Figure 8
Cojump Risk Of ABX Housing Futures
August 2006-November 2007



The data are estimates of cojump risk (19) for the ABX BBB- tranche from the first half of 2006 and the 12-month ahead CME CSI composite housing futures.