Jump and Cojump Risk in Subprime Home Equity Derivatives

Bruce Mizrach
Rutgers University
Bank of Canada
September 2008
Outline

1. Housing Market Fundamentals
Outline

1. Housing Market Fundamentals
2. Overview of Markets and Instruments
Outline

1. Housing Market Fundamentals
2. Overview of Markets and Instruments
3. The ABX Indices
Outline

1. Housing Market Fundamentals
2. Overview of Markets and Instruments
3. The ABX Indices
4. Jump Processes
1. Housing Market Fundamentals
2. Overview of Markets and Instruments
3. The ABX Indices
4. Jump Processes
5. Finite Sample Properties: Daily Returns of Intradaily Data
Outline

1. Housing Market Fundamentals
2. Overview of Markets and Instruments
3. The ABX Indices
4. Jump Processes
5. Finite Sample Properties: Daily Returns of Intradaily Data
6. ABX Jump Risk Estimates
Outline

1. Housing Market Fundamentals
2. Overview of Markets and Instruments
3. The ABX Indices
4. Jump Processes
5. Finite Sample Properties: Daily Returns of Intradaily Data
6. ABX Jump Risk Estimates
7. Linking Jump Risk to the Headlines
Outline

1. Housing Market Fundamentals
2. Overview of Markets and Instruments
3. The ABX Indices
4. Jump Processes
5. Finite Sample Properties: Daily Returns of Intradaily Data
6. ABX Jump Risk Estimates
7. Linking Jump Risk to the Headlines
8. Housing Futures
Outline

1. Housing Market Fundamentals
2. Overview of Markets and Instruments
3. The ABX Indices
4. Jump Processes
5. Finite Sample Properties: Daily Returns of Intradaily Data
6. ABX Jump Risk Estimates
7. Linking Jump Risk to the Headlines
8. Housing Futures
9. Cojumps and a Predictive Model
10. Will the Crisis Spread?
Outline

1. Housing Market Fundamentals
2. Overview of Markets and Instruments
3. The ABX Indices
4. Jump Processes
5. Finite Sample Properties: Daily Returns of Intradaily Data
6. ABX Jump Risk Estimates
7. Linking Jump Risk to the Headlines
8. Housing Futures
9. Cojumps and a Predictive Model
10. Will the Crisis Spread?
Outline

1. Housing Market Fundamentals
2. Overview of Markets and Instruments
3. The ABX Indices
4. Jump Processes
5. Finite Sample Properties: Daily Returns of Intradaily Data
6. ABX Jump Risk Estimates
7. Linking Jump Risk to the Headlines
8. Housing Futures
9. Cojumps and a Predictive Model
10. Will the Crisis Spread?
Housing Market Fundamentals
Home ownership

Figure 1. Homeownership Rate

(percent)
The Case-Shiller indices (CSI) use a 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.
Case-Shiller house price indices (2000=100)
Regional variation in price changes

Figure 5: Change in House Price Index by County
(4th quarter 2006 to 4th quarter 2007)

Percent Change in House Price Index
- Greater than 5% increase
- 4% to 5% increase
- 3% to 4% increase
- 1% to 2% increase
- Any decrease

Source: House Price Index from the Office of Federal Housing Enterprise Oversight
Mortgage Bankers Association National Delinquency Survey 2008Q2: More than 9% of mortgage loans are either delinquent or somewhere in the foreclosure process. California and Florida alone accounted for 39% of all of the foreclosures started nationally during the second quarter.
Delinquencies and foreclosures

Mortgage Bankers Association National Delinquency Survey 2008Q2:
More than 9% of mortgage loans are either delinquent or somewhere in the foreclosure process. California and Florida alone accounted for 39% of all of the foreclosures started nationally during the second quarter.

The delinquency rate was 6.41% of all loans outstanding, according to the survey. The rate was 6.35% in the first quarter, and 5.12% a year ago.
Delinquencies and foreclosures

Mortgage Bankers Association National Delinquency Survey 2008Q2:
More than 9% of mortgage loans are either delinquent or somewhere in the foreclosure process. California and Florida alone accounted for 39% of all of the foreclosures started nationally during the second quarter.

The delinquency rate was 6.41% of all loans outstanding, according to the survey. The rate was 6.35% in the first quarter, and 5.12% a year ago.

The percentage of loans that went into foreclosure in the second quarter was 1.08%, up from 1.01% in the first quarter and 0.59% a year ago. Meanwhile, 2.75% of loans in the survey were somewhere in the foreclosure process, up from 2.47% last quarter and 1.4% in the second quarter of 2007.
Foreclosures concentrated in subprime

<table>
<thead>
<tr>
<th>MBA 2007Q3</th>
<th>Loans</th>
<th>% of Foreclosures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prime Fixed</td>
<td>65%</td>
<td>18%</td>
</tr>
<tr>
<td>Prime ARM</td>
<td>15%</td>
<td>20%</td>
</tr>
<tr>
<td>Subprime Fixed</td>
<td>6%</td>
<td>12%</td>
</tr>
<tr>
<td>Subprime ARM</td>
<td>7%</td>
<td>42%</td>
</tr>
<tr>
<td>FHA</td>
<td>7%</td>
<td>8%</td>
</tr>
</tbody>
</table>
Overview of Markets and Instruments
Holdings of mortgage debt

Holdings of Mortgage Debt Outstanding by Type of Institution

- Commercial banking
- Savings institutions
- Credit unions
- Life insurance companies
- Private pension funds
- Government-sponsored enterprises
- Agency- and government-sponsored enterprises-backed mortgage pools
- Asset-backed securities issuers
- Finance companies
Mortgage originations

Figure 3. All Mortgage Originations

(billion U.S. dollars)

Source: Inside Mortgage Finance.

Source: Kiff and Mills (2007).
Subprime borrowers who 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. Schloemer, Li, Ernst, and Keist (2006) estimate that the subprime share of mortgage originations reached 23% in 2006, up from only 10% in 1998.
Subprime borrowers who 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. Schloemer, Li, Ernst, and Keist (2006) estimate that the subprime share of mortgage originations reached 23% in 2006, up from only 10% in 1998.

Alt A mortgages are loans where the borrower possesses a strong credit history, but is in need of non-traditional underwriting and processing guidelines. Examples of such non-traditional guidelines are the Trustcorp Mortgage: NINA – No Income No Assets.
**Subprime, Alt. A, Jumbo**

Subprime borrowers who 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. Schloemer, Li, Ernst, and Keist (2006) estimate that the subprime share of mortgage originations reached 23% in 2006, up from only 10% in 1998.

Alt A mortgages are loans where the borrower possesses a strong credit history, but is in need of non-traditional underwriting and processing guidelines. Examples of such non-traditional guidelines are the Trustcorp Mortgage: NINA – No Income No Assets.

A jumbo loan exceeds the borrowing limits of Federal Housing Administration (FHA) conforming mortgages. Until recently, the limit was $417,000, but it was raised in March 2008 to $729,750.
This paper does not study the residential mortgage backed securities market (RMBS), but rather a set of home equity loans (HEL) which the market considers to be asset backed securities (ABS).
This paper does not study the residential mortgage backed securities market (RMBS), but rather a set of home equity loans (HEL) which the market considers to be asset backed securities (ABS).

Ashcraft and Schuermann (2008): “First-lien subprime mortgage loans as well as second-lien home equity loans and home equity lines of credit (HELCOs) are all part of the HEL ABS sector.”
This paper does not study the residential mortgage backed securities market (RMBS), but rather a set of home equity loans (HEL) which the market considers to be asset backed securities (ABS).

Ashcraft and Schuermann (2008): “First-lien subprime mortgage loans as well as second-lien home equity loans and home equity lines of credit (HELCOs) are all part of the HEL ABS sector.”

Other non-conventional mortgages, including Alt-A and Jumbo loans, are classified as RMBS.
Change in home equity loans outstanding

Source: SIFMA

Mizrahi (Rutgers)  Subprime Risk  Bank of Canada
For more than a decade, HEL have been made available to subprime borrowers.
For more than a decade, HEL have been made available to subprime borrowers.

According to Fitch, the subprime market originated as much as USD1.4 trillion of loans in 2005-2007.
For more than a decade, HEL have been made available to subprime borrowers.

According to Fitch, the subprime market originated as much as USD1.4 trillion of loans in 2005-2007.

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.”
Credit default swaps

Credit default swaps are derivative 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 a *special purpose vehicle* (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.
Credit default swaps on ABS reference individual tranches from a special purpose vehicle (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.

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.
The ABX Indices
The ABX indices are aggregators of the performance of a variety of credit default swaps on asset backed securities.
Construction of ABX

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.
Construction of ABX

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.
MarkIt criteria

1. Deals from the largest 25 issuers (by sub-prime home equity issuance)
2. Issued within the last six months
3. Offering size of at least $500M;
4. At least 90% 1st lien mortgages;
5. Weighted average FICO credit score < 660;
6. Deals must pay on the 25th of the month;
7. Referenced tranches must bear interest at a floating rate benchmark of one-month LIBOR;
8. A 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 for inclusion.
### Issuers and entities in the ABX 1/2

<table>
<thead>
<tr>
<th>Issuer</th>
<th>Entities</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACE Securities Corp. (DeutscheBank)</td>
<td>2005-HE7</td>
</tr>
<tr>
<td>Ameriquest Mortgage Securities</td>
<td>2005-R11</td>
</tr>
<tr>
<td>Argent Securities Inc.</td>
<td>2005-W2</td>
</tr>
<tr>
<td>Bear Stearns Asset Backed Securities, Inc.</td>
<td>2005-HE11</td>
</tr>
<tr>
<td>Countrywide Asset-backed Certificates</td>
<td>2005-BC5</td>
</tr>
<tr>
<td>First Franklin MTG Loan Asset Backed</td>
<td>2005-FF12</td>
</tr>
<tr>
<td>GSAMP Trust (GoldmanSachs)</td>
<td>2005-HE4</td>
</tr>
<tr>
<td>Home Equity Asset Trust (CSFB)</td>
<td>2005-8</td>
</tr>
<tr>
<td>JP Morgan Mortgage Acquisition Corp.</td>
<td>2005-OPT1</td>
</tr>
<tr>
<td>Long Beach Mortgage Loan Trust</td>
<td>2005-WL2</td>
</tr>
</tbody>
</table>
## Issuers and entities in the ABX 2/2

<table>
<thead>
<tr>
<th>Issuer</th>
<th>Entities</th>
</tr>
</thead>
<tbody>
<tr>
<td>11 MASTR Asset Backed Securities Trust (UBS)</td>
<td>2005-NC2</td>
</tr>
<tr>
<td>12 Merrill Lynch Mortgage Investors Trust</td>
<td>2005-AR1</td>
</tr>
<tr>
<td>13 Morgan Stanley ABS Capital</td>
<td>2005-HE5</td>
</tr>
<tr>
<td>14 New Century Home Equity Loan Trust</td>
<td>2005-4</td>
</tr>
<tr>
<td>15 Residential Asset Mortgage Prdct Ser. (RFC/GMAC)</td>
<td>2005-EFC4</td>
</tr>
<tr>
<td>16 Residential Asset Securities Corp. (RFC/GMAC)</td>
<td>2005-KS11</td>
</tr>
<tr>
<td>17 Securitized Asset Backed Receivables (Barclays)</td>
<td>2005-HE1</td>
</tr>
<tr>
<td>18 Soundview Home Equity Loan Trust (Greenwich)</td>
<td>2005-4</td>
</tr>
<tr>
<td>19 Structured Asset Investment Loan Trust (Lehman)</td>
<td>2005-HE3</td>
</tr>
<tr>
<td>20 Structured Asset Securities Corp. (Lehman)</td>
<td>2005-WF4</td>
</tr>
</tbody>
</table>
Nearly every major investment bank is represented including Barclays, Goldman Sachs, JP Morgan, Merrill Lynch, Morgan Stanley and UBS.
Observations about the issuers

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.
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.
ABX rolls and tranches

54 securities met the MarkIt criteria.

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.
ABX rolls and tranches

54 securities met the MarkIt criteria.

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.
ABX rolls and tranches

54 securities met the MarkIt criteria.

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.
54 securities met the MarkIt criteria.

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.
### Deal characteristics

<table>
<thead>
<tr>
<th>Year</th>
<th>ABX</th>
<th>60+</th>
<th>FICO</th>
<th>LTV</th>
<th>ARM</th>
<th>IO</th>
<th>Full Doc</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006-01</td>
<td>11.94</td>
<td>634</td>
<td>80.36</td>
<td>81.75</td>
<td>32.13</td>
<td>58.71</td>
<td></td>
</tr>
<tr>
<td>2006-02</td>
<td>11.94</td>
<td>627</td>
<td>77.76</td>
<td>80.78</td>
<td>22.52</td>
<td>56.90</td>
<td></td>
</tr>
<tr>
<td>2007-01</td>
<td>5.48</td>
<td>626</td>
<td>79.21</td>
<td>76.84</td>
<td>15.64</td>
<td>57.57</td>
<td></td>
</tr>
</tbody>
</table>

Source: Nomura Fixed Income Research (April 2007)
## Cash flows: coupons

<table>
<thead>
<tr>
<th>Index</th>
<th>AAA</th>
<th>AA</th>
<th>A</th>
<th>BBB</th>
<th>BBB-</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABX.HE-061</td>
<td>18</td>
<td>32</td>
<td>54</td>
<td>154</td>
<td>267</td>
</tr>
<tr>
<td>ABX.HE-062</td>
<td>11</td>
<td>17</td>
<td>44</td>
<td>133</td>
<td>242</td>
</tr>
<tr>
<td>ABX.HE-071</td>
<td>9</td>
<td>15</td>
<td>64</td>
<td>224</td>
<td>389</td>
</tr>
</tbody>
</table>

A purchaser of default protection with the security trading at par 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 389 basis points.
A purchaser of default protection with the security trading at par 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 389 basis points.
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.
Cash flows: up front payments

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.

The buyer must not only pay the coupon, but also make payments up front based on the distance from par. With the index at 79.97, a protection buyer would pay

\[
$1\text{mn} \times (100 - 79.97)\% + $1,800 = $202,100.
\]
ABX as benchmark

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 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. 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.
Jump Processes
Consider a stochastic volatility model with jumps,

\[ dp_t = \mu_t \, dt + \sigma_t \, dw_{1,t} + J_t \, dq_t, \]

\[ d\sigma_t^2 = \beta (\theta - \sigma_t^2) \, dt + \gamma \sqrt{\sigma_t^2} \, dw_{2,t}, \]

where \( p_t \) is the log price of the underlying asset, \( \mu_t \) is its drift, \( \sigma_t \) is the local volatility, \( w_{1,t} \) and \( w_{2,t} \) are standard Brownian motions with correlation \( \rho \), \( q_t \) is a Poisson process with intensity \( \lambda_t \), and \( J_t \) is a normally distributed jump process with mean \( \mu_J \) and standard deviation \( \sigma_J \).
The *quadratic variation* for the return process is then

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

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

\[ RV_t = \sum_{j=1}^{M} r_{t,j}^2. \]
The *realized volatility* is

\[ RV_t = \sum_{j=1}^{M} r_{t,j}^2. \]

In the stochastic volatility model, \( J = 0 \), researchers have employed realized volatility as an estimator of the integrated volatility, \( \int_{t-1}^{t} \sigma^2(s) \, ds \).
The *realized volatility* is
\[ RV_t = \sum_{j=1}^{M} r_{t,j}^2. \]

In the 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,
\[
\lim_{M \to \infty} RV_t = [r, r]_t
\]
Bipower variation

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

\[ BV_t = \mu_1^{-2} \sum_{j=1}^{M} |r_{t,j}| |r_{t,j-1}| \]

where \( \mu_1 = \sqrt{2/\pi} \).
To extract the integrated volatility, Barndorff-Nielsen and Shephard have also introduced the \textit{realized bi-power variation},

\[ BV_t = \mu_1^{-2} \sum_{j=1}^{M} |r_{t,j}| \left| r_{t,j-1} \right| \]

where \( \mu_1 = \sqrt{2/\pi} \).

It is then possible to show

\[ \lim_{M \to \infty} BV_t = \int_{t-1}^{t} \sigma^2(s) ds. \]
By comparing realized volatility and bipower variation we have the estimate of just the jump portion of the process,

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

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

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

$$TP_t = 2^{2/3} \frac{\Gamma(7/6)}{\Gamma(1/2)} \left( \frac{M}{M - 2} \right) \sum_{j=3}^{M} |r_{t,j}|^{4/3} |r_{t,j-1}|^{4/3} |r_{t,j-2}|^{4/3}.$$
Relying on the analysis of Huang and Tauchen (2005), I utilize their relative jump measure

$$RJ_t = \frac{RV_t - BV_t}{RV_t},$$
Significant jumps

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

\[ RJ_t = \frac{RV_t - BV_t}{RV_t}, \]

I assess statistical significance using

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

which has a standard normal distribution as \( M \rightarrow \infty \) if \( J(t) = 0 \). Monte Carlo evidence in Huang and Tauchen shows that this statistic has good size and power properties in high frequency data.
Daily Return Analysis
I set the sampling interval to be daily changes, $M = 1$, and compute $n$-day rolling sample estimates of realized volatility,

$$RV_t = \sum_{k=0}^{n-1} r_{t-k}^2$$

and bipower variation,

$$BV_t = (\pi / 2) \sum_{k=0}^{n-1} |r_{t-k}| \cdot |r_{t-k-1}|.$$
I adapt the tripower quarticity for daily changes,

\[ TP_t = \left[ 2^{2/3} \frac{\Gamma(7/6)}{\Gamma(1/2)} \right]^{-3} \frac{n}{n-2} \sum_{k=0}^{n-1} |r_{t-k}|^{4/3} |r_{t-k-1}|^{4/3} |r_{t-k-2}|^{4/3} , \]

and construct the statistic

\[ z_t = \frac{RJ_t}{\left[ ((\pi/2)^2 + \pi - 5) \frac{1}{n} \max(1, \frac{TP_t}{BV_t^2}) \right]}. \]
I constrain the jump risk to be positive,

\[ J_t^2 = \frac{\max[RV_t - BV_t, 0]}{n}, \]

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

\[ J_{z,t}^2 = J_t^2 I(z_t > \Phi^{-1}_\alpha), \]

where \( \Phi \) is the cumulative normal distribution.
I constrain the jump risk to be positive,

\[ J_t^2 = \left( \max [RV_t - BV_t, 0] \right) / n, \]

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

\[ J_{z,t}^2 = J_t^2 I(z_t > \Phi_{\alpha}^{-1}), \]

where \( \Phi \) is the cumulative normal distribution.

Empiricists typically find “too many” jumps in intradaily data which they compensate for by adjusting \( \alpha \).
Monte Carlo: DGP

- Drift: $\mu(t) = 0$
- Volatility mean reversion: $\beta = 0.10$
- Volatility of volatility $\gamma = 0.05$.
- Jump frequency $\lambda \, dt = 0.05 \, dt$.
- Average jump size $\mu_J = 0.20$ with a standard deviation of $\sigma_J = 1.40$.
- The return and volatility shocks have a correlation of $\rho = -0.5$. 
Implications for relative jumps

Tauchen and Zhou (2007) note that as you raise the long run mean of volatility $\theta$, you lower the jump contribution to the total variance. At $\theta = 0.9$, the jump contributes only 10%, but at $\theta = 0.025$, the jump contribution rises to 76%. I also consider an intermediate case with $\theta = 0.2$ where the jump contributes 33%.
Tauchen and Zhou (2007) note that as you raise the long run mean of volatility $\theta$, you lower the jump contribution to the total variance. At $\theta = 0.9$, the jump contributes only 10%, but at $\theta = 0.025$, the jump contribution rises to 76%. I also consider an intermediate case with $\theta = 0.2$ where the jump contributes 33%.

I use 400 days of simulated 1-minute data which are sampled at 5-minute and daily intervals. For the daily estimator, I set the moving average to $n = 50$. The tick frequency and sample length approximate those of the ABX sample.
<table>
<thead>
<tr>
<th>θ</th>
<th>RJ</th>
<th>5%</th>
<th>1%</th>
<th>5%</th>
<th>1%</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.9</td>
<td>0.00</td>
<td>0.292</td>
<td>0.058</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.51)</td>
<td>(0.23)</td>
<td>(0.00)</td>
<td>(0.00)</td>
</tr>
<tr>
<td>0.2</td>
<td>0.00</td>
<td>0.870</td>
<td>0.200</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.97)</td>
<td>(0.43)</td>
<td>(0.00)</td>
<td>(0.00)</td>
</tr>
<tr>
<td>0.025</td>
<td>0.00</td>
<td>0.328</td>
<td>0.052</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.57)</td>
<td>(0.23)</td>
<td>(0.00)</td>
<td>(0.00)</td>
</tr>
</tbody>
</table>
### Power 5-min

<table>
<thead>
<tr>
<th>$\theta$</th>
<th>$E[J^2]$</th>
<th>$E[RJ]$</th>
<th>$J^2$</th>
<th>$RJ$</th>
<th>5%</th>
<th>1%</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.9</td>
<td>0.1</td>
<td>0.10</td>
<td>0.086</td>
<td>0.087</td>
<td>64.311%</td>
<td>53.414%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.03)</td>
<td>(0.03)</td>
<td>(13.61)%</td>
<td>(12.34)%</td>
</tr>
<tr>
<td>0.2</td>
<td>0.1</td>
<td>0.33</td>
<td>0.085</td>
<td>0.284</td>
<td>75.814%</td>
<td>69.932%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.04)</td>
<td>(0.08)</td>
<td>(11.27)%</td>
<td>(10.12)%</td>
</tr>
<tr>
<td>0.025</td>
<td>0.1</td>
<td>0.76</td>
<td>0.092</td>
<td>0.746</td>
<td>84.427%</td>
<td>82.400%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.04)</td>
<td>(0.08)</td>
<td>(9.10)%</td>
<td>(8.97)%</td>
</tr>
</tbody>
</table>
## Daily

<table>
<thead>
<tr>
<th>$\theta$</th>
<th>$E[J^2]$</th>
<th>$E[RJ]$</th>
<th>$J^2$</th>
<th>$RJ$</th>
<th>5%</th>
<th>1%</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.9</td>
<td>0.1</td>
<td>0.10</td>
<td>0.054</td>
<td>0.053</td>
<td>7.285%</td>
<td>2.726%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.03)</td>
<td>(0.03)</td>
<td>(10.13)%</td>
<td>(6.13)%</td>
</tr>
<tr>
<td>0.2</td>
<td>0.1</td>
<td>0.33</td>
<td>0.053</td>
<td>0.169</td>
<td>36.817%</td>
<td>25.420%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.03)</td>
<td>(0.08)</td>
<td>(19.47)%</td>
<td>(18.21)%</td>
</tr>
<tr>
<td>0.025</td>
<td>0.1</td>
<td>0.76</td>
<td>0.078</td>
<td>0.598</td>
<td>84.662%</td>
<td>79.917%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.04)</td>
<td>(0.10)</td>
<td>(12.16)%</td>
<td>(14.37)%</td>
</tr>
</tbody>
</table>

When the jump contributes only 10%, the power is quite weak.
ABX Daily Jump Risk Estimates

ABX Daily Jump Risk Estimates
ABX prices 2006-1 B tranches

![Graph of ABX prices 2006-1 B tranches showing a decline in BBB and BBB- ratings from April 2006 to December 2007.]
### Jump risk parameter estimates 2006-1

<table>
<thead>
<tr>
<th>Rating</th>
<th>Avg.</th>
<th>Max.</th>
<th>$\mu_j^*$</th>
<th>$N^*$</th>
<th>$\lambda^*$</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAA</td>
<td>0.2381</td>
<td>0.8117</td>
<td>-0.0000</td>
<td>91</td>
<td>0.2880</td>
</tr>
<tr>
<td>AA</td>
<td>0.0991</td>
<td>0.5561</td>
<td>-0.0018</td>
<td>38</td>
<td>0.1203</td>
</tr>
<tr>
<td>A</td>
<td>0.0910</td>
<td>0.6725</td>
<td>-0.0001</td>
<td>59</td>
<td>0.1867</td>
</tr>
<tr>
<td>BBB</td>
<td>0.0487</td>
<td>0.3823</td>
<td>-0.0001</td>
<td>11</td>
<td>0.0348</td>
</tr>
<tr>
<td>BBB-</td>
<td>0.0852</td>
<td>0.4303</td>
<td>-0.0012</td>
<td>26</td>
<td>0.0823</td>
</tr>
</tbody>
</table>
Jump risk 2006-1 AAA

AAA

27-Jul-06 15-Sep-06 4-Nov-06 24-Dec-06 12-Feb-07 3-Apr-07 23-May-07 12-Jul-07 31-Aug-07 20-Oct-07

0.0005
0.0000
-0.0005
-0.0010
-0.0015
-0.0020
-0.0025
-0.0030

Mizrach (Rutgers) Subprime Risk Bank of Canada 52 / 96
Jump risk 2006-1 AA

AA

27-Jul-06 15-Sep-06 4-Nov-06 24-Dec-06 12-Feb-07 3-Apr-07 23-May-07 12-Jul-07 31-Aug-07 20-Oct-07

Mizrach (Rutgers) Subprime Risk Bank of Canada 53 / 96
Jump risk 2006-1 BBB-

BBB-
Linking Jump Risk to the Headlines

Linking Jump Risk to the Headlines
Edward Gramlich in testimony before the House Committee on Banking and Financial Services on May 24, 2000: “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.”
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.
I utilize three time lines that have been published since the subprime crisis hit. (1) BBC; (2) JEC; (3) PIMCO;
I utilize three time lines that have been published since the subprime crisis hit. (1) BBC; (2) JEC; (3) 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. The stories caught by these filters are listed in Table 6.
Measuring news flow

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.
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 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.
## Triple XXX news flow

<table>
<thead>
<tr>
<th>Date</th>
<th>News</th>
<th>BBC</th>
<th>JEC</th>
<th>PIMCO</th>
</tr>
</thead>
<tbody>
<tr>
<td>20070402</td>
<td>New Century files for bankruptcy</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>20070622</td>
<td>Bear Stearns $3.2bn hedge fund bail out</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>20070718</td>
<td>Bear: investors will get little money back</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>20070816</td>
<td>CFC draws entire 11.5bn credit line</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>20070817</td>
<td>Fed cuts discount rate by 50 basis points</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>20071031</td>
<td>Fed delivers second rate cut</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>
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,

\[ D_{1,t} = \sum_{j=1}^{5} \# M_{t+1-j}, \quad D_{2,t} = \sum_{j=1}^{5} \# M_{t+1-j} \]

I then regress the statistically significant jumps at time \( t \) on the lagged values of the two moving sums, \( J_t, z = b_0 + b_1 D_{1,t}, i = 1, 2 \). Regressions results for all 5 credit quality tranches for the 2006-1 roll are in Table 9.
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,

\[ D_{1,t} = \sum_{j=1}^{5} \#M_{t+1-j}, \quad D_{2,t} = \sum_{j=1}^{5} \#M_{t+1-j} \]

I then regress the statistically significant jumps at time t on the lagged values of the two moving sums,

\[ J_{t,z}^* = b_0 + b_1 D_{i,t-1}, \quad i = 1, 2. \]

Regressions results for all 5 credit quality tranches for the 2006-1 roll are in Table 9.
News explains jump risk

News explains the jumps best in the AAA and BBB- tranches. The best fit is with the $D_2$ variable for the AAA, where news explains 56% of the jump risk. For the BBB-, the same variable explains nearly 53%.
News explains jump risk

News explains the jumps best in the AAA and BBB- tranches. The best fit is with the $D_2$ variable for the AAA, where news explains 56% of the jump risk. For the BBB-, the same variable explains nearly 53%.

In the middle tranches, the fits are respectable to poor. For the A and AA, news explains between 9% and 23% of the jumps. The BBB tranche, which has only 11 jumps, is uncorrelated with the news flow.
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.
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.
I report estimates of the jump contribution to total variation and the number of statistically significant jumps in Table 10. Jumps are, on average small, but they contribute 40.7% of the total return variation in the 1-month futures and 46.2% in the 12-month. Both series jump over 200 times, with the probability of a jump occurring around $\frac{2}{3}$.

<table>
<thead>
<tr>
<th>Contract</th>
<th>Avg. $RJ$</th>
<th>Max $RJ$</th>
<th>$\mu_j^*$</th>
<th>$N^*$</th>
<th>$\lambda^*$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$f^1$</td>
<td>0.4071</td>
<td>1.0000</td>
<td>0.0013</td>
<td>212</td>
<td>0.6709</td>
</tr>
<tr>
<td>$f^{12}$</td>
<td>0.4617</td>
<td>1.0000</td>
<td>0.0012</td>
<td>221</td>
<td>0.6994</td>
</tr>
</tbody>
</table>
I report estimates of the jump contribution to total variation and the number of statistically significant jumps in Table 10. Jumps are, on average small, but they contribute 40.7% of the total return variation in the 1-month futures and 46.2% in the 12-month. Both series jump over 200 times, with the probability of a jump occurring around $2/3$. 

<table>
<thead>
<tr>
<th>Contract</th>
<th>Avg. $f^1$</th>
<th>Max $f^1$</th>
<th>$\mu_j^*$</th>
<th>$N^*$</th>
<th>$\lambda^*$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$f^1$</td>
<td>0.4071</td>
<td>1.0000</td>
<td>0.0013</td>
<td>212</td>
<td>0.6709</td>
</tr>
<tr>
<td>$f^{12}$</td>
<td>0.4617</td>
<td>1.0000</td>
<td>0.0012</td>
<td>221</td>
<td>0.6994</td>
</tr>
</tbody>
</table>
Jump risk in near-month contract

\[ f_1 \]

-0.0030 -0.0020 -0.0010 0.0000 0.0010 0.0020 0.0030 0.0040

27-Jul-06 15-Sep-06 4-Nov-06 24-Dec-06 12-Feb-07 3-Apr-07 23-May-07 12-Jul-07 31-Aug-07 20-Oct-07

Mizrach (Rutgers)

Subprime Risk

Bank of Canada
Jump risk in 12-month expiry
Smaller impact of news

<table>
<thead>
<tr>
<th>Contract</th>
<th>$D_{1,t-1}$</th>
<th>$D_{2,t-1}$</th>
<th>Stat.</th>
</tr>
</thead>
<tbody>
<tr>
<td>$f^1$</td>
<td>1.5669</td>
<td>1.3200</td>
<td>Coeff</td>
</tr>
<tr>
<td></td>
<td>(-2.57)</td>
<td>(-2.07)</td>
<td>(t-stat)</td>
</tr>
<tr>
<td></td>
<td>0.0259</td>
<td>0.0153</td>
<td>$R^2$</td>
</tr>
<tr>
<td>$f^{12}$</td>
<td>0.2271</td>
<td>-0.1547</td>
<td>Coeff</td>
</tr>
<tr>
<td></td>
<td>(-0.36)</td>
<td>(-0.27)</td>
<td>(t-stat)</td>
</tr>
<tr>
<td></td>
<td>-0.0040</td>
<td>-0.0042</td>
<td>$R^2$</td>
</tr>
</tbody>
</table>
Cojumps
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*. I restrict the analysis here to the contemporaneous daily correlation,

\[ cp_t = \sum_{k=0}^{n-1} r_{1,t-k} r_{2,t-k}, \]

where \( r_{1,t} \) and \( r_{2,t} \) are the returns in markets 1 and 2.
There is, as of this writing, no formal asymptotic theory for cojumps, so I follow BLT and use the studentized statistic,

$$z_{cp,t} = \frac{cp_t - \overline{cp}}{s_{cp}},$$

where

$$\overline{cp} = \frac{1}{T} \sum_{t=1}^{T} cp_t,$$

and

$$s_{cp} = \left[ \frac{1}{T-1} \sum_{t=1}^{T} (cp_t - \overline{cp})^2 \right]^{1/2}.$$

I will designate the significant cojumps as

$$cp_{t,z}^* = \text{sign}(r_{1,t} r_{2,t}) \times cp_t 1(|z_t| > \Phi_\alpha^{-1}).$$

I use the absolute value because the cojump test is two-sided. I explore the finite sample performance in the next section.
Cojump power simulation

<table>
<thead>
<tr>
<th>$\rho_J$</th>
<th>$\theta = 0.1$</th>
<th></th>
<th>$\theta = 0.5$</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5%</td>
<td>1%</td>
<td>5%</td>
<td>1%</td>
</tr>
<tr>
<td>0.50</td>
<td>92.532%</td>
<td>90.442%</td>
<td>90.103%</td>
<td>88.502%</td>
</tr>
<tr>
<td></td>
<td>(19.68)%</td>
<td>(23.25)%</td>
<td>(22.73)%</td>
<td>(25.13)%</td>
</tr>
<tr>
<td>0.75</td>
<td>88.810%</td>
<td>87.088%</td>
<td>87.710%</td>
<td>86.118%</td>
</tr>
<tr>
<td></td>
<td>(17.99)%</td>
<td>(19.54)%</td>
<td>(20.15)%</td>
<td>(21.24)%</td>
</tr>
</tbody>
</table>

At $\rho_J = 0.5$. The test is quite powerful and seems unaffected by the jump contribution to the variance. We reject between 90 and 92.5% at the 5% significance level. As we increase the number of cojumps by setting $\rho_J = 0.75$, the detection rate falls off just a little, to 87.7% at the 5% level for the case $\theta = 0.5$.
Cojump estimates AAA

AAA and $f_{12}$
Cojump estimates BBB-

BBB- and $f_{12}$

Mizrach (Rutgers)  Subprime Risk

Bank of Canada 76 / 96
### Cojump news regressions

<table>
<thead>
<tr>
<th>Tranche</th>
<th>$D_{1,t-1}$</th>
<th>$D_{2,t-1}$</th>
<th>Stat.</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAA</td>
<td>-4.0632</td>
<td>-3.1544</td>
<td>Coeff</td>
</tr>
<tr>
<td></td>
<td>-(4.42)</td>
<td>-(3.99)</td>
<td>(t-stat)</td>
</tr>
<tr>
<td></td>
<td>0.4263</td>
<td>0.3736</td>
<td>$R^2$</td>
</tr>
<tr>
<td>BBB-</td>
<td>-0.4364</td>
<td>-0.3558</td>
<td>Coeff</td>
</tr>
<tr>
<td></td>
<td>-(1.55)</td>
<td>-(2.33)</td>
<td>(t-stat)</td>
</tr>
<tr>
<td></td>
<td>0.0549</td>
<td>0.1553</td>
<td>$R^2$</td>
</tr>
</tbody>
</table>
Discussion of cojump risk

There are 25 significant cojumps in the AAA tranche/12-month futures pair. All of these episodes occur in the summer of 2007 once the subprime crisis was well under way. There is a significant negative period in August 2007 followed by a shorter positive episode in mid-to-late October.

I identify 27 significant cojumps in the BBB- pairing. There is a strong positive spike on February 27, 2007 which is the day that jump risk spikes in the BBB- ABX tranche. There are some positive moves in the ABX index in late May and early June 2007. Cojump risk is negative again in the first part of August. The BBB- remains insignificant for the rest of the sample after August 13.

News does appear to explain much of the cojumps risk for the AAA tranche. Both news dummies are highly significant and the $R^2$ reaches 0.43. The story is less clear with the BBB- where only the $D_2$ dummy is significant and news explains, at most, 15% of the risk.
Discussion of cojump risk

There are 25 significant cojumps in the AAA tranche/12-month futures pair. All of these episodes occur in the summer of 2007 once the subprime crisis was well under way. There is a significant negative period in August 2007 followed by a shorter positive episode in mid-to-late October.

I identify 27 significant cojumps in the BBB- pairing. There is a strong positive spike on February 27, 2007 which is the day that jump risk spikes in the BBB- ABX tranche. There are some positive moves in the ABX index in late May and early June 2007. Cojump risk is negative again in the first part of August. The BBB- remains insignificant for the rest of the sample after August 13.
Discussion of cojump risk

There are 25 significant cojumps in the AAA tranche/12-month futures pair. All of these episodes occur in the summer of 2007 once the subprime crisis was well under way. There is a significant negative period in August 2007 followed by a shorter positive episode in mid-to-late October.

I identify 27 significant cojumps in the BBB- pairing. There is a strong positive spike on February 27, 2007 which is the day that jump risk spikes in the BBB- ABX tranche. There are some positive moves in the ABX index in late May and early June 2007. Cojump risk is negative again in the first part of August. The BBB- remains insignificant for the rest of the sample after August 13.

News does appear to explain much of the cojumps risk for the AAA tranche. Both news dummies are highly significant and the $R^2$ reaches 0.43. The story is less clear with the BBB- where only the $D_2$ dummy is significant and news explains, at most, 15% of the risk.
To capture jump risk persistence, I will include lagged jumps $J_{1,t-1,z}^*$ in the empirical model. Extreme events are modeled using lagged squared values of the ABX jumps, $J_{1,t-1,z}^{2*}$. 

$J_{1,t-1,z} = b_0 + b_1 J_{1,t-1,z}^* + b_2 J_{1,t-1,z}^{2*} + b_3 J_{2,t-1,z}^* + b_4 (f_{1,t-1} f_{1,t-1})$, 

Mizrach (Rutgers) Subprime Risk Bank of Canada 79 / 96
To capture jump risk persistence, I will include lagged jumps $J_{1,t-1,z}^*$ in the empirical model. Extreme events are modeled using lagged squared values of the ABX jumps, $J_{1,t-1,z}^{2*}$.

The cojump risk from the housing market $J_{2,t-1,z}^*$ is in our specification as well.
Predictive model of jump risk

To capture jump risk persistence, I will include lagged jumps $J_{1,t-1,z}^*$ in the empirical model. Extreme events are modeled using lagged squared values of the ABX jumps, $J_{1,t-1,z}^{2*}$.

The cojump risk from the housing market $J_{2,t-1,z}^*$ is in our specification as well.

Finally, there may be risks to the ABX index from changes in home prices in the near future. I include the slope of the housing futures curve $(f_{t-1}^{12} - f_{t-1}^1)$ as the final explanatory variable.

\[
J_{1,t,z}^* = b_0 + b_1 J_{1,t-1,z}^* + b_2 J_{1,t-1,z}^{2*} + b_3 J_{2,t-1,z}^* + b_4 (f_{t-1}^{12} - f_{t-1}^1),
\]
## Empirical model estimates

<table>
<thead>
<tr>
<th>Tranche</th>
<th>Constant</th>
<th>$J_{1,z,t-1}^*$</th>
<th>$J_{2,z,t-1}^*$</th>
<th>$J_{*,z,t-1}$</th>
<th>$(f_{t-1}^{12} - f_{t-1}^1)$</th>
<th>$\overline{R}^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAA</td>
<td>-0.2446</td>
<td>0.1112</td>
<td>-441.6708</td>
<td>0.0508</td>
<td>-0.0199</td>
<td>0.0756</td>
</tr>
<tr>
<td></td>
<td>-(2.41)</td>
<td>(0.34)</td>
<td>-(0.54)</td>
<td>(2.13)</td>
<td>-(2.29)</td>
<td></td>
</tr>
<tr>
<td>AA</td>
<td>-0.2476</td>
<td>0.6340</td>
<td>-468.7428</td>
<td>-0.0142</td>
<td>-0.0214</td>
<td>0.8483</td>
</tr>
<tr>
<td></td>
<td>-(1.28)</td>
<td>(1.52)</td>
<td>-(13.40)</td>
<td>-(0.20)</td>
<td>-(1.27)</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>-0.8450</td>
<td>-0.2187</td>
<td>-1,156.9378</td>
<td>0.0363</td>
<td>-0.0670</td>
<td>0.5884</td>
</tr>
<tr>
<td></td>
<td>-(2.99)</td>
<td>-(0.95)</td>
<td>-(4.87)</td>
<td>(0.61)</td>
<td>-(3.14)</td>
<td></td>
</tr>
<tr>
<td>BBB</td>
<td>-1.1830</td>
<td>-0.0927</td>
<td>-1,595.0460</td>
<td>-0.0267</td>
<td>-0.1030</td>
<td>0.3103</td>
</tr>
<tr>
<td></td>
<td>-(0.94)</td>
<td>-(0.16)</td>
<td>-(0.88)</td>
<td>-(0.15)</td>
<td>-(1.20)</td>
<td></td>
</tr>
<tr>
<td>BBB-</td>
<td>-9.9029</td>
<td>-0.1508</td>
<td>57.5454</td>
<td>1.0907</td>
<td>-0.6873</td>
<td>0.8393</td>
</tr>
<tr>
<td></td>
<td>-(9.91)</td>
<td>-(0.56)</td>
<td>(1.21)</td>
<td>(4.27)</td>
<td>-(9.42)</td>
<td></td>
</tr>
</tbody>
</table>

Mizrach (Rutgers)

Subprime Risk

Bank of Canada
The model fits the data quite well, explaining 31% to 85% of the jumps.
The model fits the data quite well, explaining 31% to 85% of the jumps.

$b_1$, the coefficient on lagged jumps, is statistically insignificant in each specification, but the lagged squared jump risk, $b_2$, is significant for the AA and A tranches. The extreme jumps appear to be climatic for the market and lower the jump risk the next day, $b_2 < 0$. 
The model fits the data quite well, explaining 31% to 85% of the jumps.

\[ b_1, \text{ the coefficient on lagged jumps, is statistically insignificant in each specification, but the lagged squared jump risk, } b_2, \text{ is significant for the AA and A tranches. The extreme jumps appear to be climatic for the market and lower the jump risk the next day, } b_2 < 0. \]

Jump risk from the housing futures appears to matter only for the highest and lowest rated tranches, and it tends to increase the jump size, \( b_3 > 0 \).
The slope of the housing futures yield curve matters for jumps in 3 of the 5 tranches. A steeply sloping yield curve like we had in the housing bubble contributes to negative jumps, $b_4 < 0$. 

Consider May 19, 2006, the 1-month composite futures price was at 235.20 and the 12-month ahead price was 255.80. This spread of 20.60 leads to an expected jump of 1.42% in the BBB- tranche. A possibly hopeful sign is that the inversion of the futures curve since June 19, 2006 makes jumps up more likely.
The slope of the housing futures yield curve matters for jumps in 3 of the 5 tranches. A steeply sloping yield curve like we had in the housing bubble contributes to negative jumps, \( b_4 < 0 \).

Consider May 19, 2006, the 1-month composite futures price was at 235.20 and the 12-month ahead price was 255.80. This spread of 20.60 leads to an expected jump of \(-1.42\%\) in the BBB- tranche.
The slope of the housing futures yield curve matters for jumps in 3 of the 5 tranches. A steeply sloping yield curve like we had in the housing bubble contributes to negative jumps, $b_4 < 0$.

Consider May 19, 2006, the 1-month composite futures price was at 235.20 and the 12-month ahead price was 255.80. This spread of 20.60 leads to an expected jump of $-1.42\%$ in the BBB- tranche.

A possibly hopeful sign is that the inversion of the futures curve since June 19, 2006 makes jumps up more likely.
Will the Crisis Spread?
Market losers

The mortgage originators have experienced large declines in shareholder equity, with Countrywide and First Franklin experiencing declines in their stock prices of \(-78.7\%\) and \(-32.2\%\) in 2007. New Century, a California based lender specializing in the subprime market, declared bankruptcy on April 1, 2007.
The mortgage originators have experienced large declines in shareholder equity, with Countrywide and First Franklin experiencing declines in their stock prices of $-78.7\%$ and $-32.2\%$ in 2007. New Century, a California based lender specializing in the subprime market, declared bankruptcy on April 1, 2007.

IndyMac bank, one of the largest thrifts, was seized by the FDIC on July 12, 2008. There have been 11 failures as of September 2008.
Market losers

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

IndyMac bank, one of the largest thrifts, was seized by the FDIC on July 12, 2008. There have been 11 failures as of September 2008.

Major Wall Street firms have, as of June 2008, written down more than $200 billion in assets, with the largest losses at UBS ($37bn), Citigroup ($34.5bn), and Merrill Lynch ($23.8bn).
The mortgage originators have experienced large declines in shareholder equity, with Countrywide and First Franklin experiencing declines in their stock prices of $-78.7\%$ and $-32.2\%$ in 2007. New Century, a California based lender specializing in the subprime market, declared bankruptcy on April 1, 2007.

IndyMac bank, one of the largest thrifts, was seized by the FDIC on July 12, 2008. There have been 11 failures as of September 2008.

Major Wall Street firms have, as of June 2008, written down more than $200$ billion in assets, with the largest losses at UBS ($37bn$), Citigroup ($34.5bn$), and Merrill Lynch ($23.8bn$).

Lehman Brothers may soon follow Bear Stearns? Lehman’s share price has fallen below the Bear takeover price of $10$. 
The *Wall Street Journal* reported in December 14, 2007 that Goldman Sachs’ structured products trading group earned more than $4bn in profits in 2007 from shorting subprime securities using the ABX.
The *Wall Street Journal* reported in December 14, 2007 that Goldman Sachs’ structured products trading group earned more than $4bn in profits in 2007 from shorting subprime securities using the ABX.

John Paulson’s Credit Opportunities hedge fund returned 589.9% in 2007 betting on a decline in subprime mortgages, generating Paulson $3.7bn.
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.”
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.”

According to Inside Mortgage Finance, only $10 billion of subprime loans were issued in the 2008Q1.
The ABX rallies and falters - AAA tranches

- ABX-HE-AAA 06-1
ABX BBB- No Rally
On May 14, 2008, MarkIt introduced the “penultimate ABX,” a new more senior slice of the AAA tranche for the 07-2 roll. It currently trades about 15% above the AAA.
Foreclosures spread beyond subprime

Mortgage Bankers Association Report 2008Q2: “Subprime ARM loans accounted for 36 percent of all foreclosures started and prime ARMs, which include option ARMs, represented 23 percent. However, the increase in prime ARMs foreclosure starts was greater than the combined increase in fixed-rate and ARM subprime loans. Thus the foreclosure start numbers will likely be increasingly dominated increasingly by *prime ARM loans.*”
On September 7, 2008, the federal government took control of the two GSEs.
On September 7, 2008, the federal government took control of the two GSEs.

The plan commits the government to provide as much as $100 billion to each company to backstop any shortfalls in capital.
On September 7, 2008, the federal government took control of the two GSEs.

The plan commits the government to provide as much as $100 billion to each company to backstop any shortfalls in capital.

In July 2008, the Congressional Budget Office gave a rough estimate of $25 billion. Other estimates run as a high as $200 billion (still smaller in real terms than the S&L bailout).
Asset backed securities outstanding
## ABS outstanding

<table>
<thead>
<tr>
<th>Year</th>
<th>Automobile Loans</th>
<th>Credit Card Receivables</th>
<th>Home Equity Loans</th>
<th>Student Loans</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996</td>
<td>71.4</td>
<td>180.7</td>
<td>51.6</td>
<td>10.1</td>
</tr>
<tr>
<td>1997</td>
<td>77.0</td>
<td>214.5</td>
<td>90.2</td>
<td>18.3</td>
</tr>
<tr>
<td>1998</td>
<td>86.9</td>
<td>236.7</td>
<td>124.2</td>
<td>25.0</td>
</tr>
<tr>
<td>1999</td>
<td>114.1</td>
<td>257.9</td>
<td>141.9</td>
<td>36.4</td>
</tr>
<tr>
<td>2000</td>
<td>133.1</td>
<td>306.3</td>
<td>151.5</td>
<td>41.1</td>
</tr>
<tr>
<td>2001</td>
<td>187.9</td>
<td>361.9</td>
<td>185.1</td>
<td>60.2</td>
</tr>
<tr>
<td>2002</td>
<td>221.7</td>
<td>397.9</td>
<td>286.5</td>
<td>74.4</td>
</tr>
<tr>
<td>2003</td>
<td>234.5</td>
<td>401.9</td>
<td>346.0</td>
<td>99.2</td>
</tr>
<tr>
<td>2004</td>
<td>232.1</td>
<td>390.7</td>
<td>454.0</td>
<td>115.2</td>
</tr>
<tr>
<td>2005</td>
<td>219.7</td>
<td>356.7</td>
<td>551.1</td>
<td>153.2</td>
</tr>
<tr>
<td>2006</td>
<td>202.4</td>
<td>339.9</td>
<td>581.2</td>
<td>183.6</td>
</tr>
<tr>
<td>2007</td>
<td>198.5</td>
<td>347.8</td>
<td>585.6</td>
<td>243.9</td>
</tr>
</tbody>
</table>
### ABS Issuance

<table>
<thead>
<tr>
<th></th>
<th>2007</th>
<th>2008</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Home Equity</td>
<td>222</td>
<td>63</td>
<td>-71.7</td>
</tr>
<tr>
<td>Credit Cards</td>
<td>95</td>
<td>90</td>
<td>-4.9</td>
</tr>
<tr>
<td>Auto Loans</td>
<td>67</td>
<td>75</td>
<td>11.3</td>
</tr>
<tr>
<td>Student Loans</td>
<td>61</td>
<td>55</td>
<td>-10.4</td>
</tr>
<tr>
<td>Other</td>
<td>61</td>
<td>42</td>
<td>-31.3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>507</strong></td>
<td><strong>325</strong></td>
<td><strong>-35.9</strong></td>
</tr>
</tbody>
</table>

*Excludes CDOs and Mortgages
Source: Thomson Financial

Fed lending

US Federal Reserve, Uncommitted Treasury Securities

Before TAF (5 – Dec 2007): $775B

Bear Stearns Crisis

Most Recent Data
30 – Apr 2008: $382B

Most Recent, Less Expected Sterilization of $50B TAF Expansion: $332B

Most Recent, Less TAF and Securities Pledged to Expanded Collateral TSLF: $275.5B