The Breakpoint Method

The Breakpoint Grid

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A Comparison of Breakpoint Ratios and Credit Ratings

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In this article we introduce Breakpoint, a concept that AD&Co has developed as a flexible means to assess the credit risk of mortgage bonds. It combines the ideas of dynamic continuous credit rating, stress risk analysis and a probabilistic view at losses.

Terminology

Breakpoint (BP) – a market scenario, out of a sorted set, that forces a non-agency bond to lose its 1st dollar of principal. This term can be generalized to describe a scenario causing a bond to lose exactly 25% of principal, 50% of principal, etc.

Breakpoint Ratio – breakpoint scenario's metric (relative to the base case) such as a collateral loss ratio, CDR (or MDR) scale ratio, generic "scale" of sorted scenarios, etc. This is an estimate of distance-to-default and is the basis for dynamic rating. If the base-case collateral loss is estimated at 10%, and a bond's breakpoint collateral loss is 20%, one says the Breakpoint Ratio for this bond is 2.0.

Breakpoint Grid – a user-defined set of stress scenarios, sorted in order of increasing losses. A bond's breakpoint is usually located between two adjacent grid points (if found), or lies outside the grid (if not found or non-existing).

The Vasicek distribution – a theoretical probability distribution of 1-period default rates in an infinite cohort of identical loans. This is a two-parameter curve that is driven by the default probability of an individual borrower (same for all borrowers) and the correlation between individual assets' values (same for any pair of borrowers).

The Breakpoint Ratio

Credit ratings, meant to provide a certain degree of investor confidence, clearly failed to do so. AAA-rated non-agency securities are not immune to losses anymore. Furthermore, rating agencies often maintain a conservative stance on their initial ratings and may delay downgrading bonds.

Unlike agency ratings, AD&Co's breakpoint ratios change continuously. They reflect the dynamics of interest rates and home prices, as well as monthly updated delinquency composition. A shrinking ratio points to credit deterioration well in advance of an official downgrade. For example, we analyzed a AAA mezzanine bond backed by an Alt-A collateral of option ARMs that was put on negative watch earlier this year. By the time it happened, the Breakpoint Ratio already had fallen to 0.65 and the bond was projected to lose over 20% of its principal on AD&Co's model. Some AAA bonds we have analyzed still maintain their initial rating, but our assessment of the Breakpoint Ratio, in a 0.8 – 1.5 range, indicates that the write-downs are not unlikely to occur in the future.

In our analytical work we consider several possible definitions for the Breakpoint Ratio:

A. The explicit MDR vector scale that breaks the bond.

   This simple and easy-to-understand measure is almost model-free and closely related to the Vasicek distribution scale (see below). Its downside is that not all senior bonds can break even under 100 MDR if the loss severity scale is frozen.

B. Collateral cumulative loss scale, i.e., a ratio of collateral loss that breaks the bond to the collateral loss under the base case ("Simple BP Ratio" – see Exhibit 1).

   This measure is rather robust, too. Its main disadvantage is that the risk of losing in the same scale is not equally presented in different pools. Let us compare two hypothetical deals, one new (no delinquencies) and another one very seasoned with lots of delinquent loans (hence, with high certainty of losses). A Breakpoint Ratio of 2.0 should point to a higher risk level for the new deal than for the old one.

C. Collateral cumulative loss scale computed for current loan only ("Extended BP Ratio" – see Exhibit 1).

   This metric is free of the issue pointed out for B.

D. User-defined, grid-specific scale.

   A user can enumerate scenarios in a customized fashion. For example, "Scenario 1.0" can be the base case. "Scenario 2.0" can feature a user-defined combination of inflated MDR scale, and/or Severity scale, and/or home price shifts, etc. Then, a breakpoint of 1.65 can be interpreted as an "interpolated" scenario. The same measure can be viewed as the Breakpoint Ratio.

Exhibit 1. Examples of Breakpoint Ratio computation

		(A)	*(B)*	*(D)*	*A/B*	*[A-(B-D)]/D*
Deal ID	**Bond**	**Break Point Future Loss**	**Expected Collateral Loss**	**Expected Collat Losses for Current Loans**	**Simple BP Ratio**	**Extended BP Ratio**
NAA06AR1	AVI	21,803,054	12,277,706	5,942,971	1.78	2.60
CWF05025	A11	13,585,643	9,184,583	8,807,148	1.48	1.50
DAA050006	IIA3	32,020,475	19,607,642	16,446,564	1.63	1.75
WFM0701	IA22	60,598,456	80,537,621	80,488,665	0.75	0.75

The first bond (AV1) in Exhibit 1 has a simple BP Ratio of 1.78, which, simply interpreted says that losses on the entire collateral of the deal would have to be 1.78 times greater than the expected losses for this bond to reach a breakpoint. The Extended BP ratio suggests that the expected losses of the currently performing loans would have to be 2.6 times their expected losses for the AV1 class to risk a principal write-down. In contrast, the last bond in the table (IA22) has a very low BP Ratio, simple and extended. According to the Simple and Extended BP Ratios, only 75% of the expected collateral losses would have to occur for this bond to break.

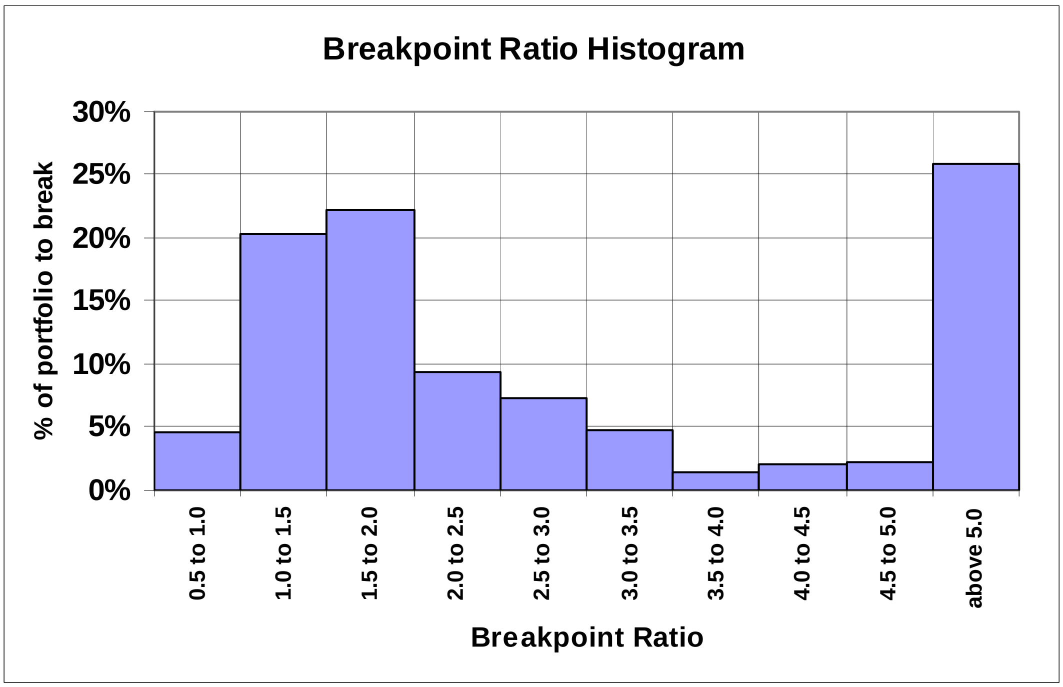
Naturally, the Extended BP Ratio is always larger than the Simple BP Ratio if a bond doesn't break at the base case; it is smaller if a bond breaks. These two measures are close to one another for new bonds – like the last bond in Exhibit 1.

A Breakpoint Ratio Histogram

For portfolios of MBS or ABS, Breakpoint ratios can't and shouldn't be aggregated. For example, if one possesses a portfolio of equally weighted bonds from Exhibit 1, the averaged BP Ratio will surely exceed 1.0. However, the IA22 bond, hence the entire portfolio, does lose in the base case, so the average BP Ratio is rather misleading.

A histogram of Breakpoint Ratios displays more informative statistics. For example, Exhibit 2 depicts the results for the analysis of an AAA MBS portfolio sorted by the Breakpoint Ratio.

Exhibit 2. Histogram of Breakpoint Ratios



For the histogram, we defined the Breakpoint Ratio as the MDR scale (version A from the above list of choices). About 5% of the portfolio should have been downgraded by major rating agencies for having a BP ratio below 1.0 – those bonds are expected to experience principal write-down even at the base case. Bonds having BP ratios between 1.0 and 1.5 (20% of the portfolio) are the next candidates for downgrading, etc. Therefore, the Breakpoint Histogram is a useful first sketch of portfolio credit risk.

The Breakpoint Grid

How, speaking technically, would we calculate the Breakpoint Ratio? We would have to iterate over a set of credit scenarios until the bond's write-down becomes equal to the target (with some accuracy). In the process, we have to inspect the results of these iterations, which, if not discarded, can become a good credit risk report!

So, instead of starting with the Breakpoint Ratio search, we first define a grid of stress scenarios (MDR scales, and/or Severity Scales, and/or HPA assumptions, etc.) sorted in order of increasing losses that may be of interest for credit risk management. Using our LoanDynamics™ Model (LDM) we will forecast prepayments, defaults, losses, and bond write-downs for each of the scenarios. This process delivers a valuable risk metrics and, at the same time, narrows the search interval for the Breakpoint. For example, Exhibit 3A shows a Breakpoint Grid set in scale of base-case MDR vector predicted by the LDM. Once each grid point was analyzed, the Breakpoint search was performed between scenario scales 1.0 and 1.5.

Exhibit 3A. Breakpoint Grid in Scale of MDR

	input		*output*				
	Scenario "Scale"	**MDR scale**	**Cum writedown**	**Cum Loss**	**Cum Default**	**Avg CDR**	**Simple BP Ratio**
	0.0	0.0	-	-	-	0.0	0.00
	0.5	0.5	-	2.8	13.6	2.4	0.57
base case	1.0	1.0	-	4.9	23.4	4.6	1.00
	1.5	1.5	0.01	6.5	31.0	6.5	1.34
	2.0	2.0	0.11	7.9	37.2	8.4	1.62
	2.5	2.5	0.44	9.0	42.4	10.1	1.86
	3.0	3.0	1.03	10.0	46.7	11.8	2.06
	3.5	3.5	1.68	10.9	50.4	13.4	2.24
	4.0	4.0	2.35	11.6	53.6	14.9	2.40
	4.5	4.5	2.98	12.3	56.5	16.3	2.53
	5.0	5.0	3.59	12.9	59.0	17.7	2.66
breakpoint	1.46	1.46	0.01	6.4	30.4	6.4	1.31

Note that the simple collateral loss ratio grows slower than the MDR scale. Collateral life contracts with faster termination, both voluntary and mandatory. Therefore, the cumulative default rate (% of loans defaulted) and the cumulative collateral loss can't grow with the exact pace of CDR. This explains why the Breakpoint Scale is 1.46 whereas the Simple BP Ratio is only 1.31.

Exhibit 3B depicts the Breakpoint Grid construction using a combination of two HPA shocks, the short-term shift and the long-term shift. Note that the short-term HPA rate is an instantaneous rate annualized. It is not equal to the 1st-year HPA rate, which is comprised of 63% of the short-term HPA and 37% of the long-term HPA. The 2nd-year HPA is comprised of 23% of the short-term HPA and 77% of the long-term HPA, etc. The cumulative loss and default levels for Breakpoints shown in Exhibits 3A and 3B are comparable to each other although not identical due to some difference in predicted vectors.

Exhibit 3B. Breakpoint Grid of HPA shocks

	input				*output*				
	"Scale"	Yr1 HPA	Yr2 HPA	Long-term HPA	Cum writedown	Cum Loss	Cum Default	Avg CDR	Simple BP Ratio
	0	1.0	4.9	7.2	0.0	0.0	0.0	0.0	0.00
	0.5	-0.7	4.0	6.7	0.0	2.2	12.4	2.3	0.46
base case	1	-2.5	3.0	6.2	0.0	4.9	23.4	4.6	1.00
	1.5	-4.2	2.0	5.7	0.3	8.5	34.3	7.1	1.75
	2	-6.0	1.1	5.2	3.8	13.8	45.6	10.0	2.84
	2.5	-7.8	0.1	4.7	10.1	20.9	56.8	13.1	4.31
	3	-9.5	-0.8	4.2	17.3	28.2	65.9	16.5	5.81
	3.5	-11.3	-1.8	3.7	22.7	33.4	71.8	19.4	6.88
	4	-13.0	-2.8	3.2	26.5	36.7	75.7	22.0	7.56
	4.5	-14.8	-3.7	2.7	29.2	39.1	78.5	24.3	8.05
	5	-16.6	-4.7	2.2	31.3	40.8	80.7	26.4	8.41
breakpoint	1.75	-5.1	1.6	5.4	0.0	6.6	28.9	5.8	1.35

In order to aggregate the Breakpoint Grid for a portfolio, we first need to make sure that each scenario point is common for every position. At first glance, it seems that constructing the grid in terms of a common factor (like a single home price index) makes more sense than using an MDR scale. However, if we extend the notion of "common market factor" and include LDM model risk, we start to understand that an MDR scale can serve the purpose.

Assessing probabilities and expectations

Can we assign each of the stress scenarios a probability? In order to achieve this goal, we normally employ a model that randomly simulates interest rates and home prices ("Credit OAS," see Levin and Davidson [2008]). Alternatively, we can employ a simpler and intuitive analytical approach offered by O. Vasicek [1991, 2002] who has constructed a theoretical distribution of the infinite-cohort default rate (x) as a function of two parameters, borrowers' default rate p and the correlation between borrowers' asset values, ρ. The Vasicek formula is

$$W(x) = N\{\frac{\sqrt{1-\rho}N^{-1}(x) - N^{-1}(p)}{\sqrt{\rho}}\}$$

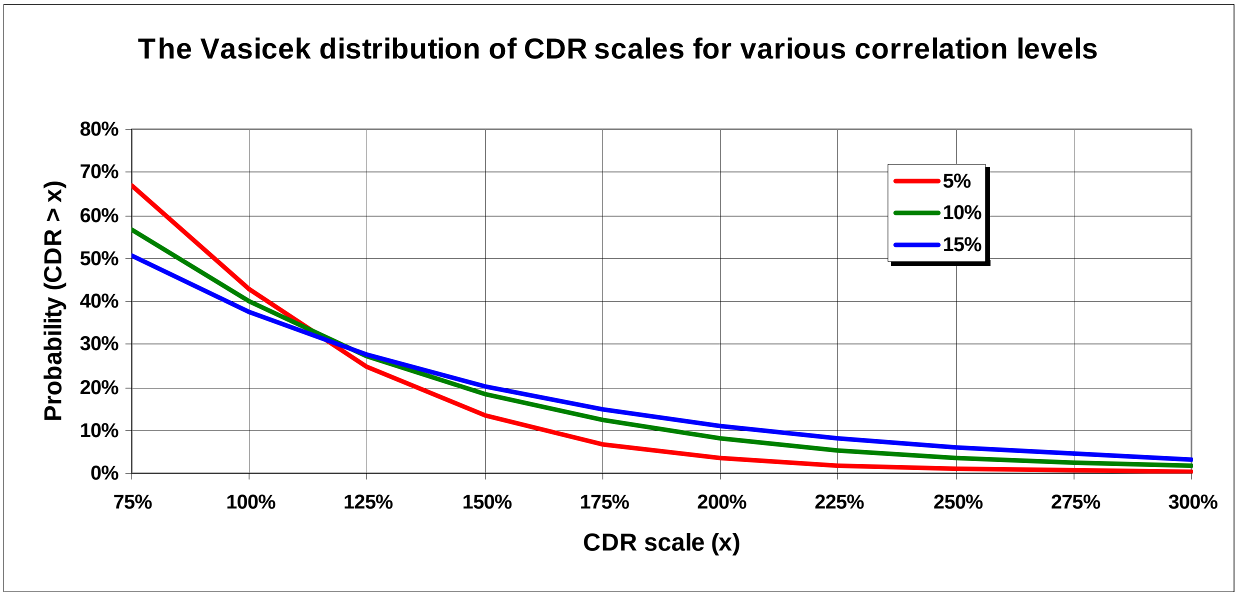
where, as usual, N stands for the cumulative standard normal distribution. Vasicek characterized the distribution as "highly skewed," which is correct unless $p = 0.5$ in which case it becomes symmetrical.

Correlation between individual borrowers' default decisions can be explained by their dependence on common market factors. As we mentioned, these factors can be a common HPI index or a common model error.

The Vasicek distribution is almost model-free (under several very simplified and practically unrealistic assumptions) in that it doesn't require explaining loan defaults via complex modeling. We don't need to know which factors affect individual defaults, their volatilities, etc. Everything is given in terms of p and ρ. Individual default rate p can be taken from the LDM whereas the correlation parameter ρ can be recovered from the way the market prices ABS capital structures[1]. According to AD&Co's own research, the ABS-implied correlation parameter typically varies between 6% and 15%, but it has been higher during the ongoing MBS crisis. An alternative way of getting correlation can be based on statistics of empirical losses (see Mashayekhi and Wang [2008]). The Vasicek model underlies the Basel II accord, and the 15% level is elected there as the standard (FitchRatings [2008]).

We can apply the Vasicek distribution to the CDR or MDR scales. For each position or a group, we can interpret the CDR scale as a random number so that it corresponds to *x* in the Vasicek distribution. For example, for a 10% average CDR, $p = 0.1$. A 200% scale will correspond to the random default rate of $x = 0.2$. Then, given correlation ρ, we can compute probability that the default rate doesn't exceed *x*. Exhibit 4 depicts the probability of not exceeding CDR scales, for 3 different correlation parameters, 5%, 10%, and 15%; a higher correlation leads to a fatter tail.

Exhibit 4. Probability of Exceeding CDR Scenario Scales



In addition to the probability of exceeding the stressed levels, we can compute the probability of reaching the breakpoint. For example, the CDR-based BP ratio of 1.46 shown in Exhibit 3 would point to a 14% to 21% probability, depending on correlation (Ro), in Exhibit 4.

Putting it all together

We can now combine the breakpoint grid loss results with the probability assessment into one concise report. Results can be presented for each position and/or aggregated by collateral type. This portfolio loss report considered in conjunction with the Breakpoint Ratio histogram (Exhibit 2) delivers the necessary information to assess portfolio credit risk.

[1] AD&Co's analytical tool that recovers ρ from market prices of tranches (within a single deal) is called the *Implied Default Model* (see Levin and Davidson [2008]).

Exhibit 5. A sample report of portfolio credit risk

MDR Model Scale	*75%*	*100%*	*125%*	*150%*	*200%*	*250%*	*300%*
Cumulative collateral loss, %							
ALT A FIXED	6.3	8.0	9.5	10.9	13.2	15.1	16.7
JUMBO FIXED	4.5	5.8	7.0	8.1	10.1	11.7	13.2
…							
OPTION ARM	9.0	11.4	13.5	15.4	18.6	21.2	23.3
Cumulative collateral default, %							
ALT A FIXED	24.2	30.2	35.5	40.2	47.9	54.1	59.1
JUMBO FIXED	20.1	25.5	30.3	34.7	42.2	48.3	53.3
…							
OPTION ARM	23.0	28.8	33.9	38.4	46.0	52.1	57.1
Cumulative bond write-downs, %							
ALT A FIXED	0.0	0.4	1.0	1.6	3.0	4.5	5.8
…							
JUMBO FIXED	0.0	0.3	0.9	1.6	3.0	4.3	5.5
OPTION ARM	0.1	0.3	0.9	2.1	7.1	12.3	16.6
TOTAL, %	0.1	0.2	0.4	1.0	3.3	5.7	7.8
TOTAL, $M	…	…	…	…	…	…	…
1.0 - Vasicek probability (chance to exceed)							
Correlation (Ro)							
5%	66.7%	42.9%	24.7%	13.3%	3.5%	1.0%	0.4%
10%	56.6%	39.9%	27.3%	18.4%	8.1%	3.6%	1.7%
15%	50.7%	37.5%	27.6%	20.3%	11.0%	6.0%	3.3%

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This article describes a method that AD&Co uses in its credit analysis projects and services for clients. Report samples are shown solely for demonstration purposes. When writing the article, I used materials and views contributed by Anne Ching, Andrew Davidson (who proposed using the Breakpoint Ratio) and Will Searle.

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A Comparison of Breakpoint Ratios and Credit Ratings

By Ming Zheng

This article analyzes the Breakpoint Ratio (BPR) of subprime MBS and compares the BPR movements in relation to rating agency downgrades. Breakpoint Analysis is designed to provide a dynamic and timely alternative to a credit rating once a bond has been issued. Through our test, we have indeed found evidence to support this argument. We also provide a tentative rule to map BPR to agency credit ratings.

What is BPR?

BPR is the ratio of the collateral losses required to cause the first dollar of a bond's principal writedown to the projected loss in the base case economic scenario. A lower BPR means loss is more likely to incur.

What drives change in BPR?

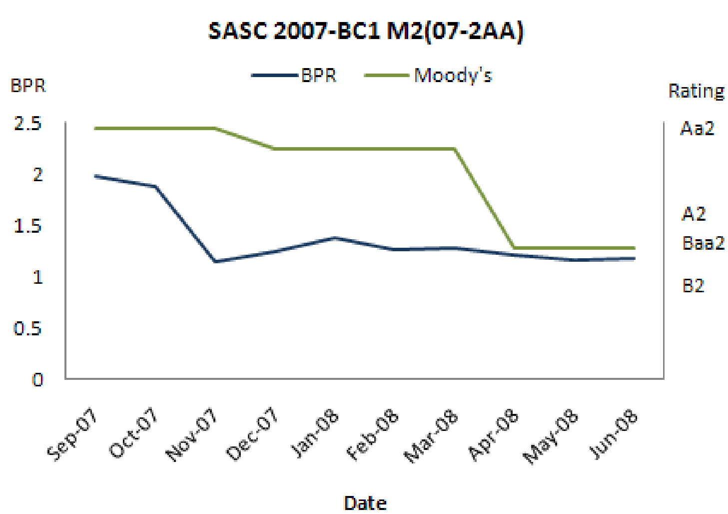
1. Changes in collateral (delinquencies)
2. Changes in home price forecast (market)
3. Changes in interest rates
4. Changes to LDM model (held constant for this analysis)

Examination of the Relationship between BPR and Credit Rating

We look at the BPR of over 270 bonds in the ABX 06-1 to ABX 07-2 index and examine them from September 2007 to June 2008. In general, BPR declined over the time period, which reflects increasing default risk due to rising delinquencies and falling house prices. We found that BPR often tends to decline before the downgrade is announced.

Exhibit 1 shows that for SASC 2007-BC1 M2 there was a substantial BPR drop in October 2007. Although the agency rating remained unchanged at that time, the rating was eventually downgraded in April 2008 to a level anticipated by BPR back in October 2007.

Exhibit 1



We divide the 270 bonds into several groups by their original ratings in September 2007. The average BPR of each group is plotted as the example shows us in Exhibit 2. It is very clear that higher rated bonds have higher BPR on average. From these graphs we can also see that the agency was less likely to downgrade a bond if the bond is rated above A, or above investment grade. Exhibit 3 shows us that there are larger gaps between BPR decline and credit rating decline for bonds with higher ratings.

Exhibit 2

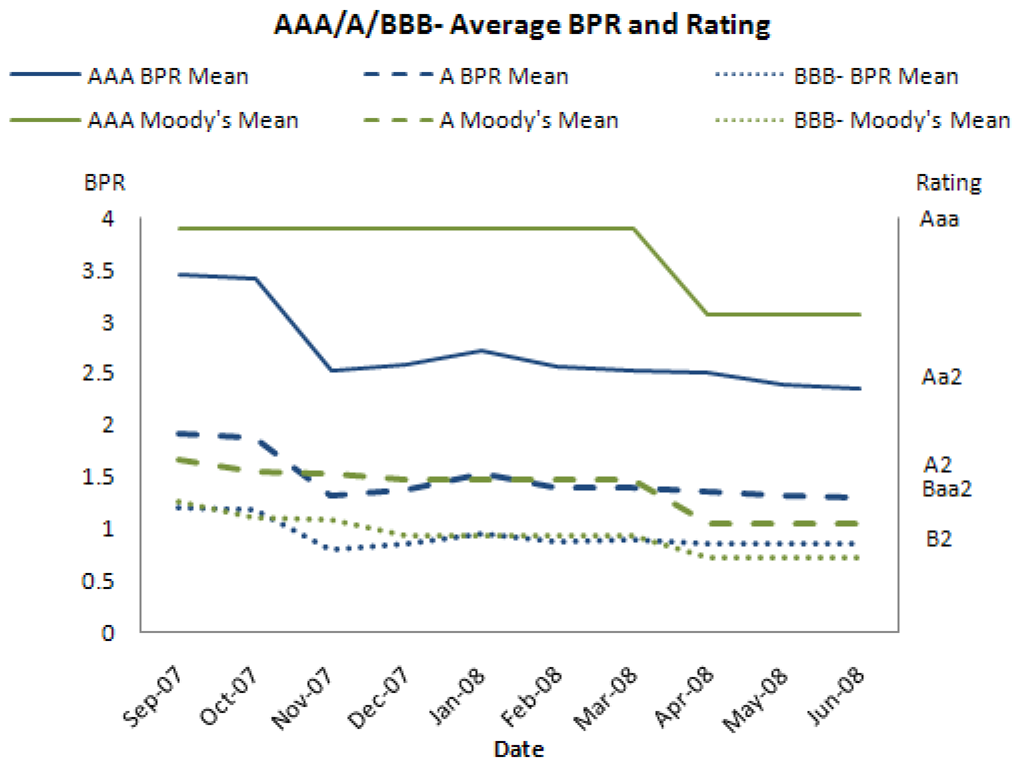
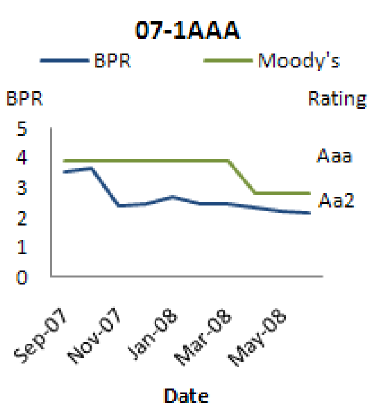
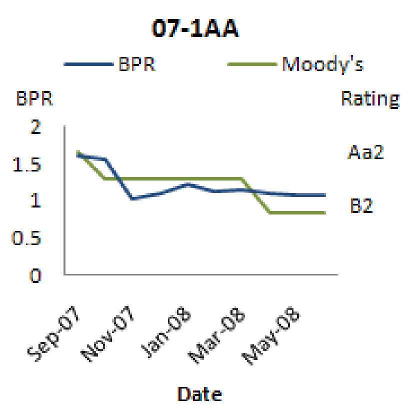
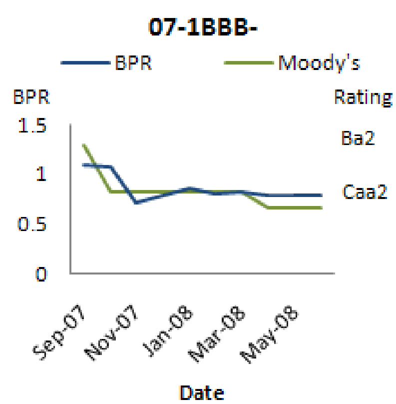


Exhibit 3







Within ten months, these 270 bonds were downgraded 318 times by Moody's and 321 times by S&P. 186 of these downgrades by Moody's happened in April 08 and 148 by S&P happened in January 2008. The BPR is recalculated monthly.

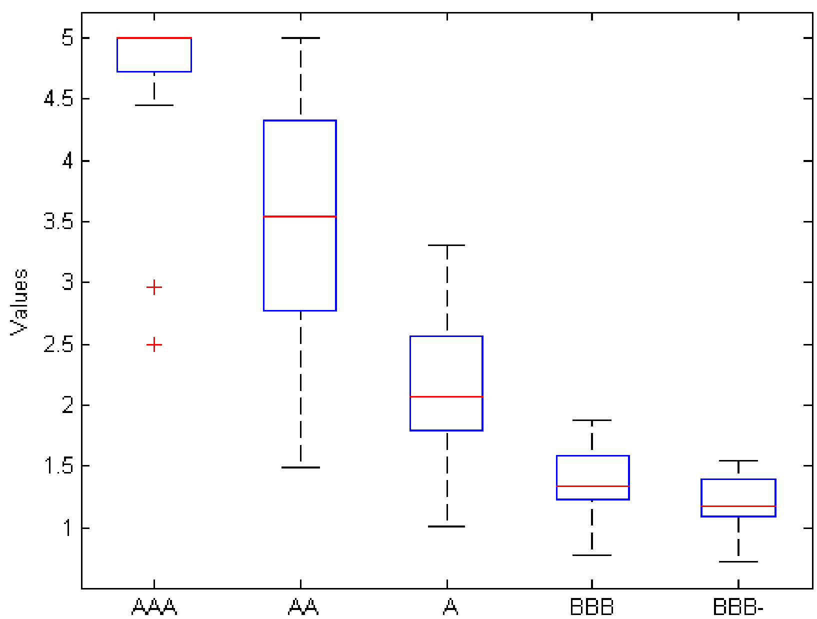
Table 1

Downgrade	0907	1007	1107	1207	0108	0208	0308	0408	0508	0608	Total
Moody's	0	73	4	55	0	0	0	186	0	0	318
S&P	0	83	4	2	148	2	27	16	39	0	321

Mapping BPR to Credit Rating

To help investors better understand BPR we create an approximate mapping between BPRs and credit ratings. To do this we compare the BPRs of various bonds with the same ratings. Exhibit 4 is a box plot of bonds from ABX06-2 in September 2007. The upper bar of the boxes represents the 75th percentile or the third quartile of the data and the lower bar of the boxes represents the 25th percentile, or the first quartile of the data. The red bar in the middle of each box represents the median. This chart presents a possible mapping of BPRs to ratings. For example AA bonds are likely to have a BPR of around 3.5, while AAA bonds would have a BPR of about 5.

Exhibit 4



We can produce charts like exhibit 4 for a variety of time periods and vintages. Based on that analysis we are currently using a Breakpoint to Agency rating mappings as shown in the following table (Table 2) which reflects the average of data over a variety of time periods and vintages as shown in Exhibit 5.

Table 2

Moody's	**S&P**	**BPR**
Aaa	AAA	4
Aa2	AA	2.5
A2	A	1.7
Baa2	BBB	1.4
Ba2	BB	1.1
B2	B	0.9
Caa2	CCC	0.7
C/Ca	CC	0.6

Exhibit 5