Measuring Final Loss Severity of Defaulted RMBS

JIAN HU AND RICHARD CANTOR

JIAN HU
is director of structured finance default research at Moody's Investors Service in New York City.
jian.hu@moodys.com

RICHARD CANTOR
is a managing director at Moody's Investors Service.
richard.cantor@moodys.com

In Hu and Cantor [2004], we define two concepts of default—payment default and material impairment—for structured finance securities. Payment default includes both interest shortfalls and principal losses, regardless of whether defaults are subsequently cured. Material impairment (or impairment, for simplicity) excludes cured payment defaults, because these are often temporary and inconsequential, but includes securities rated Ca or C that are not yet in payment default but are almost certain to sustain losses in the future.

Here we focus on estimating final loss severity rates, given default (or commonly known as LGD), using data from defaulted residential mortgage-backed securities (RMBS) and home equity loan-backed (HEL-backed) securities. We examine the relationship between loss severity rates and tranche size, seniority, time to default, and credit ratings.

Measuring loss severity in structured finance requires a different approach from that used in corporate finance. Typically, recovery rates (1 – loss severity rate) on a defaulted corporate instrument are measured as the ratio of the 30-day post-default bid prices on the defaulted securities to the face values. Bid prices on defaulted structured securities are not generally available or reliable, so the standard corporate approach to measuring loss severity is not applicable to structured finance.

For defaulted securities that have "matured"—securities whose balance has been reduced to zero either through paydowns, write-downs, or a combination of both, and that are no longer making payments to investors—lifetime losses can be calculated directly by summing their history of periodic losses (both lost interest and principal payments) and discounting the losses back to a reference date, using the security's own coupon rate as the discount rate.

To measure the overall average loss severity on defaulted structured finance securities, we need a method for the estimation of ultimate loss severity rates on defaulted securities that have not yet matured. Our fundamental data come from 187 RMBS and HEL securities that had defaulted before the end of 2002 and were not cured. Definitive lifetime cumulative loss totals are available only for the 86 securities that have subsequently matured; expected lifetime losses must be estimated for the other 101 defaulted securities with positive balances that have not yet matured.

We focus on two loss severity rate measures: lifetime losses as a share of the principal balance at origination, and lifetime losses as a share of the principal balance at the date of default inception. The former measure is likely to be of primary interest to buy-and-hold investors, and the latter of more interest to secondary market investors in general and distressed security investors in particular.

While direct comparison of structured and corporate loss severities on default balances may be appropriate, comparison of severities based on origination balances is not. The reason is that corporate bonds rarely amortize, and corporate severity estimates rarely differentiate between measures based on default balances or on origination balances.

Loss severity measured at the default date exceeds loss severity measured at origination, because 1) a structured security may distribute a substantial portion of its principal to investors prior to its default, and 2) the present value of lifetime losses is lower at origination than at default because of discounting. For a corporate security, the difference between loss severity at origination and loss severity at default is generally less substantial—it is limited to the discounting effect—because its balance at origination is generally equal to its balance at default.

To estimate the final LGD rates of defaulted RMBS and HEL securities, we examine three different approaches. The first approach to estimating lifetime cumulative losses on non-matured securities—which we call the *static* approach—is to infer their loss severity rates directly from a small number of characteristic factors at the time of default. These factors provide only static information about the defaulted security, such as tranche size, seniority, and the number of months from origination to default, that may imply a loss severity rate on a non-matured security. As it relies on an estimated relationship between the static factors and final loss severity rates based on data observations from matured defaults, the static approach is likely to impart an upward bias on the loss severity. Many securities in the matured sample matured precisely because they experienced high losses, and their balances were rapidly written down to zero. Many of the other securities have not matured because their loss experience has been less severe.

The second approach to estimating lifetime cumulative losses on non-matured securities—the *dynamic* approach—relies primarily on the ratio of losses realized versus total principal balance reduced since the default date to predict a security's final cumulative loss. The total principal balance reduced since the default date includes principal that was lost and principal that was paid from default date to the current date.

The basic idea in the dynamic approach is that as a defaulted security's principal balance declines over time, the share of this balance that is lost, as opposed to the share that is reduced through principal distribution to investors, reveals the rate at which the security is likely to suffer losses on its remaining balance. The matured sample indicates that, for most defaulted securities, losses on any remaining balance are typically incurred at a lower rate than the loss rate on the principal balance to date. The dynamic approach thus incorporates a deceleration in loss accumulation.

The third approach—a *blended* approach—places weights on both static and dynamic estimates of a final loss severity rate that vary over the life of the security. We recommend this third approach for two reasons. The dynamic approach generally produces more accurate estimates of final loss severity rates than the static approach, as defaulted securities become more seasoned and closer to their final maturity over time. Yet the static approach provides better forecasts than the dynamic approach in the period shortly after the default's inception. We can weight each approach differently over time.

The static approach suggests that the ultimate loss severities on the non-matured securities are only slightly lower than on the matured securities. The dynamic approach predicts that the ultimate loss severities on the non-matured securities are much lower than predicted by the static approach. Because many non-matured securities have already seasoned for many years, the blended approach and the dynamic approach typically provide similar loss severity rate estimates.

When we combine the realized final loss severity rates from the matured sample with the final loss severity rates estimated from the non-matured sample using the blended approach, we find, on average, a defaulted RMBS would eventually lose about 51% of its default date balance or 34% of its original balance. For greater tranche size and higher seniority class and rating category, loss severity is diminished.

I. DEFINING DEFAULTS AND LOSS SEVERITIES

In Hu and Cantor [2004] we define a structured security as in payment default if it suffers either an interest shortfall or a principal write-down. A payment default is called *cured* as of a certain date if all of its outstanding interest shortfalls and principal losses have been repaid. A payment default is *uncured* if interest shortfalls or principal losses are still outstanding.[1]

We focus exclusively on uncured payment defaults, since cured defaults are temporary and inconsequential for most investors. To estimate an average loss severity rate that includes cured defaults, we simply incorporate the additional defaults—with zero loss severity rates—into the calculation. The average cumulative loss severity rate values from uncured payment defaults can be multiplied by the cumulative impairment rates to obtain cumulative loss rates.

Unlike corporate bonds, which usually carry the same par balance at origination as the face value due at maturity, many structured finance securities amortize over the life of the transaction. Losses on defaulted structured securities, however, typically accrue over time because of additional missed interest and write-downs. Consequently, the amount of final losses is known only for matured defaults, where *mature* means a zero outstanding principal balance.[2] Final loss severity rates on non-matured defaults (defaults with positive principal balances outstanding) cannot be known with any certainty.

We define the loss severity rate (or loss, given default, rate) as the discounted present value of periodic losses, including both interest shortfalls and losses of principal using compounded coupon rates as discount rates, expressed as a share of the principal balance on a certain reference date. The generic formula is:

$$LGD_t = \{\sum_{s=k}^{t} \frac{IS_s + LP_s}{(1 + c_s)^s}\}/B_k \qquad (1)$$

where LGD_t is the loss severity rate accumulated to date at time t; IS_s and LP_s are the net interest shortfalls and net loss of principal in time period s; c_s is the discount rate for the loss in time period s; and B_k is the outstanding principal balance at time k, where k can be any date such as the date of the first default event (default date), denoted by time D, or the date of origination, denoted by time O.

Time t can be the bond's maturity, denoted by time T, which would of course also imply that the loss severity to date is in fact the final lifetime loss severity. Time t could also be any reporting date, such as the end of a sample period, when the loss severity rate to date can be measured. Time s denotes any date between reference date k and current date t.

We use compounded coupon rates as discount rates. For fixed-rate securities, there is a single coupon rate, but for securities with variable coupon rates, discount rates are derived from interest payments and then compounded to a given reference date. When interest payments are irregular, we smooth the discount rates.

II. DATA SAMPLE

We focus exclusively on defaults in the RMBS and HEL sectors for several reasons. First, these represent the overwhelming majority of matured defaulted securities. In our database of defaulted securities as of year-end 2002, 100 defaulted securities had matured; 89 of them were RMBS or HEL-backed securities.

Second, RMBS and HELs combined are the single largest asset type within structured finance. At the beginning of 2004, they made up about 47% of all structured finance securities rated by Moody's.

Third, RMBS/HELs represent a relatively homogeneous group with residential mortgages as collateral. In fact, at the beginning of 2004, more than 85% of the HELs were backed by subprime first-lien (B&C) mortgages. The rest of the HEL collateral included high loan-to-value (LTV) mortgages, home equity lines of credit (HELOCs), home improvement loans, and net interest margins (NIM).

Fourth, a considerable number of early vintage RMBS were backed by mortgages that were subprime and would now be classified into the HEL sector. This is especially true of the defaulted RMBS. However, almost all RMBS deals issued in the last three or four years were prime jumbo loans or Alt-A loans, and are of high quality. Few have experienced defaults.

The collateral for HEL securities has also changed. In the old days, HEL securitizations generally came in two types: second-lien mortgages or HELOCs. The overwhelming majority of HEL deals issued more recently have been collateralized by first-lien subprime mortgage loans. Therefore, it is difficult separating HELs from RMBS over a long sample period.

III. REALIZED LOSS SEVERITY RATES TO DATE

It is instructive to describe the loss severity rates separately for the matured and non-matured defaults.

Matured Defaults

Exhibit 1 describes the characteristics of the 86 matured defaulted securities. Note first that final loss severity rates were very high for matured defaults. The mean loss severity rate is 65.8% and the median 89.1%. Exhibit 2 shows that about 48% of matured securities had sustained a loss severity of more than 90% of their default date balance.[3]

Second, the median default date balance was substantially higher than the mean. A substantial proportion (about 60%) of matured securities defaulted with more than 95% of their original balance outstanding, while the default date balances for the rest of the securities vary broadly from 5% to 95%.

These numbers are not surprising. Consider that 1) the average time from origination to default was 38

EXHIBIT 1

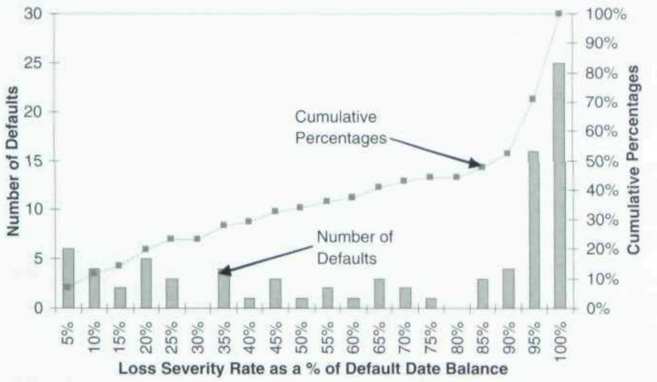
Characteristics of Matured Defaults 1988–2002

	Mean	Median
Number of Observations	86	86
Number of Deals	59	59
Final Loss Severity Rate (% of default date balance)*	65.8%	89.1%
Final Loss Severity Rate (% of original balance)	44.7%	49.9%
Default Date Balance* (% of original balance)	81.9%	96.5%
Time from Origination to Default (months)	38	37
Time from Default to Maturity (months)	27	18
Tranche Size (% of total deal balance at origination)	13.8%	5.0%
Rating at Origination	Baa3	Baa3
Rating at Default	B2	B2

**Default date balance is the principal balance at the time of default expressed as a percentage of the principal balance at origination (also called original balance).*

EXHIBIT 2

Distribution of Loss Severity Rates for Matured Defaults



months; 2) most defaults were subordinated tranches; and 3) the typical RMBS and HEL securitization restricts the amount of principal paid to the subordinated tranches during the first several years.

Third, the mean and median original ratings were Baa3, five notches above the B2 rating at the time of default. This means Moody's had downgraded these securities appropriately to reflect the changes in their credit quality.

Finally, half of the matured defaults were small tranches. Tranche balance at origination as a percent of the total deal balance was at a median of 5% and a mean of 14%. The mean is higher than the median as a result of eight senior defaulted securities with tranche sizes above 80%.

Non-Matured Defaults

For the 101 defaulted securities that had not matured as of the end of 2002, final loss severity rates are unknown. Exhibit 3 shows summary characteristics of the realized loss severity rates as of the end of 2002.

EXHIBIT 3

Characteristics of Non-Matured Defaults 1988–2002

	Mean	Median
Number of Observations	101	101
Number of Deals	92	92
Loss Severity Rate to Date* (% of default date balance)	28.0%	21.8%
Loss Severity Rate to Date* (% of original balance)	18.3%	12.6%
Remaining Principal Balance* (% of original balance)	32.2%	31.1%
Maximum Loss Severity Rate** (% of default date balance)	60.1%	65.7%
Default Date Balance (% of original balance)	76.4%	90.6%
Time from Origination to Default (months)	48	45
Time from Default to Date* (months)	52	52
Tranche Size (% of total deal balance at origination)	22.7%	5.8%
Rating at Origination	Baa2	Baa3
Rating at Default	B1	B2

**As of 12/31/2002.*

*** For each defaulter, this is the sum of the loss severity rate to date and the discounted present value of the remaining principal balance (assuming all will be lost at the end of the sample period).*

Note first in Exhibit 3 that the mean and median loss severity rates to date for these securities are markedly lower than those of the matured defaults in Exhibit 1. In Exhibit 3, the mean is greater than the median. Exhibit 4 shows that more than 56% of the non-matured securities have sustained loss severity rates of less than 25%.

Both the means and medians of default date balances are lower than those in Exhibit 1, although the overall distribution of default date balances is similar between matured and non-matured defaults. About 26% of non-matured defaults had 95% or more principal balance outstanding at the time of default. This is in sharp contrast to the 60% mentioned earlier in Exhibit 2.

Exhibit 3 also demonstrates that non-matured securities experienced their first default event on average about 48 months after origination. This is about 12 months longer than the average time to default of matured securities. The non-matured securities continued to accumulate losses for an average of 52 months following default, while matured defaults were largely written down within an average of 27 months after default.

Some non-matured securities had only a small amount of principal balance remaining, with average and median remaining balances around 30%. About a third of the non-matured securities had less than 10% of their original principal balance remaining, as Exhibit 5 demonstrates.

While it is certain that additional losses will accumulate on these defaults, it appears that the non-matured final loss severity rates will be lower than those of matured defaults. Exhibit 3 shows that the average of maximum loss severity rates is below the average of final loss severity

EXHIBIT 4

Distribution of Loss Severity Rates for Non-Matured Defaults—December 2002

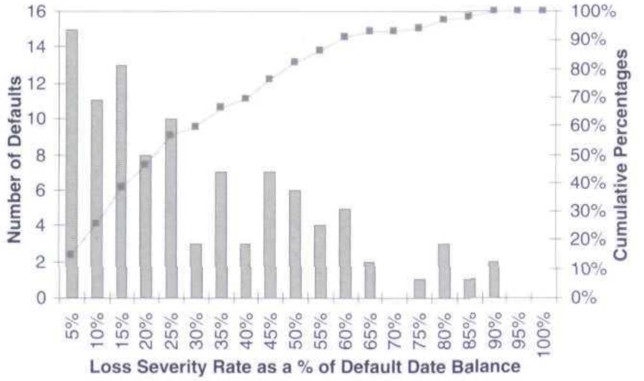
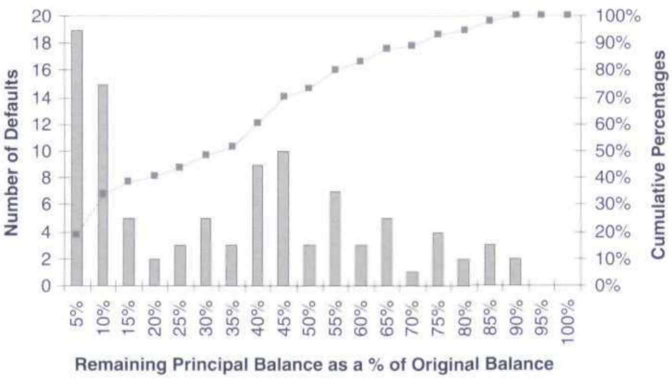


EXHIBIT 5

Distribution of Remaining Principal Balances of Non-Matured Defaults



rates of matured defaults; the median of maximum loss severity rates is substantially lower than the median final loss severity rates of matured defaults.

Finally, the median ratings at origination or at default are similar for non-matured and matured defaults, but the average rating is one notch higher for non-matured defaults. This suggests that the non-matured defaults' overall credit quality are generally better.

IV. ESTIMATING FINAL LOSS SEVERITY RATES FOR NON-MATURED DEFAULTED SECURITIES

We examine three ways to predict final loss severity of defaulted securities that have not yet matured:

1. A static model that infers loss severity directly from a combination of default characteristic variables such as tranche size (measured by tranche balance as a share of deal balance at origination); time to default (measured by months from origination to default); and default date balance (measured by balance at default as a share of original tranche balance, also called tranche factor at default date).
2. A dynamic model that estimates a security's future loss as a share of the remaining principal balance based on the ratio of principal balance lost versus the total principal balance reduced since default date, and the rate at which the pace of loss accumulation historically decelerates (a parameter we will call *beta*).
3. A blended model that allows the relative weights assigned to the static and dynamic severity estimates (a parameter we will call *alpha*) to vary with the age of the securities.

Static Model

We examined many default characteristic variables in search for determinants of final loss severity rates of matured securities. The variables we find to be highly correlated with severity rates are: tranche size, time to default, seniority, and default date balance. These variables are static factors in the sense that they do not change once a default is identified.

Larger tranches sustained smaller losses. Matured securities with tranche balances at origination greater than 70% of a deal balance sustained an average loss of 5% as a share of original balance, while defaulted securities with a tranche balance of less than 2% of deal balance at origination sustained an average loss of roughly 60%.

Senior tranches, on average, have sustained much lower loss severity rates than non-senior tranches. The average loss severity rate of matured senior securities was only 10% of their default date balance, while the average of non-senior securities was about 70%.

Multifactor regression results indicate that tranche size, time to default, and default date balance are jointly significant in differentiating final loss severity rates. The seniority variable, however, is highly correlated with tranche size, so we eliminate it. In fact, all matured senior securities had tranche sizes of more than 80%.

To ensure that estimates of final loss severity rates fall between zero and one, we apply a logit transformation to final loss severity rates.[4] The transformed loss severity rate is the dependent variable. The quadratic form associated with the time to default variable indicates a seasoning pattern similar to the seasoning patterns of rating transitions and default rates.[5] The static multifactor regression model is expressed in Equation (2):

$$\text{Log}\left(\frac{\text{Final Loss Severity Rate}}{1 - \text{Final Loss Severity Rate}}\right)$$

$$\begin{aligned} &= \underset{(0.0261)}{0.2432}(\text{Time to Default}) - \\ &\quad \underset{(0.000392)}{0.0038}(\text{Time to Default})^2 - \\ &\quad \underset{(0.5349)}{4.7090}(\text{Tranche Size}) - \\ &\quad \underset{(0.4698)}{1.5080}(\text{Default Date Balance}) \end{aligned} \tag{2}$$

where loss severity rate is measured as a percent of the default date balance; time to default is measured by the months from origination to default; tranche size is measured by the tranche balance at origination as a percent of total deal balance at origination; and default date balance is measured by the principal balance at default over the principal balance at origination.

The model estimated using the sample of 86 matured RMBS and HEL defaults has an R^2 of 53%. All coefficients are statistically significant at the 95% confidence level. The standard errors of estimates are shown in the parentheses.

The static model in Equation (2) provides a simple method to project final loss severity rates for non-matured defaults. One needs simply to compute the values of three variables: tranche size, time from origination to default, and default date balance, and input them into the equation.

The average of the static estimates of final severity rates for non-matured defaults is 57.8% (as a percent of default date balance), which is lower than the average final severity rate of 65.8% for matured defaults. The static estimate is on average much higher than the loss severity rate to date, which is the minimum, for non-matured defaults. The average of the static estimates of final severity rates is also close to the average of maximum severity rates (60.1%), derived under the assumption that these securities will lose all their remaining principal balances.

The static estimates are likely to overestimate final loss severity rates due to survival biases. The very fact that, unlike the securities in the matured sample, balances of the securities in the non-matured sample are not written down to zero suggests that these securities are likely to have lower final loss severities.

Dynamic Model

Dynamic information about loss accumulation to date and principal balance remaining can be used to get better estimates of non-matured securities' ultimate loss severity rates. For example, the loss severity rate to date is typically the minimum of a defaulted security's final severity rate, while the remaining loss cannot typically exceed the remaining principal balance.[6]

In our sample of matured securities, we find loss to date as a percentage of the principal balance reduced since default is the most useful dynamic variable for the projection of future loss. This variable is a measure of loss accumulation rate to date because it reflects the amount of loss accumulated per unit of principal balance reduced.

We assume that the remaining loss as a share of the current outstanding balance is a multiplier of the loss accumulation rate to date. It is assumed to be time-invariant from the time of default until maturity. The equation is:[7]

$$\frac{RL_t^i}{B_t^i} = \beta\left(\frac{L_t^i}{B_D^i - B_t^i}\right) \tag{3}$$

where RL_t^i is the amount of remaining loss at time t for defaulter i; B_t^i is the amount of remaining principal balance at time t for defaulter i; L_t^i is the loss accumulated to time t; and B_D^i is the principal balance outstanding at the time of default D. $B_D^i - B_t^i$ is the principal balance reduced from default to time t.[8]

The parameter beta (ß) specifies the relationship between the rate of future loss accumulation and the rate of historical loss accumulation to date since default. While one might expect that ß would normally equal one—that loss accumulates at a constant rate over time—we find that, in fact, the pace of loss accumulation usually decelerates over time in the matured sample. For the 2,212 monthly loss observations from the 86 matured defaults, we estimate ß to be 0.39.[9]

Equation (3) describes how, knowing ß, one can project the remaining loss as a share of the remaining principal balance. The total final loss is the sum of the estimated remaining loss, RL_t^i, and the realized loss to date, L_t^i. The estimated final loss severity rate as a share of the default date balance is therefore $(RL_t^i + L_t^i)/B_D^i$.

The average of final loss severity rate estimates based on the dynamic model is 38%, which is about 10 percentage points higher than the loss severity rate to date, but much

EXHIBIT 6

Comparison of Realized and Estimated Final Loss Severity Rates 1988-2002

	As Percent of Default Date Balance		As Percent of Original Balance	
	Mean	Median	Mean	Median
Matured Defaults (total 86 defaults)[a]	65.8%	89.1%	44.7%	49.9%
Non-Matured Defaults (total 101 defaults)				
Minimum Loss Severity Rates (or Loss Severity Rates to Date)[b]	28.0%	21.8%	18.3%	12.6%
Dynamic Model Estimates	38.0%	36.8%	24.8%	25.5%
Blended Model Estimates	38.8%	37.9%	25.5%	28.2%
Static Model Estimates	57.8%	78.8%	32.2%	35.6%
Maximum Loss Severity Rates[c]	60.1%	65.7%	38.0%	46.2%
All Defaults (total 187 defaults)[d]	51.2%	52.0%	34.3%	33.0%

Notes:

[a]Realized final loss severity rates for the 86 matured defaults.

[b]Loss severity rates through year-end 2002 for the 101 non-matured defaults. This is the minimum of a defaulter's final loss severity rate since it is almost certain that its losses are permanent.

[c]Maximum final loss severity rates, or the sum of loss severity rate to date and the discounted present value of the remaining principal balance (assuming all lost at the end of the study period).

[d]Combines the blended model estimates of final loss severity rates of non-matured defaults and the realized final loss severity rates of matured defaults.

lower than the average of static estimates or the average of realized final severity rates on matured defaulted securities.

Blended Model

The simple one-factor dynamic loss prediction model suffers from one weakness. When defaults are relatively recent, such as only a few months since default was initiated, the loss relative to the principal balance reduced may not yet be informative enough to yield a reliable prediction of the final loss severity rate. For these young defaults, static estimates may produce more reliable loss predictions. To this end, we develop a more comprehensive loss prediction model that takes into account both static and dynamic factors.

A blended model weights both the static and dynamic severity estimates to obtain a single final severity estimate. The model allows relative weights on the static and dynamic estimates to change over different stages of a defaulter's life. When the default is fairly recent, the blended model will assign more weight to the static estimate than to the dynamic estimate. When the default has seasoned some, the dynamic severity estimate will be given more weight than the static severity estimate.

The blended model is specified as:

$$\frac{RL_t^i(blended)}{B_t^i} = \alpha(t)\left[\frac{RL_t^i(dynamic)}{B_t^i}\right] + [1-\alpha(t)]\left[\frac{RL_t^i(static)}{B_t^i}\right] \tag{4}$$

where RL_t^i (blended) represents the remaining loss to be estimated; RL_t^i (dynamic) represents the remaining loss estimated using the dynamic model in Equation (3); RL_t^i (static) is the difference between the static estimate of the final loss severity rate and the realized loss to date; and $\alpha(t)$ is the relative weight variable. We impose boundaries of zero and one directly on the remaining loss as a share of the outstanding principal balance.

We considered a wide variety of functional relationships between alpha and time, and finally chose the functional form for alpha of: $\alpha(t) = 0.053t$, if $t <= 12$, or $\alpha(t) = 1$ if $t > 12$. This form states that the relative weight placed on the dynamic estimate increases over time, and after the 12 month no weight will be given to the static estimate.

Exhibit 6 shows the average final severity rates calculated according to the blended model, with comparisons to the other severity rate estimates for non-matured defaults and the realized severity rates for matured defaults. The average of final loss severity rate estimates according to the blended model is about 38.8% (as a percent of default date balance), slightly higher than the average of dynamic estimates, but much lower than the average of static estimates, or the average of realized final loss severity rates for matured defaults.

The average of severity rate estimates according to the blended model is slightly higher than the average of loss severity rate estimates from the dynamic model. This is largely because the blended model puts positive weight on the static estimate only during the first 12 months after default. Many of these non-matured defaults have been in

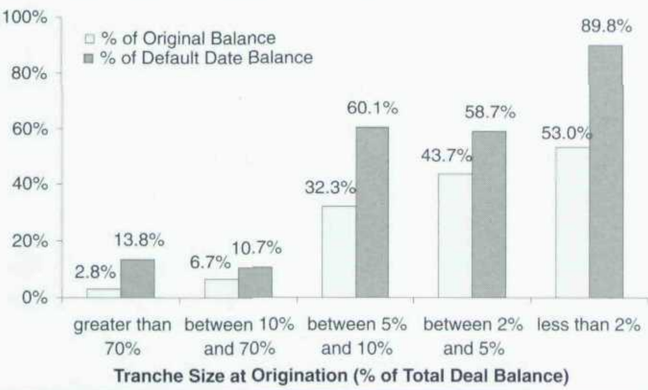
EXHIBIT 7

Final Loss Severity Rates by Rating 1988-2002 (estimates from blended model used for non-matured sample)

% of Default Date Balance					% of Original Balance				
Rating at Default	**Number**	**Mean**	**Median**	**Standard Deviation**	**Rating at Origination**	**Number**	**Mean**	**Median**	**Standard Deviation**
Aaa	1	1.5%	1.5%		Aaa	12	2.3%	2.7%	1.4%
Aa	5	4.1%	3.0%	2.5%	Aa	25	8.1%	6.3%	6.6%
A	7	25.4%	15.8%	30.5%	A	15	20.2%	9.9%	22.3%
Baa	21	33.3%	20.4%	28.8%	Baa	66	40.9%	43.2%	23.4%
Ba	41	47.2%	42.4%	32.7%	Ba	32	32.2%	35.6%	23.7%
B	54	59.5%	60.1%	34.2%	B	37	58.3%	66.3%	24.5%
Caa	38	54.0%	55.7%	30.6%					
Ca/C	20	74.0%	79.8%	26.8%					
Investment-Grade	34	26.4%	14.8%	28.2%	Investment-Grade	118	27.4%	20.2%	25.1%
Speculative-Grade	153	56.8%	58.7%	32.8%	Speculative-Grade	69	46.2%	43.2%	27.3%
All	187	51.2%	52.0%	34.0%	All	187	34.3%	33.0%	27.4%

EXHIBIT 8

Median Loss Severity Rates by Tranche Size 1988-2002



default for more than 12 months. The blended model uses the dynamic estimate alone to determine the remaining loss once the security has established a one-year loss record.

Exhibit 6 also shows final loss severity rates measured as a percentage of original balance. As expected, overall loss severity rate levels on the basis of the original balance are lower than those measured against their default date balance, while the relationships among the estimates are similar for the two severity rate measures.

We recommend the blended model for the projection of final loss severity rates on non-matured defaults. It takes into account both sets of valuable information in the static and the dynamic factors. It uses a clear structural framework that separates the static estimate from the dynamic estimate and relies on only two key parameters—a beta (the loss deceleration parameter), and an alpha (the weight variable). The model is thus easy to implement and flexible enough to allow for judgment.

V. FINAL LOSS SEVERITY RATES OF ALL DEFAULTED SECURITIES

When we combine the realized final loss severity rates from the matured defaults and the estimated final loss severity rates from the non-matured defaults, we can perform statistical analyses on final loss severity rates with a full sample.

By Rating

Exhibit 7 shows the average and median final loss severity rates by rating using the entire sample. Moody's ratings are strongly predictive of loss severity rates, given default. Ratings at default are particularly useful indicators of final loss severity rates, but ratings at origination are good predictors as well.

The only element of non-monotonicity in Exhibit 7 is that defaulted securities originally rated Baa sustained an average loss severity of about 41% as a share of their original balance, higher than the 32% loss severity rate averaged by securities rated Ba at origination.

Exhibit 7 also shows that the median final loss severity rates in the investment-grade rating category (investment-grade at the time of default) are significantly lower than the means. In the speculative-grade rating category, the means and medians are similar.

By Tranche Size

Exhibit 8 shows how loss severity rates vary by tranche size. There is a strong correlation between tranche size and final loss severity rate. Thinner tranches typically

EXHIBIT 9

Median Loss Severity Rates by Seniority 1988-2002

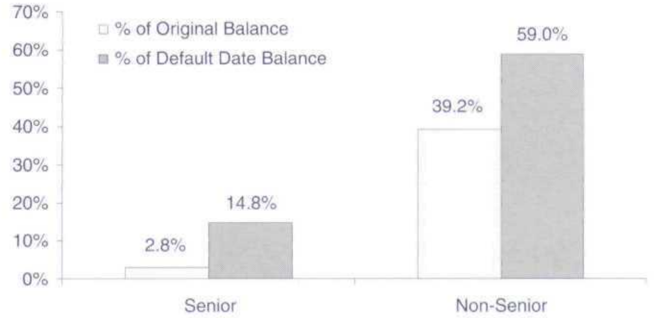


EXHIBIT 10

Average Loss Severity Rates over Multiyear Horizons by Rating for Defaulted RMBS and HELs 1988-2003*

	1-Year	2-Year	3-Year	4-Year	5-Year
Aaa	1.53%	8.92%	7.31%	5.58%	4.72%
Aa	5.14%	8.51%	10.22%	10.15%	9.71%
A	34.04%	30.03%	24.55%	22.40%	20.91%
Baa	38.84%	39.76%	36.23%	33.16%	29.76%
Ba	40.83%	36.49%	33.80%	32.11%	30.14%
B	47.90%	50.70%	50.28%	48.50%	46.99%
Caa	64.59%	58.75%	56.54%	53.51%	53.51%
Investment-Grade	34.68%	35.11%	30.60%	26.97%	24.04%
Speculative-Grade	48.03%	44.58%	42.33%	40.24%	38.02%
All	43.71%	40.65%	36.59%	33.14%	30.21%

Multiyear average loss severity rates are expressed as a percentage of principal balance at cohort date (i.e., the first day of a calendar year).

**As of the end of 2003, the total number of matured defaults that were uncured had increased to 117, and the number of non-matured defaults had increased to 118. The additional matured default observations enable us to test the accuracy of our loss projection models.*

sustained higher loss severity rates. The differences appear to be particularly significant at the 10% cutoff level.

By Seniority

As expected, seniority plays a prominent role in determining final loss severity rates, not only because senior tranches absorb losses only after junior tranches have been written down, but also because senior tranches tend to be thicker than junior tranches. There are only 26 senior defaulted securities in the entire sample or approximately 14% of all defaulted securities.

Loss severity rates by seniority are shown in Exhibit 9. Note the striking differences between senior and non-senior (including mezzanine and subordinated) security loss severity rates. The average loss severity rate as a percentage of original balance for senior tranches is only 7.4% of the average severity rate for non-senior tranches.

By Time Horizon

Average loss severity rates by time horizon are necessary inputs to the computation of multiyear cumulative loss rates. Typically, multiyear average loss severity rates are multiplied directly by multiyear default rates to yield multiyear loss rates.

The concept of multiyear loss severity can best be explained by example. Suppose we know the average loss severity [as a percent of the principal balance at any given date, such as the first day of a calendar year (also known as cohort date)] of securities that were rated single-B two years before they defaulted and securities rated single-B one year before they defaulted. We will call these loss severity values *marginal loss severity rates*.

To calculate the average loss severity rates of the single-B rated securities that defaulted within two years (either in year 1 or year 2), we take a weighted average of the one-year and the two-year marginal severity rates, where the weights are the shares of the two-year cumulative default rates attributable to year 1 and year 2 (called incremental default rates in year 1 and year 2).

For securities defaulted in year 1, let the average marginal loss severity rate be LGD1. For securities defaulted in year 2, the average marginal loss severity rate is LGD_2. Let the incremental default rate in year 1 be ΔCDR_1, and the incremental default rate in year 2 ΔCDR_2 so that $\Delta CDR_1 + \Delta CDR_2 = CDR_2$, where CDR_2 is the two-year cumulative default rate.

The average two-year loss severity rate is:

$$(LGD_1 \times \Delta CDR_1 + LGD_2 \times \Delta CDR_2)/CDR_2$$

The numerator in the formula is effectively the two-year cumulative loss rate.

We repeat this procedure for various horizons and rating categories to create Exhibit 10. Multiyear average loss severity rates are closely correlated with ratings for all time horizons. In general, average loss severity rates decline with the horizon. This result is to be expected, because typically payments are made between cohort formation dates and default dates. These payments result in lower severity rates for longer horizons than for short horizons because, as a share of cohort date principal balance, the loss severity rate of a default occurring in the distant future is lower than a default occurring shortly after the cohort date.

VI. CONCLUDING REMARKS

We have developed methods to predict the final loss severity rates for RMBS defaults in not yet matured securities and studied the statistical properties of final loss severities within a sample of 187 defaulted residential mortgage-backed securities.

We have demonstrated that Moody's ratings are highly correlated with loss severity rates. Larger and thicker tranches typically sustain lower loss severity rates than smaller and thinner tranches. Similarly, senior securities suffer lower average loss severity rates than mezzanine or junior securities.

We analyze the results of three separate loss severity prediction models—static, dynamic, and blended models—in order to predict the final loss severity rates on defaults that have not matured.

Our proposed measures of loss severity rates are generally applicable to all asset classes in structured finance, although the advantage of the blended loss prediction model depends on principal payment and principal loss information since default. For defaulted securities in assets other than RMBS or HELs that have sustained principal losses, the model framework is generally applicable, but its parameters need to be estimated for different asset types. The model will not work properly, however, on defaulted securities that have not yet sustained any principal losses.

ENDNOTES

The authors thank Warren Kornfeld for his valuable comments and Alexandra Neely for excellent research assistance.

[1]Some cured defaults may have incurred economic losses in the present value sense (since not all structured securities promise interest on interest in the event of default), but typically the economic losses on cured defaults are extremely small. A security is defined as materially impaired if it sustains a payment default that has not been cured (i.e., no more losses outstanding), or has been rated Ca or C, even though it may not have suffered any losses.

[2]In some cases, even though the tranche balance has been reduced to zero, money will become available to investors of certain tranches. The amount of such reimbursement, if any, is typically small.

[3]The mean severity rate of all corporate bonds (both secured and unsecured and senior and junior bonds included) over 1982-2003 was about 65%, and the median was 69%.

[4]A logit transformation on a variable x takes the form of $\log[x/(1-x)]$. The inverse of this transformation takes a value between 0 and 1.

[5]The seasoning pattern of rating transitions in structured finance is documented in Hu and Cantor [2003]. The seasoning pattern of default rates in structured finance is documented in Hu and Cantor [2004].

[6]Static estimates of final severity rates can sometimes fall outside these boundaries.

[7]Heteroscedasticity and autocorrelation present challenges in estimation of this type of model. A regression is heteroscedastic when the scale of the dependent variable and the explanatory power of the model vary cross-sectionally. Dependent variables observed over time tend to be correlated, and such autocorrelation will be present in disturbances across periods. For models with only heteroscedasticity, White t-statistics are widely used to compute statistical significance levels. For models with only autocorrelation, autoregressive or moving-average error models are widely used. When there are both problems, especially when the types of heteroscedasticity and autocorrelation are unknown with certainty, the general method of moments (GMM) has proven to be useful in the estimation. We use the GMM method with a Bartlett kernel estimator for the bandwidth function and impose boundaries of 0 and 1 on the dependent variable.

[8]Loss of principal is the initial default event for all but one defaulter in the sample of matured defaults. The interest shortfall defaulter is not included in the model estimation. Overall interest loss as a share of total losses averages less than 3%.

[9]Although the reported standard error of the estimate from the regression is low at 0.024, we know it is biased downward due to the presence of multiple observations and overlapping data from the same transaction. The coefficient estimates, nevertheless, should be unbiased estimates.

REFERENCES

Hu, J., and R. Cantor. "Defaults and Losses Given Default of Structured Finance Securities." *The Journal of Fixed Income*, March 2004, pp. 5-24.

——. "Structured Finance Rating Transition: 1983-2002." *The Journal of Fixed Income*, June 2003, pp. 7-27.