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Model Construction and Development of RBC Factors for Fixed Income Securities for the NAIC's Life Risk-Based Capital Formula

A report prepared by the American Academy of Actuaries C1 Work Group

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Contents

I. Background

This report has been prepared by the American Academy of Actuaries[1] (Academy) C1 Work Group[2] to document the considerations, assumptions, and methodology used in the development of investment risk factors for fixed income assets in the NAIC's Life Risk Based Capital (RBC) formula.[3]

The purpose of the NAIC's Risk Based Capital formula is to identify potentially weakly capitalized companies. RBC establishes a de facto minimum amount of capital to be held by insurers in order to avoid regulatory intervention. This minimum capital amount protects statutory surplus from the fluctuations that reduce statutory surplus. The C1 capital provides protection from statutory insolvency due to losses in statutory asset value due to bond defaults, common stock depreciation, and other changes associated with investment activity flowing through statutory surplus.

RBC is calculated from three separate formulas (Life, Health, and P&C). Life RBC is an after-tax calculation, while the Health and P&C RBC calculation is before-tax. The RBC framework is based on separate distributions for material risk components (i.e., C0–C4 RBC components), aggregated to establish total capital requirements. Statutory required capital is based on an assumption of a going concern insurance enterprise where required capital is established in addition to policy reserves. Further, required capital is based on the assumption that the insurer establishes adequate policy reserves through statutory formulaic requirements plus any reserves held as a result of Asset Adequacy Analysis.

Statutory policy reserves are established to pay future policyholder benefits. Statutory policy reserves for life insurance (comprised of statutory formulaic minimums plus additional funds arising from Asset Adequacy Analysis) include some provision for expected asset losses. RBC, or more specifically, the C1 component, establishes minimum capital standards in accordance with certain risks that could affect surplus levels,[4] including:

- Credit risk: Risk that an issuer, counterparty or reinsurer will default by not performing in a manner consistent with its contractual obligation as applicable to repay principal and/or interest or to satisfy a counterparty or reinsurer payment.

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[1] The American Academy of Actuaries is an 18,500+ member professional association whose mission is to serve the public and the U.S. actuarial profession. The Academy assists public policymakers on all levels by providing leadership, objective expertise, and actuarial advice on risk and financial security issues. The Academy also sets qualification, practice, and professionalism standards for actuaries in the United States.

[2] Members of the Academy's C1Work Group include co-chairpersons Nancy Bennett and Jerry Holman, and members Adam Arians, Mark Birdsall, Ross Bowen, Ken Griffin, Kory Olsen, Rich Owens, Jennifer Parkes, Guanghui Peng, Jim Reiskytl, Ruth Sayasith, Lisa Thomas, Chris Trost, Daron Yates, and Mark Yu.

[3] We want to thank the following individuals for their assistance throughout this project: Chris Anderson, John Bruins, Brian Cope, Joe Dunn, Kenneth Emery, Joel Levine, Mike Little, Alfred Medioli, Kerry Nelson, Gerard Painter, Matti Peltonen, Gabriel Petek, Robin Prunty, Bill Quadrini, Robert Riegel, Jessica Riley, Scott Robinson, Kenn Tevin, Ed Toy, Elaine Weiche, Michele Wong, and Mike Zurcher.

[4] American Academy of Actuaries Report of the Invested Assets Work Group regarding the C-1 Framework, to the NAIC's Life RBC Work Group, June 2011. http://actuary.org/files/publications/C1_Framework_Report_061011.pdf.

- Deferral risk: Risk that issuer may suspend dividends/coupons or the expected redemption schedule without triggering a default.
- Subordination risk: Risk that payments to some creditors will take a lower priority, or be subordinated to other creditors.
- Event Risk: the risk that an issuer will not be able to make a payment because of dramatic and unexpected events.

The C1 component of the Life RBC formula is dependent on the rating assigned by the Nationally Recognized Statistical Rating Organizations (NRSRO). To the extent that investment risks are reflected in the NRSRO rating, then that risk is captured in the C1 capital requirement. Specifically, deferral risk, credit leverage or the degree of subordination are reflected in the NRSRO rating. Event risk is very difficult to predict, but to the extent that event risk contributes to default experience, event risk is implicitly reflected in the C1 factors via the historical default experience.

C1 excludes the following risks:

- Fair Value Depreciation of Debt Instruments: Risk of market price fluctuation of an asset not due to interest or credit related effects. Technically, fair value depreciation is not a specific security risk but is the outcome of many other possible risks. C1 RBC is based on statutory book value accounting (i.e., amortized cost). Statutory surplus is not affected by the changes in the fair value of debt instruments that are not at or near default; consequently, C1 risk capital does not capture the risk of fair value depreciation associated with most debt instruments.

- Currency Risk: Risk that a non-dollar-denominated bond (i.e., a bond whose payments occur in a foreign currency) has uncertain U.S. dollar cash flows affecting current income and asset value. The uncertainty of the cash flows and asset value is dependent on the foreign exchange rate at the time the payments are received or the bond is valued.

  Currency risk is excluded from the C1 factors due to the complexity of modeling the risk in the C1 model. Some companies may reflect currency risk in the calculation of C3 capital requirements. To the extent that non-US dollar denominated securities are sold to generate cash for products included in RBC C3 modeling, the C3 RBC component could capture currency risk. Because insurers' C3 models vary in their level of sophistication, there is no assurance that all currency risk will be captured in the C3 component.

- Liquidity Risk: Risk that assets cannot be traded with the expected bid/ask spread, anticipated price continuity or sufficient depth, thus causing price realization or execution that is unfavorable or nonexistent.

  Liquidity risk cannot be captured by RBC. Liquidity risk is a result of a short term need for cash. Holding additional capital to cover short term cash needs would likely not be effective in mitigating liquidity risk. In the event of a liquidity need, there would be limited value to holding more securities that would need to be sold to generate the cash. In a liquidity crisis, more liquid assets are needed, not just more assets.

A complete description of the risks included in the RBC formula is contained in the American Academy of Actuaries Report of the Invested Assets Work Group regarding the C-1 Framework, to the NAIC's Life RBC Work Group, June 2011 (http://actuary.org/files/publications/C1_Framework_Report_061011.pdf).

The C1 component of the NAIC's RBC formula assumes there is 100 percent correlation among the C1-o risks for different types of assets (i.e., all assets except equities which are captured in C1-cs). The C1-o and C1-cs risks are assumed to be independent of each other. While there is an additional charge for concentration risk, the C1 RBC component provides no allowance for the risk mitigation provided by active portfolio management or sector diversification.

In developing the proposed C1 bond factors, certain constraints from the regulators were defined:

- RBC needs to be an auditable value, calculated from published financial statements. Consequently, the C1 factors were developed from a fairly simplistic projection of future losses. More complex credit models were considered (e.g., structural, closed form models), but rejected due to the need for reliance on non-public data.
- The C1 component must be based on the credit ratings reported in the NAIC Annual Statement.
- The C1 component must represent the statistical safety level prescribed by regulators. Essentially, the recommended C1 factors have been developed using a similar methodology to the current factors.

II. Proposed RBC C1 Bond Factors

A. Proposed Bond Factors

The following chart displays the recommended factors. Recommendations are after-tax, but the after-tax factors have also been converted to a before-tax basis to facilitate comparison of the factors shown in the RBC filing. The factors for individual securities are derived from losses projected over a ten-year time horizon and a 92nd percentile statistical confidence level. Detailed documentation of the methodology and assumptions is contained in this report.

Table 1. Proposed Basic C1 Bond Factors

Bond Rating	Current Category	Proposed Category	Before Tax Current Factors	Before Tax Proposed Factors Uncompressed	Before Tax Proposed Factors Compressed	After Tax Proposed Factors Compressed
Aaa	NAIC1	P1	0.40%	0.28%	0.34%	0.25%
Aa1	NAIC1	P1	0.40%	0.43%	0.34%	0.25%
Aa2	NAIC1	P2	0.40%	0.63%	0.72%	0.52%
Aa3	NAIC1	P2	0.40%	0.79%	0.72%	0.52%
A1	NAIC1	P3	0.40%	0.96%	1.16%	0.84%
A2	NAIC1	P3	0.40%	1.13%	1.16%	0.84%
A3	NAIC1	P3	0.40%	1.30%	1.16%	0.84%
Baa1	NAIC2	P4	1.30%	1.49%	1.49%	1.07%
Baa2	NAIC2	P5	1.30%	1.68%	1.68%	1.21%
Baa3	NAIC2	P6	1.30%	2.01%	2.01%	1.45%
Ba1	NAIC3	P7	4.60%	3.55%	3.55%	2.56%
Ba2	NAIC3	P8	4.60%	4.39%	4.39%	3.16%
Ba3	NAIC3	P9	4.60%	5.62%	5.62%	4.05%
B1	NAIC4	P10	10.00%	5.99%	5.99%	4.32%
B2	NAIC4	P11	10.00%	7.86%	7.86%	5.66%
B3	NAIC4	P12	10.00%	10.31%	10.31%	7.42%
Caa1	NAIC5	P13	23.00%	14.45%	17.31%	12.46%
Caa2	NAIC5	P13	23.00%	19.85%	17.31%	12.46%
Caa3	NAIC5	P13	23.00%	29.82%	17.31%	12.46%

For the purposes of this documentation, the term “current factors” refers to the C1 Bond factors used in the NAIC’s 2014 Life RBC formula. The recommended factors in the table above should be considered base factors, before any rounding or adjustments for portfolio effects such as number of issuers or portfolio size. The original 1992 RBC formula makes an adjustment based on the number of issuers in a bond portfolio. The RBC formula doubles the C1 factor for the top ten largest holdings of debt related issuers, not limited to bonds, and excluding certain securities (e.g., bonds with C1 RBC equal to zero) to increase capital requirements for concentration risk. Up to 10 bond issuers in a portfolio can be subject to this adjustment. Possible adjustments to these recommended base factors will be considered and subsequently recommended to the NAIC's IRBC Work Group. Adjustments may include issuer concentration and number of issuers within the portfolio.

The recommended set of C1 factors increases the number of factors from six to fourteen. Currently, C1 factors are defined for each of the NAIC bond designations 1-6, where designation 6 contains bonds in or near default. The Academy's C1 Work Group recommends increasing the number of designations to 14 (where designation 14 contains bonds in or near default) to eliminate the large jumps in the C1 factors and to better align the C1 factors with investment risks. Further, the more granular set of categories will better track changes in portfolio distributions by not relying on average assumptions. For example, in the current system, A-rated bonds were assumed to represent 50 percent of the holdings in the NAIC 1 designation, but the industry average has increased to 70 percent since the inception of RBC. The greater weight in the lower end of the category causes an understatement of risk capital.

The Academy's C1 Work Group's analysis was based on the full set of alpha-numeric ratings (i.e., 19), with the recommended set of factors based on compressing the 19 factors to 13 factors (plus one factor for bonds in or near default). The compressed scheme should reduce the large jumps between C1 factors (as in the current scheme), while still maintaining the relative risks of each designation. The compression of the 19 letter modifier ratings to 13 categories is done for two reasons:

- The statistical credibility of the default in certain alpha-numeric rating classes;
- Some state laws require the reporting of investment grade securities (Aaa – Baa) in the top two designations; some regulators on the NAIC's Investment RBC Work Group and NAIC staff stated a preference to designate investment grade securities in the top six designations, as long as supported by the analysis.

The letter modifiers encompassed by Ba and B rated bonds were each assigned their own factor because the differences between them was considered to be large enough to merit distinction. While the Caa letter modifiers also vary significantly by rating, there are relatively few industry holdings and the data is less statistically credible. Consequently, the proposed factors include the aggregation of Caa1, Caa2, and Caa3 into one factor (P13) based on the industry holdings in these three rating categories. The current factors for NAIC 5 are based on a 100 percent weighting in the Caa3 rating category.

In addition to the 13 factors, we are continuing with a recommendation of setting the factor for bonds in or near default equal to the factor for unaffiliated common stock before any beta adjustment (i.e., 30%). Bonds at or near default (currently, NAIC 6) are held at market value in the Life Annual Statement reflecting write-downs. The C1 factor will be applied to a bond that has already been written-down, raising the question of how much capital should be held for further write-downs and ongoing market volatility. Subsequent write-downs can be made. While the 30% factor might seem high, the C1WG has not reviewed the extent of any data or analysis on the ultimate principal recovered after the end of the workout period. Consequently, absent a compelling reason to change the current basis, the C1WG recommends the continuation of the 30% common stock factor for bonds in or near default.

In the C1 calculation, the factors are applied to an individual security or issue. While the factors have been established at the 92nd percentile over a ten-year horizon, the expected C1 coverage for a typical portfolio is expected to be in the 95-96th percentile statistical safety level. The coverage level for a representative portfolio will be analyzed in more depth while analysis is being performed on the factor adjustments reflecting portfolio effects. Given the different number of issuers and the composition of each differently sized portfolio, the statistical coverage level will vary from the 92nd percentile. Generally we expect the coverage to be higher, but in some instances may be lower. See Appendix D, Representative Portfolio for further discussion. The portfolio adjustments will be defined, in part, so that all the portfolios tested will result in a coverage level in a similar range (e.g., 95-96th percentile).

The recommended factors apply to the carrying value of the security (i.e., amortized cost for bonds in good standing, market value for bonds in or near default). The C1WG considered an adjustment to the calculation to account for differences between carrying value and par value. As described in the methodology section below, the loss is defined relative to par value. While adjustments are made when the carrying value is greater than the par value for certain structured securities, the C1WG concluded a similar adjustment is not warranted for corporate bonds.

The C1WG analyzed industry bond holdings as of December 31, 2011. The holdings were sorted according to the carrying value relative to the par value. Approximately 73% of holdings were within 2.5% of par. As a result of an extended low interest rate environment, a material portion of the average portfolio was held at a premium to par (approximately 19% of industry holdings had carrying value greater than 102.5% of par value). The basic C1 factors were recalculated with an adjustment that eliminates any discount or premium. The analysis showed that the basic C1 factors are approximately understated by 1.3% on average. An individual insurer's portfolio can show greater variation, depending on the holdings.

The C1WG concluded that the additional complexity in the RBC calculation was not justified by the modest increase in the accuracy of C1 capital and is not recommending adjustments to the basic C1 bond factors for premium/discounts. The offsetting effects in a portfolio of bonds held at a premium and those held at a discount negate the need for a carrying value adjustment. However, our analysis does show that that as the proportion of premium bonds increases, the understatement in capital requirements increases. Consequently, we suggest that state examiners consider an insurer's distribution of bonds relative to par value as a potential flag. An insurer with a large proportion of premium bonds could contribute to a weaker capital position.

B. Observations on Recommended Factors

On an after tax basis, the average C1 charge for bonds for the industry, before covariance and before any adjustments for the number of portfolio issuers or concentration increased from 0.84% to 1.12%. The average industry C1 charge for bonds increased from 1.16% to 1.56% on a before tax, before covariance basis and before any adjustments for the number of portfolio issuers or concentration. This average C1 charge is based on the aggregate bond holdings for the life insurance industry, based on an average of the holdings on December 31, 2011 and December 31, 2013.

Generally, the recommended factors increase for investment grade ratings and decrease for below investment grade ratings. As discussed in the reconciliation analysis, the main drivers of the changes arise from changes in the historical experience for default and recovery rates relative to the assumptions used in developing the 2002 C1 factors. Comparisons between the current and recommended factors are complicated for many reasons, including:

- the discontinuity of grouped ratings under NAIC 1 vs. their underlying letter ratings.
- the assumed vs. actual weighting of ratings within the NAIC 1 category. The original weighting assumed 50% A in the NAIC 1 category. This weighting has migrated to 70%.
- the weightings underlying the Caa rating have changed; The 1994 factors used a single rating of unknown source. At that time, the Caa letter modifiers did not exist, but the documentation indicated three gradients of default rates where the lowest quality was used. Because there are so few assets in this quality range, we have used a weighting of the underlying letter modifiers consistent with the other letter ratings. Any of the letter modifiers, or a different weighting of them, could be chosen, if preferred by the regulators, as the P13 factor.

C. Reconciliation Analysis

In the following section, the recommended base factors have been compared to the current C1 factors. The current C1 factors were last analyzed in 2002. While the methodology was changed, no changes were made to the original C1 factors first reported in 1994 as a result of this 2002 analysis. The model used to develop 2002 factors was reconstructed in the 2015 bond engine and was used as the basis for comparison. The major differences between the 2015 recommended factors and the 2002 factors have been quantified and explained.

In order to compare the recommended factors to the current factors, a stepping process, changing one assumption at a time, was used to derive the component effect on the C1 factors. Because the current factors have five categories, excluding in or near default bonds, the proposed factors on a letter modifier basis were converted to the same five categories using industry weightings of the underlying letter modifier ratings.

The main differences are caused by changes in the assumed interest rate, default rates and recovery rates. A number of other effects contribute to the differences. The “other” effects are detailed in an expanded discussion in Appendix E, Reconciliation of Factors. The table below quantifies these differences:

Table 2. Attribution of Change in 2002 vs. 2015 C1 Factors

		2002 Pre-tax C1	Discount Rate	Default	Recovery	Other	**Total Change**	**2015 Pre-tax C1**
	Aaa	0.40%	0.05%	(0.04%)	0.11%	(0.24%)	(0.12%)	0.28%
	Aa	0.40%	0.09%	(0.08%)	0.23%	0.03%	0.27%	0.67%
	A	0.40%	0.15%	0.03%	0.25%	0.33%	0.76%	1.16%
NAIC 1	Aaa-A	0.40%	0.11%	(0.02%)	0.21%	0.12%	0.42%	0.82%
NAIC 2	Baa	1.30%	0.21%	0.06%	0.20%	(0.10%)	0.37%	1.67%
NAIC 3	Ba	4.60%	0.52%	(0.23%)	(0.65%)	0.05%	(0.31%)	4.29%
NAIC 4	B	10.00%	0.84%	(2.35%)	(2.56%)	1.64%	(2.43%)	7.57%
NAIC 5	Caa	23.00%	1.41%	(6.76%)	(5.01%)	4.67%	(5.69%)	17.31%

The major reasons for the change in factors are summarized below:

1. Discount rate – a material assumption as the C1 capital requirement essentially pre-funds capital required for losses in the tail of the distribution over the ten-year time horizon. The methodology used in developing the C1 factors involves the projection of future losses over ten years, discounted at a single interest rate. The rate used in developing the recommended factors is materially lower than the rate used in the current factors.
2. Default experience – increases the factors for investment grade ratings while decreasing the factors for below investment grade ratings. The impact of the change in default experience should be viewed as a package of the baseline rates and the modifications for economic conditions during the course of a modeled scenario.
3. Recovery methodology – The new C1 model reflects historical experience for recoveries; investment grade securities have experienced lower recovery rates, particularly in the tails of the distribution. More complete data about recoveries is available, as compared to the available information in the early 1990's and in 2002.
4. The "Other" differences are grouped and include factor differences due to portfolio structure, granularity, rounding and methods. Details are provided in Appendix E, Reconciliation of Factors.

III. General Modeling Approach

A. General

The C1 capital represents the amount of funds needed such that this amount is sufficient to cover losses in excess of those anticipated in policy reserves that could occur within the bond portfolio over the specified time horizon within the stated confidence level. In essence, the C1 capital is equivalent to pre-funding future excess losses at the chosen confidence level and time horizon (i.e., ten years).

The methodology for developing C1 factors is best described as a historical model. The factors are developed from historical default rates and loss given default experience for a representative life insurance portfolio. The factors do not reflect differences in individual company portfolios and assume a homogeneous structure for each corporate bond. Different types of credit models were considered before choosing the historical model, namely structural and reduced form credit models. Both structural and reduced form models produce forward-looking credit assessments based on the current market environment. The current C1 method uses historical data and assumes future experience will be similar to past experience. While structural and reduced form models are more sophisticated, the results are more challenging to understand and cannot be replicated from published data. Consequently, the decision was made to continue use of the historical approach to develop C1 factors. A more in-depth discussion of structural and reduced form models is included in Appendix F.

The C1 capital charges are derived from a simulation model where the cash flows for a representative bond portfolio are projected assuming different random economic conditions. Losses are projected over ten years. The projection of losses is based on a random selection of economic condition at the start of the projection period (e.g., expansion or recovery.) Default rates and recoveries vary from a baseline assumption dependent on the economic condition. Economic conditions were simulated over the modeling period using a U.S. expansion and contraction transition matrix. The recommended factors have been derived from running the model over 10,000 scenarios, where the economic condition at the start of the projection period is random for each scenario.

The required capital for a given scenario is calculated as the amount of initial funds needed such that the accumulation of this initial fund and subsequent cash flows will not become negative at any point throughout the modeling period. Requiring capital to pre-fund the greatest loss is more conservative than pre-funding the cumulative losses over the ten-year projection period, but this condition has been part of the C1 requirements since RBC was introduced in the early 1990's. There are additions and subtractions from this required capital fund:

- Additions to the capital fund include fund interest, tax recoveries on the loss, and an annual "risk premium"
- Subtractions to the capital fund include default losses net of recoveries and any taxes paid.

The risk premium is a mechanism for capturing the expected losses assumed to be covered by statutory policy reserves. The risk premium (more fully documented in a subsequent section of this documentation) represents the level annual mean loss from default (after tax), as derived from the baseline default and LGD rate assumptions for the C1 bond factors. Risk premiums added to the fund are assumed to earn interest at interest rate assumption, the 5 percent pretax.

The investment income (e.g., coupon income) from the assets in the fund is not an addition to this capital fund, with two exceptions. The income from the portion of assets funding the risk premium and the risk free income on capital are included as additions to the fund. The implicit assumption is that any profit from investments is fully distributed to policyholder dividends or used to absorb product or operational losses.

For each scenario, the required capital factor is equal to the greatest amount required to offset the present value of projected net cash flows determined annually divided by beginning assets. The required capital factors for each economic scenario are rank-ordered, thereby producing a distribution of required capital factors. The C1 charge for each rating designation is set at the 92nd percentile in the loss distribution.

B. Definition of Loss and Statutory Carrying Value

Loss is defined as the net principal loss given default, in excess of the expected loss assumed in statutory policy reserves. Bonds are assumed to be held at par value. The basic C1 factors do not make any adjustment for bonds carried at a premium or discount.

RBC is understated for bonds with carrying value greater than par value, while RBC is overstated for bonds with carrying value less than par value. As discussed earlier, an adjustment to the C1 factor calculation was considered for differences between the carrying and par value. While there is an inconsistency in C1 treatment between structured securities and corporate bonds, the C1WG did not think the adjustment would produce a materially different RBC C1 amount to justify the complexity added to the RBC formula.

In drawing this conclusion, the corporate bond model was used to approximate the carrying value effect. The analysis showed that the degree of discount in the reported carrying value compared to the expected recovered amount is likely overstated. Because the final par value of bonds issued at a discount is often reported as par value rather than a lower accreted value (especially for zero coupon bonds), the apparent discount is overstated. Recoveries would be based on an accreted value not a higher par value that would include as yet unearned interest. For most portfolios, the net amount of over- or understatement is likely immaterial. The impact of discount bonds will offset the impact of premium bonds.

An analysis of life industry holdings as of December 31, 2011 (the basis for the representative portfolio) showed that 73% of the bonds are held within a 5% band, (plus/minus 2.5%) of par. Bonds at more than a 2.5% premium to par outweigh those bonds at more than a 2.5% discount to par by over 2 to 1. Ten percent of bonds are in the 2.5% - 7.5% range of premium to par. Overall, 19% of bonds exceed 2.5% premium to par; 8% are held at more than a 2.5% discount to par.

C. Reinvestment Assumptions

In the projection of future cash flows, net cash flows resulting from defaulted bonds are reinvested in assets with the same characteristics as the assets of the same starting rating that have not defaulted. The full principal amount rather than the salvage amount is reinvested. Reinvesting the full principal amount maintains the same portfolio size throughout the modeling period and consistent with pre-funding losses for a portfolio. Reinvestment is always made in a bond with a maturity equal to the remaining term in the projection period at the credit quality of the bond at the start of the projection period. This assumption is not the same as maintaining the same mix of rated bonds as at time zero because the quality of assets fans out (downgrades and upgrades) as the cohort progresses through time.

Reinvestment assumptions do not reflect active investment strategies due to modeling limitations; it is very difficult, if not impossible, to replicate buy or sell decisions made by humans. The reinvestment strategy did not change if reinvestments were being made in a random stressed economic scenario.

D. Risk Premiums

The risk premium (RkP) is defined as the level, annual expected loss over ten years for each rating class. The risk premium is a representation of the expected losses funded by statutory policy reserves. While the Standard Valuation Law does not explicitly define the level of credit losses covered by statutory reserves, the general consensus in the actuarial community is that statutory policy reserves (tabular plus additional reserves due to cash flow testing) at least cover credit losses up to one standard deviation (approximately 67th percentile). In defining the risk premium, the C1 WG chose to set the risk premium at the mean credit loss. This level reflects conservatism, but recognizes that there is no reserve offset for assets backing capital.

The RkP is a level, annualized risk premium and represents the amount of spread contained in the assets backing statutory reserves. The RkP% is applied to the beginning of year assets to determine the annual contribution, the Risk Premium Amount (RPA). Beginning of year assets are set equal to statutory reserves. The RPA offsets total losses in the determination of the net maximum loss, present value basis, for each trial. The Risk Premium formula is defined as follows:

$$\text{RkP\%} = \sum_{t=1}^{H} [(1-rt) * v^{t-1/2} * D_{e,t} * LGD_{e,t}] / [(1+\text{i})^{1/2} a_{\overline{H|}}]$$

Where:

$D_{e,t}$ = Expected default rate year t

$LGD_{e,t}$ = Expected loss given default percentage year t

rt = recoverable loss given default tax rate

i = after tax interest rate

v = the discount rate = 1/(1 + i)

$a_{\overline{H|}}$ = an annual annuity over H years

H = horizon year

The Risk Premium Amount is defined as follows:

RPA = RkP% * A_t where

RPA = Risk Premium Amount

A_t = Assets at beginning of year t

Note for the C1 modeling purposes:

rt = 28% = .8* 35%

i = 3.25% = .65* 5.00%

H = 10

The Risk Premiums used in the recommended 2015 C1 Bond Factors are included in the table below:

Table 3. Risk Premiums by Rating Class

	2015	Current
Aaa	0.008%	0.04%
Aa1	0.016%	0.04%
Aa2	0.027%	0.04%
Aa3	0.043%	0.04%
A1	0.065%	0.04%
A2	0.089%	0.04%
A3	0.116%	0.04%
Baa1	0.147%	0.19%
Baa2	0.185%	0.19%
Baa3	0.234%	0.19%
Ba1	0.579%	0.93%
Ba2	0.770%	0.93%
Ba3	1.049%	0.93%
B1	1.461%	2.13%
B2	2.064%	2.13%
B3	2.915%	2.13%
Caa1	4.010%	4.32%
Caa2	5.050%	4.32%
Caa3	5.088%	4.32%

The recommended C1 factors are based on the same basic methodology as was used in developing the original C1 factors in the early 1990's and reviewed in 2002. It should be noted that there was no attempt to align this C1 methodology with the methodology used to define the prescribed default costs in the Valuation Manual, section VM-20. While there are some valid reasons for consistency between the two methods, VM-20 prescribed default costs were developed before this latest review of the C1 factors. The prescribed default costs will affect the statutory reserves held for certain life insurance policies issued after January 1, 2017 (based on the current expected adoption date), while the C1 factors will apply to all existing assets after the implementation date. The margins built into the VM-20 baseline defaults are defined at 70 CTE (Conditional Tail Expectation), or approximately defined at the 85th percentile. The 70 CTE level will produce higher defaults than the defaults assumed in existing policy reserves and in the current and recommended C1 factors. Further, the VM-20 prescribed default costs do not reflect recoveries.

When VM-20 becomes the predominant valuation method for inforce policies, the C1WG recommends a comparative review of the VM-20 and C1 methodologies to bring the two methodologies more in line with each other.

E. Application of C1 Factors to Fixed Income Assets Other than Public Corporates

The C1 factors recommended in this document are based on the loss experience for public U.S. corporate bonds. The loss experience is based on defaults for senior, unsecured issues. Loss experience for several types of fixed income securities is not reflected in the loss assumptions, including the following: private placements, 144a, municipals, sovereigns, hybrids, mezzanine debt. The C1 Work Group has not developed separate models for fixed income assets other than US public, corporate bonds. However, C1 factors must be established for these non-modeled fixed income asset types.

In the current RBC formula, the C1 bond factor is applied to any asset reported in the NAIC's Schedule D (excluding the structured securities which follow a different modeling process to determine their C1 charge). The C1 Work Group recommends the continuation of this practice and the use of one common set of C1 factors for all fixed income securities reported in Schedule D, based on the following rationale:

1. The C1 calculation is based on the rating of the security reported in the NAIC Schedule D of the Annual Statement. Most of the ratings are provided by National Recognized Statistical Rating Organizations. Discussions with these NRSROs confirm the use of a global ratings process. This global ratings process strives to establish equivalence across all sectors for a given rating. Consequently, an Aa rated corporate bond and an Aa rated municipal bond by Moody's both have the same outlook for future loss experience (Note that S&P's rating process is based on the outlook for future default experience). The global ratings process results in adjustments being made to the ratings such that the outlook for future default outlook is the same regardless of the type of bond.

2. While S&P and Moody's publish separate default studies for corporates, municipals, and sovereigns, the data has not been adjusted for recent changes in the ratings criteria and methodologies. Moody's transitioned to a global ratings process in 2010, while S&P states to have always followed a global rating process. The S&P criteria have been adjusted over time to reflect actual default experience. Because neither Moody's nor S&P has restated their default studies to reflect changes in their ratings processes, there is no credible default study published for municipals, sovereigns, or other fixed income asset classes based on consistent criteria.

3. Developing a separate set of factors for municipals, privates, or another type of fixed income assets would require a credible default study and a different process for calculating the C1 requirement that did not rely on the reported rating (i.e., a different process than multiplying a factor times the reported statement value at the appropriate rating). A review of the default studies, along with the opinions of some investment professionals raise some questions about the validity of the equivalence of the global ratings process. Some interested parties believe that municipals, privates, and other non-modeled securities have lower expected losses than corporates. However, this belief is tantamount to dismissing the credibility of the NRSRO ratings, thereby violating one of the constraints of the NAIC's RBC calculation to calculate C1 from published data.

The C1WG understands the desire to develop separate C1 factors as these asset types have a different risk profile than corporate bonds. However, the constraints of the RBC process drive the recommendation of the Academy's C1 Work Group to continue the use of one common set of C1 factors for all securities reported in Schedule D.

F. Asset Valuation Reserve

When RBC was implemented in 1994, the Asset Valuation Reserve (AVR) and the Interest Maintenance Reserve (IMR) were also implemented. Consequently, updating the C1 factors necessitates updating the AVR factors. First, here is some background on the AVR and the relationships between AVR, RBC, and statutory policy reserves.

AVR is a liability, set aside in Life Annual Statements to absorb credit losses and protect statutory surplus against large fluctuations in equity values. AVR is also considered by many to be "above the line surplus" **because** AVR is a "reserve" for future losses**.** The AVR default component measures the default reserve risks at approximately the same standard as that of the other statutory reserve components. AVR also affects:

- Investment limits under the Model Investment Law
- Limitations on Ordinary shareholder dividend
- The cap on the Admitted Deferred Tax Asset

AVR acts like a fund that moves up and down depending on a company's asset loss experience, subject to a maximum; this maximum functions as a smoothing mechanism. AVR decreases when credit losses exceed expected and increase when credit losses are less than expected in any year, always moving toward the targeted reserve level. Contributions to the AVR are deducted from Statutory Gain from Operations, essentially setting aside part of the spread on riskier asset classes for future credit losses. Without these AVR contributions, Statutory Gain from Operations would be artificially increased each year until the credit losses occur. AVR is counter-cyclical, partitioning capital for stress conditions via the AVR mechanism.

AVR buffers unassigned surplus from the credit effects of debt instruments and the fair value changes of equities. AVR reduces what would otherwise be unassigned surplus so there is less risk of insurers paying excessive dividends or taking other risks, particularly as asset values appreciate. AVR encourages conservative and stable dividend policy through economic cycles. AVR is only required for Life companies. The AVR may be more effective in stabilizing dividend policies for life insurers that are typically funding longer term liabilities.

AVR that is not used for asset adequacy analysis is part of Total Adjusted Capital (TAC); TAC equals unassigned surplus plus the unused portion of AVR plus one half of the dividend liability. Because the establishment of AVR reduces unassigned surplus, the definition of TAC results in AVR "disappearing" from the RBC framework in most instances. The RBC Instructions have recently been changed to eliminate the double counting of AVR in cash flow testing and in the calculation of TAC. To the extent that an insurer uses a portion of the AVR in cash flow testing, that portion cannot be included in TAC. Note that few insurers rely on any portion of the AVR in cash flow testing. Finally, an individual company's AVR balance has limited or no bearing on the calculation of its required capital or the RBC ratio.

The Annual Statement instructions and the AVR NAIC Handbook state that the AVR reserve objective was set to cover default losses at the 85th percentile, consistent with valuation reserves[5] also assumed to be set at the 85th percentile. Maximums for fixed income are set equal to the post-tax C1 factor for each asset type.

Further insight into the purpose of AVR can be obtained in the original report on AVR and IMR to the NAIC's Financial Condition E Committee from 2002. As stated in the report, the primary functions of the Asset Valuation Process are the following:

- Assure that all assets and liabilities are reported on as consistent a financial basis as is practical.
- Minimize the impact that capital gains and losses arising from movements in interest rates have upon provisions for credit related losses. That is, distinguish capital gains/losses arising from changes in interest rates from capital gains/losses arising from changes in the assets' credit worthiness.
- Provide a reserve consistent with valuation actuary standards that adequately provides for future volatile incidence of asset losses.
- Provide appropriate recognition of long-term expected returns for equity type investments.

[5] Valuation reserves refer to the actuarial reserves established to cover future policy benefits.

Further, the 2002 Report describes the relationship between AVR and statutory policy reserves (Pg. 8). Highlights include:

- The Valuation Actuary's Opinion includes a statement that the assets backing the liabilities make adequate provision for the company's liabilities. That is, the Actuary must look beyond the statutory valuation formulas and satisfy himself that the cash flows generated by the assets will probably be sufficient to discharge the liabilities.
- Prior to the AVR and IMR, there were many circumstances under which the statutory formula valuation methods gave rise to inappropriate results.
- It is desirable that the valuation of the assets and liabilities be made as consistent as possible to (1) minimize the instances where, in order to render a clean opinion, the actuary must establish extra reserves due to interest rate gains or potential for defaults and (2) increase the likelihood that assets supporting liabilities are sufficient even in the absence of an Actuarial Opinion. The development of an AVR and IMR will correct many of these deficiencies in consistency.

For bonds, mortgages and other fixed income assets, there is a separate default component. The default component is based on the following calculations:

- Basic contribution – based on estimated annual after-tax losses, assuming no variation from the 1992 baseline assumptions. The basic contribution does not allow for any deviations, particularly in the tail of the distribution. The Basic Contribution is set equal to the risk premiums by rating class.
- Reserve objective – based on 85% of the distribution of losses for each asset class, where the 85^{th} percentile represents approximately one standard deviation, where it is assumed that statutory policy reserves cover one standard deviation.
- Maximum reserve – equal to the after-tax Risk Based Capital factors for each asset type.
- Accumulated balance = beginning balance +/- gains (losses) + basic contribution.
    - Note that gains/losses are added – no offset for any recoveries.
    - C1 bond model pre-funds net losses. The projected fund does not reflect projected gains or investment income.
- Ending balance = beginning balance +/- gains (losses) + basic contribution + 20% of (reserve objective – accumulated balances) + voluntary contribution.
- Ending balance not to exceed maximum reserve.

The following table contains the updated factors for the basic AVR contributions for the Bond Component, consistent with the recommended C1 factors. The AVR factors have been developed from the same bond model and loss given default experience as the C1 factors. The C1 Work Group has not performed any analysis on the effectiveness of the AVR in relation to its original objectives. These AVR factors serve to align the experience used in the development of the AVR and C1 RBC. The reserve objective is defined at the 85^{th} percentile and the basic contribution factor is defined as the mean.

Table 4. AVR Factors

	Basic Contribution	Reserve Objective Factor		Blended Category	Basic Contribution	Reserve Objective Factor
Aaa	0.008%	0.11%		P1	0.01%	0.14%
Aa1	0.016%	0.19%		P1	0.01%	0.14%
Aa2	0.027%	0.29%		P2	0.04%	0.35%
Aa3	0.043%	0.39%		P2	0.04%	0.35%
A1	0.065%	0.48%		P3	0.09%	0.59%
A2	0.089%	0.58%		P3	0.09%	0.59%
A3	0.116%	0.67%		P3	0.09%	0.59%
Baa1	0.147%	0.77%		P4	0.15%	0.77%
Baa2	0.185%	0.88%		P5	0.19%	0.88%
Baa3	0.234%	1.06%		P6	0.23%	1.06%
Ba1	0.579%	1.85%		P7	0.58%	1.85%
Ba2	0.770%	2.28%		P8	0.77%	2.28%
Ba3	1.049%	2.86%		P9	1.05%	2.86%
B1	1.461%	3.15%		P10	1.46%	3.15%
B2	2.064%	4.16%		P11	2.06%	4.16%
B3	2.915%	5.50%		P12	2.92%	5.50%
Caa1	4.010%	7.81%		P13	4.43%	9.49%
Caa2	5.050%	10.68%		P13	4.43%	9.49%
Caa3	5.088%	18.18%		P13	4.43%	9.49%

G. Interest Maintenance Reserves

Per the NAIC's Annual Statement Instructions, the IMR captures the realized capital gains/(losses) that result from changes in the overall level of interest rates and amortize those gains/losses into income over the approximate remaining life of the investment sold. The IMR includes realized capital gains/(losses) on debt securities (excluding loan-backed and structured securities) and preferred stocks whose NAIC/Securities Valuation Office (SVO) rating classification at the end of the holding period is not different from its NAIC rating classification at the beginning of the holding period by more than one NAIC rating classification.

The recommended C1 factors increase the number of NAIC rating classifications from the current six to fourteen. If the increased number of factors is adopted by the NAIC, the IMR instructions regarding one rating classification may need to be revised to appropriately separate capital gains and losses that arise from interest rate changes from other capital gains and losses. The C1 WG has not performed any analysis on this IMR issue, and recommends the appropriate NAIC work group consider the impact of fourteen bond classifications on the determination of capital gains/losses to be included in the IMR.

IV. Assumptions

Below are high level summaries of the key assumptions used in the model that form the basis for C1 RBC factors. Generally, assumptions are based on historical experience. Any margin in the assumptions would reflect smoothing or uncertainty due to insufficient data. Any margin for conservatism will be reflected in aggregate, through the chosen protection level.

The following table summarizes the assumptions used in the 2015 recommendation and the current factors, as reviewed in 2002. A description of each assumption is further summarized below, with the full details included in the Appendices.

Table 5. Comparison of Assumptions

Assumption	2002 Assumption/Method	2015 Assumption/Method
Defaults	Based on data Moody's Default Rates, "Moody's 1991 Special Comment: Corporate Default and Recovery Rates, 1970-1990"	Based on 1983-2012 cohort data from "Moody's 2012 Special Comment: Corporate Default and Recovery Rates, 1920-2012"
Recovery	Baseline LGD distribution varies by rating class. Documentation does not include data source for recovery assumptions.	Baseline LGD distribution uses senior unsecured bond assumption for all ratings. Based on proprietary data provided by Standard & Poor's from S&P CreditPro® LossStats data covering the period 1987-2012.
Economic State	5 State model; basis unknown. Application of model: 1. Baseline default rates are modified by economic state. 2. Baseline LGD distribution for each rating class is modified by economic state.	Combination 4 state-2 state model; based on 1983-2012 NBER data. Application of model: 1. Baseline default rates are modified by economic state; two state model for Aaa-A and four state model for Baa-Caa. 2. Baseline LGD distribution is modified by economic state (2 state model).
Number of scenarios simulated	2,000	10,000
Number of rating classes modeled	9 alpha including Caa1, Caa2 and Caa3, compressed to 5 C1 factors	19 alpha-numeric, compressed to 13 C1 factors
Rating class distribution	NAIC 1: AAA/Aaa = 25%,	The compression to the 13 factors was based on industry holdings.

Assumption	2002 Assumption/Method	2015 Assumption/Method
	AA/Aa = 25%, A/A = 50% NAIC 5: 100% Caa3	
Reserve Offset (i.e., the Risk Premium)	Expected losses assumed to be equal to AVR basic contribution factors; the AVR basic factors were assumed to be a proxy for the level of losses covered by statutory policy reserves.	Statutory policy reserves assumed to provide coverage for the expected losses, where the expected losses are assumed to be equal to the mean of the updated loss distribution.
Reinvestment Amount	Salvage Value	Full Par Value
Time Horizon	10 years	10 years
Confidence Level of rating class subset of Representative Portfolio	92^{nd}% ile	92^{nd} % ile
Discount Rate	6% after tax	3.25% after tax
Tax Recovery on Default	26.25% 75% recovery of capital loss tax benefit.	28% Corporate tax rate and timing of loss recognition, updated for current data, reflecting SSAP 43R; 80% recovery of capital loss tax benefit.
Ordinary Tax Rate	35%	35%
Rating class of subset of Representative Portfolio	Documentation incomplete	Average NAIC 1 portfolio distribution, excluding US government full faith and credit bonds, of category size 6 companies, based on life industry holdings at 12/31/2011; Data represented approximately 287,000 positions; 782 companies.
Number of securities in rating class subset of portfolio	400, size distribution varies by rating.	405, same size distribution used for all ratings.

A. Default

The group examined Moody's and S&P default data sets and selected the Moody's cohort bond default rates for the baseline assumption based on the methodologies used in preparing the default studies. Ratings transition probabilities are embedded in the Moody's cohort tables. Consequently, the C1 bond model used annualized default rates calculated over the ten year time horizon rather than annual rates combined with a transition matrix. The raw default data was smoothed across ratings and experience years using a 4th degree fit. The goal of the smoothing process was to define the default rates whose patterns were rational within the resulting smoothed table, yet consistent with experience.

The default experience was based on public corporate bonds for all sectors combined. The default rates did not distinguish by industry sector. Further, default rates did not vary by the tenor or maturity of the bond. Finally, default rates did not consider the impact market spreads could have on default rates.

More information about the default rates is included in Appendix A.

B. Recovery

Similar to the default assumption, the recovery assumption relies on historical data. The loss given default percentage (i.e., the complement of recovery such that LGD = 1 – recovery rate) is combined with the occurrence of default to determine a modeled total loss percentage. The loss given default (LGD) assumption is based on proprietary data provided by Standard & Poor's from S&P CreditPro® LossStats data covering the period 1987-2012. The LGD assumption is based on senior unsecured bond data, consistent with the data provided by S&P.

Current factors assumed recovery, without modification for economic conditions, was based on a normal distribution. Proposed factors are based on experience that exhibits a positively skewed distribution. Proportionally, there are a greater number of smaller amount recoveries than recoveries of larger amounts. Bond characteristics that affect LGD such as type of collateral, type of settlement, variation of capital layers, industry and region were not used due to limited data and to avoid unwarranted complexity in the RBC calculation. Without further refinement of associated bond characteristics, senior unsecured data was used for the LGD assumption.

As described by S&P and Moody's, their ratings process is based on the rating for a senior unsecured bond, adjusted for the particular issue's seniority position. Therefore, any variation in recovery due to an issue's lien position is captured in the rating. Some data shows varying recovery rates by lien position. The C1WG considered the development of C1 bond factors where the lien position was explicitly recognized. Consideration was given to using a matrix of C1 factors (e.g. rating and lien position) rather than the vector of factors currently used. Due to the increased complexity to the RBC calculation, along with other practical implementation concerns, the use of a matrix reflecting lien position was abandoned.

Because RBC relies on the reported rating from an NRSRO, no further adjustments were made to the recovery assumptions in the development of the C1 bond factors. Relative to the current factors' assumption, this recovery assumption produces a higher average LGD at higher quality ratings and slightly lower average LGD at below investment grade ratings.

Further details about the recovery rates are included in Appendix B.

C. Economic Model

Default probability and recovery rates are the two key assumptions used to develop C1 factors for corporate bonds. Historical data and associated research indicate that default probabilities are strongly influenced by the economy, with recovery rates also influenced by the economy, but to a lesser extent. The baseline bond default probabilities were developed using 1983 to 2012 corporate bond historical data and recovery rates were developed using 1987 – 2012 corporate bond historical data. This same data was used to develop assumptions as to how default and recovery rates vary by different economic states. The goal of this analysis was to develop an economic model or process for adjusting base default and recovery rates in different economic scenarios.

The National Bureau of Economic Research's (NBER) classification of economic states were evaluated, resulting in a classification of 1991, 2001, 2008 and 2009 as "contraction" years within the time horizon of 1983 to 2012. Differences of default and recovery experiences among different economic states were reviewed and "scalars" were developed that quantified how default probabilities and recovery rates varied.

The economic modeling approach for our default and recovery rate is summarized as follows:

1. Default Rate:
    a. 2-state model for Aaa, Aa, A with the same economic scalar for all the three categories.
    b. 4-state model for Baa, Ba, B and Caa-C rating categories. Each rating category has its own unique economic scalar.

2. Recovery Rate:
    a. 2-state model with the same economic scalar for all the rating categories.

Additional details on the economic model are contained in Appendix C.

D. Representative Portfolio

The development of the C1 factors is basically a two-step process. In the first step, basic factors are developed that apply to an individual security. These factors are based on the prescribed statistical safety level (92nd percentile over ten years). The second step involves the analysis of these individual factors on a portfolio of bonds in order to determine the anticipated coverage for a portfolio, in aggregate.

The Representative Portfolio (RP) is a major assumption and input item in the development of the basic C1 factors. The RP is a generic portrayal of the structure of a bond portfolio. The RP is designed to capture the key features affecting the C1 risk factor. The RP is identical for each rating class.

While there are several factors affecting a generic risk analysis of any corporate bond portfolio (e.g., mix of ratings, size distribution and number of issuers held in the insurer's portfolio), the representative portfolio did not reflect all of these factors. The RP did not consider the potential risk differences attributed to sector, duration, or structural characteristics of the bond (e.g., position in the credit structure, callability, covenants, etc.). The representative portfolio captures the major variables affecting LGD (ratings, issuer size variation, number of issuers) to evaluate aggregate risk.

The representative portfolio portrays bonds subject to the C1 charge on a consolidated basis. The representative portfolio is based on the December 31, 2011 corporate bond portfolios of all life insurers provided by the NAIC. Any company identifier information was not provided to the Academy. Bonds not subject to the C1 charge (e.g., US government full faith and credit securities and zero coupon bonds) are excluded from the representative portfolio.

Further details on the construction of the Representative Portfolios are included in Appendix D.

E. Time Horizon

The time horizon is a key assumption in the development of C1 Bond factors. The C1 factors set aside capital to fund potential bond losses at the chosen confidence level over the chosen time horizon. The confidence level and time horizon comprise the statistical safety level for capital requirements and is prescribed by the regulators. The C1WG provided input to the regulators to assist in defining the statistical safety level. This input is summarized in the following section to provide additional background.

The current bond factors are based on a ten-year time horizon. Generally speaking, there are two major perspectives on the choice of a time horizon. The first perspective ties the time horizon to the average duration of the liabilities, while the second perspective equates the time horizon with the average length of a business credit cycle. In this second perspective, the time horizon is independent of the products sold by the company.

Products have changed in the last twenty years, suggesting a shorter timeframe may be justified. The average duration of liabilities will vary significantly by product type and between individual companies. During the development period for the C1 factors (i.e., 2012-2014), the modified duration of the assets of life insurers is approximately seven and a half years, consistent with a ten-year average maturity. The average credit cycle varies with the state economy and many other factors, but seven to ten years is typical.

Further, even if the time horizon were changed, the statistical confidence level would likely have been changed such that a similar level of capital cushion was produced by the factors. For example, changing the ten-year time horizon to two years might be accompanied with an increase to the 98^{th} percentile confidence level. Changing from a 92^{nd} percentile over ten years to a 98^{th} percentile over two years might result in similar C1 factors.

The issues described in the paragraphs above were discussed with regulators. With no compelling reasons to change the time horizon, the regulators chose to continue with the statistical safety level of the 92^{nd} percentile over ten years.

F. Discount Rate

As described above, the C1 factor is based on the present value of the projected cash flows. The discount rate (DR) used for bonds in developing the current factors is 6 percent after-tax. The same DR is used for all simulations and does not vary over the projection period.

For the 2015 recommended factors, the DR is 5% pre-tax/3.25% after-tax. The basis for the DR is the ten year LIBOR swap rate. Based on the average ten-year swap rate over the past twenty years, this rate was determined to be 5.02% pre-tax or 3.26% after-tax. These rates were then rounded to 5% and 3.25%, respectively. The same DR is used for all simulations and does not vary over the projection period. Note that the average ten-year US Treasury rate over the last twenty years has been 4.57% pre-tax and 2.97% after-tax.

The C1WG considered different bases for the discount rate, such as the earned rate on the capital set up to fund future losses. Use of this rate would be consistent with the concept of requiring capital on the assets backing capital. Because the bond model does not make this assumption, we did not pursue this basis for the discount rate. Note that capital is required for the assets backing the surplus of an insurance company, suggesting that the earned portfolio rate would be a more suitable basis. While true, the bond model would have been refined to model defaults on those "surplus assets." Those default losses would reduce the earned rate toward the swap rate. The extra modeling did not seem worth the refinement

Ideally, the discount rate would also vary by projection year or by economic scenario. Given the logic of the bond model as designed, it is not feasible to incorporate a dynamic discount rate. Consequently, the C1 Work Group selected a discount rate based on the average ten-year swap rate over the past 20 years.

G. Federal Tax

The Life RBC factors are all calculated on an after-tax basis. Because the purpose of RBC is to protect statutory surplus, an after-tax calculation is consistent with the reporting of statutory surplus. Specifically, changes in statutory surplus (e.g., net income) are after-tax.

The Academy's Tax Work Group reviewed the basis for the tax factor and updated the tax assumption used in developing the recommended 2015 C1 bond factors.

Background:

> The 2001 tax assumptions were based on Statement of Statutory Accounting Principles (SSAP) #10. The NAIC adopted a new SSAP #101 effective January 1, 2012, replacing SSAP #10 (as well as SSAP #10R, that was an interim standard between SSAP #10 and SSAP #101). For the life insurance industry as a whole, SSAP #101 increased the amount of deferred tax asset recognized in the statutory financial statements as compared to SSAP #10.
>
> The 2001 tax assumptions used an effective tax factor of 26.25% for bonds carried at amortized cost. This tax factor was based on the assumption that 50% of the write-downs were realized in the calendar year they occurred and that 50% of the Deferred Tax Assets of the Life Insurance Industry were recognized. In other words, 26.25% = 35%{.50 + .50(.50)}. The assumption of 50% realized losses was an estimate reflecting various economic interest cycles and common tax strategy of offsetting fixed income capital gains with losses whenever possible.

2015 Corporate Bond Model:

In developing the tax assumptions for the 2015 C1 Bond Factors, the NAIC provided the Academy's Tax Work Group with data from the 2011 and 2012 annual statements to evaluate the impact of the revised DTA admissibility per SSAP 43R. The NAIC compiled data from the 2011 and 2012 Life Annual Statements. The NAIC compiled data showing the portion of deferred taxes statutorily recognized as a proportion of the total deferred tax assets averaged over the past two years. This data showed 63 percent recognition of deferred tax assets for the life insurance industry and is to be used in determining the after tax RBC Bond and related book valued asset factors.

The updated tax factor for assets carried at book value (for life insurers, all bonds are carried at book value or amortized for those bonds that are not in or near default) is 28%. This 28% rate is calculated as (50% plus [63% of 50%]) = 81.5% of the tax rate for taxable income (currently 35%.) The result is rounded down.

The tax factor for all assets carried at market value (i.e., those bonds in or near default) is unchanged at 100 percent of the tax rate for capital gains (currently 35%.)

V. Validation of Bond Model

Following the completion of the initial modeling phase, a subgroup of the C1 Work Group started a review of the model. It is important to emphasize the subgroup's role as an independent reviewer. Members of the group had not participated in the initial modeling. The activities and assessments of this independent validation cover four main areas of scope:

- Structure and methodology
- Calibration and data
- Implementation and results of the Model
- Model documentation

The model validation did not identify any input or coding errors. However, as a result of the review, modifications were made to the smoothing technique used in deriving the default assumptions and in the economic conditions transition matrix. In addition, several aspects of the documentation were enhanced. The validation team deemed the model to be appropriate for its current purpose.

Appendix A - Default

A. Baseline Default Rates

The following section describes the default probability model, source of default data, specific data considerations, data analysis, smoothing of the data and a recommendation of baseline default rates.

1. Default Probability Models

The current C1 bond factors were determined using a historical default rate model. This model assumes past experience is a reliable predictor of future default rates. Since the development of the current factors, new credit models have been developed. Different credit models were considered (e.g., structural and reduced form) as potential choices for the default assumptions.

Given the pros/cons, the decision was made to continue with the historical model due to time, budget and complexity constraints. As practice catches up with theory, a structural model may be a good next step for a future update. A more in depth discussion of these models can be found in Appendix F.

2. Source of Raw Default Data

We examined published studies and supplemental data from Moody's and S&P, which are listed below:

- "Moody's 2013 Special Comment: Corporate Default and Recovery Rates, 1920-2012"
- "Moody's 2012 Special Comment: Corporate Default and Recovery Rates, 1920-2011"
- "S&P's 2011 Annual Global Corporate Default Study & Rating Transitions"
- "S&P's 2012 Annual Global Corporate Default Study & Rating Transitions"
- Supplemental data from Moody's showing default rates without financial companies

The Moody's and S&P studies were consistent in most, but not all, of their respective methodologies. A critical difference is in their treatment of withdrawn ratings in the reported default experience. Moody's removes withdrawn ratings from exposure periods after the rating is withdrawn in constructing the cohorts, (see Reflecting Ratings Migrations below for a description of cohorts), whereas S&P leaves withdrawn ratings in their static pools, (conceptually the same as cohorts), at all points in time. Moody's treatment of withdrawn ratings is consistent with our application of their default experience. In the C1 model, a bond issue is exposed to the probability of default throughout the entire ten year time horizon by virtue of the method default rates are developed. As described in more detail below, the bond model uses annualized default rates, where the default rates have been developed from ten year cumulative experience. Using default experience with withdrawn ratings removed would be appropriate if the C1 model used annual default rates where rating deterioration is reflected by a transition matrix. Therefore, the Moody's cohort bond default rates were selected for the baseline assumption before smoothing

3. Reflecting Ratings Migrations

Because C1 default charges are based on a long term (10-year) horizon, ratings migrations (upgrades/downgrades) must be considered in the modeling. There are two general methods to incorporate ratings migration: 1) cohort default rates and 2) transition tables combined with annual default rates.

A cohort consist of all bonds of a given rating as of a given start date. For example, all A2-rated bonds on January 1, 1995 make up a cohort. Experience for each cohort is measured over the following calendar years without considering any rating change subsequent to the cohort start date. Cohort tables combine like experience years of bond defaults. For example, the 1997 experience of the January 1, 1995 cohort would be experience year-3. This year-3 experience would be combined with the 2007 experience for the cohort starting January 1, 2005, which is also experience year-3. This construction of default experience provides a known initial rating (which aligns with C1 bond factor assignment), and implicitly includes ratings migration over the modeled horizon period.

Ratings transitions probabilities could be used to predict future ratings distributions that would be applied to one-year default rates. In order to use ratings transitions and annual default rates, one would need a transition table for each period of time (i.e., 1, 2, 3, .. *n* years). This is because the cumulative transition over, for example, two years is not the same as chaining together two one-year transitions. The progression of ratings transition for a bond is not a Markov process. However, Moody's only provides one-year rating transition probabilities (i.e., Moody's transition matrix is based on the one-year prior rating with ratings updated every year. Therefore, the cohort tables will be used in the C1 default model.

4. Data Analysis

Three sets of default data were analyzed:

- Moody's 1983-2011 default data
- Moody's 1983-2012 default data
- A proprietary subset of Moody's 1983-2011 data excluding the experience of the financial companies.

The Moody's published reports include financial institutions, corporates and regulated utilities with long term debt ratings. Municipal and sub-sovereign debt issuers, structured finance securities, and private placements are generally excluded. 1983 is the first experience year that Moody's reported default rates by numerical modifier (e.g., A1, A2, A3.) Prior to 1983, there was no experience reported by numerical modifier. Because an important objective of this project is to explore the potential of expanded granularity of the C1 factors, data prior to 1983 was not used in our assumptions

In the early phase of the C1 project, 2011 data were analyzed. Once available, 2012 data were used.

We considered using the proprietary subset of default data excluding financial companies due to a question raised about the impact of a change in ratings methodology in the financial sector after the financial crisis in 2008-2009. One reason to exclude financial results is to obtain a better prediction of future experience since the rating method was changed prospectively. The results with and without the financial sector were non-intuitive. While there was a significant change in the default rates for A-rated securities, as expected, another significant change was that Baa-default rates dropped, indicating there were many Baa financial companies that defaulted. It is our understanding that there are not a large number of Baa financial companies because they would not be able to do business at that rating level.

In general, we are not supportive of removing data from the default study. There is always the potential for rating errors, methods are continually evolving and the market is always changing. Therefore, the decision was made to continue to use the 1983-2012 data inclusive of all sectors.

Finally, we considered the use of default rates that varied by industry sector, however, there was limited data available. In addition, there are practical considerations with how to classify bonds by industry. Hypothetically, if sufficient data were available, a model with industry correlation factors could be built. As such data is not available, we made the assumption that correlations are implicit in the default data.

5. Smoothing Default Rates

In analyzing the raw Moody's cohort data, issues with data credibility were observed in cells with scarce data. Therefore, a smoothing technique was applied to create smooth probability of default curves across ratings and experience years. Smoothing will ensure the default and survival probabilities follow expected patterns and have general relationships that have been observed. For example, as shown in several empirical default studies, defaults should increase as quality decreases and defaults should increase as time since issuance increases.

Several different approaches were considered to smooth the default data; each of these approaches is described in greater detail later in this paper. These approaches were evaluated using the 1983-2011 data. Ultimately, Smoothed Spots Rates with a 4th degree fit based on the resulting correlation to the raw data are used, as described below. Once the 1983-2012 data became available, the 4th degree fit model was applied to create baseline default rates.

6. Recommended Baseline Default Rates

Table 1 below shows the smoothed Moody's Default Probability by Rating and by Year since Rating with the recommended 4th degree method described above.

Table A1: Smoothed (Across Ratings) Spot Rates-4th Degree, based on 2012 Moody's Study

	Year									
Rating	1	2	3	4	5	6	7	8	9	10
Aaa	0.0006%	0.0035%	0.0003%	0.0429%	0.0353%	0.0331%	0.0276%	0.0276%	0.0276%	0.0276%
Aa1	0.0019%	0.0093%	0.0081%	0.1006%	0.0694%	0.0575%	0.0459%	0.0459%	0.0459%	0.0459%

Aa2	0.0060%	0.0205%	0.0334%	0.1778%	0.1132%	0.0883%	0.0714%	0.0714%	0.0714%	0.0714%
Aa3	0.0152%	0.0401%	0.0853%	0.2503%	0.1628%	0.1277%	0.1085%	0.1149%	0.1147%	0.1302%
A1	0.0321%	0.0714%	0.1617%	0.2958%	0.2166%	0.1798%	0.1621%	0.1909%	0.1930%	0.2192%
A2	0.0587%	0.1186%	0.2475%	0.3102%	0.2759%	0.2485%	0.2364%	0.2788%	0.2810%	0.3160%
A3	0.0963%	0.1866%	0.3237%	0.3065%	0.3444%	0.3374%	0.3348%	0.3761%	0.3744%	0.4137%
Baa1	0.1463%	0.2813%	0.3777%	0.3050%	0.4280%	0.4516%	0.4613%	0.4853%	0.4750%	0.5119%
Baa2	0.2115%	0.4094%	0.4078%	0.3258%	0.5357%	0.5994%	0.6233%	0.6139%	0.5906%	0.6172%
Baa3	0.2980%	0.5802%	0.4224%	0.3876%	0.6810%	0.7939%	0.8316%	0.7749%	0.7352%	0.7424%
Ba1	0.7105%	1.4432%	1.8693%	1.5233%	1.7449%	1.7515%	1.7078%	1.5334%	1.4443%	1.4954%
Ba2	1.0063%	1.9872%	2.2929%	2.1668%	2.3279%	2.3655%	2.2744%	2.0006%	1.8926%	1.8935%
Ba3	1.4600%	2.7258%	3.0015%	3.2222%	3.1594%	3.1858%	2.9959%	2.6712%	2.5708%	2.5038%
B1	2.1906%	3.7464%	4.1911%	4.8806%	4.3347%	4.2567%	3.8919%	3.6475%	3.6175%	3.4742%
B2	3.4193%	5.1856%	6.1239%	7.3335%	5.9529%	5.5898%	4.9598%	5.0620%	5.2329%	5.0499%
B3	5.5658%	7.2644%	9.0528%	10.5716%	8.0655%	7.1040%	6.1568%	7.0286%	7.6375%	7.5922%
Caa1	9.4369%	10.3752%	12.8837%	13.8108%	10.5168%	8.4945%	7.3790%	9.3908%	10.7398%	11.3238%
Caa2	16.5878%	15.3652%	16.0130%	14.1073%	12.5049%	9.0084%	8.4219%	10.8939%	12.8422%	14.7016%
Caa3	29.9787%	24.7770%	10.4211%	3.9865%	12.1112%	7.6755%	8.9264%	8.5585%	9.6569%	12.3167%

B. Default Rate Smoothing

The baseline default rates were smoothed to minimize data anomalies and served as input to the C1 bond model. An example of a data anomaly is the 4th year cumulative default rate for Aa3, A1, and A2 with rates of .478%, 1.064% and .898% respectively. We would expect cumulative rates to increase as credit rating declines. Default rates were smoothed after considering three different smoothing methods, described below.

1. <u>First Iteration Smoothing Attempt</u>

The starting points were the cumulative default rates published in the Moody's Annual Default Study, Exhibit 35 - Average Cumulative Issuer-Weighted Global Default Rates by Alphanumeric Rating, 1983-2011. This data is published as percentages; the numerical values below have been derived by dividing the percentages by 100.

Annual spot rates from the cumulative rates have been derived:

Year 1 annual rate = Year 1 cumulative rate.

Year 2 annual = (Year 2 cumulative - Year 1 Cumulative)/(1-Year 1 Cumulative)

Year n annual = (Year n cumulative - Year n-1 Cumulative)/(1-Year n-1 Cumulative)

It is important to note that our use of the term "spot rate" implies the one year default rate for a given experience year. It is not meant to relate to spot rates observed relative to yield curves

An array of third and fourth degree models, that smoothed cumulative and spot rates, were created as candidates for the smoothing method to apply. They are described below followed by Table A2 that shows the results of these models.

Third Degree Models: Ax^3+Bx^2+Cx+D, where A through D are constants obtained from a third degree least squares fit.

Smoothed Spot Rates-3rd Degree

- This method uses the observed cumulative rates, transforms them into annual spot rates, then smooths those spot rates with a cubic least squares fit.
- R^2 range from 43% to 95% with a simple average R^2 of 82%.

Smoothed Logarithmic Spot Rates- 3rd Degree

- This method uses the observed cumulative rates, transforms them into annual spot rates, takes the natural log of the quantity (spot rate/(1-spot rate)), smooths those modified spot rates using a cubic least squares fit, then reverses the natural log function by taking the quantity $1/(1+e^{\text{fitted value}})$.
- R^2 range from 54% to 95% with a simple average R^2 of 82%.

Fourth Degree Models: $Ax^4+Bx^3+Cx^2+Dx+E$, where A through E are constants obtained from a fourth degree least squares fit.

Smoothed Cumulative Rates- 4th Degree

- This method uses the observed cumulative rates, and then transforms them into spot rates. Because some higher rated categories may not have any defaults for some time periods, a judgmentally developed formula was used to make the values more reasonable. These modified values are then smoothed using a 4th degree least squares fit.
- R^2 range from 54% to 96% with a simple average R^2 of 85%.

Smoothed Logarithmic Cumulative Rates- 4th Degree

- This method uses the observed cumulative rates, takes the natural log of the quantity (cumulative rate/(1-cumulative rate)), smooths these rates using a 4th degree fit, reverses the natural log function by taking the quantity $1/(1+e^{-\text{fitted value}})$, then transforms the resulting fit into spot rates.
- R^2 range from 12% to 95% with a simple average R^2 of 68%.

Smoothed Spot Rates- 4th Degree

- This method uses the observed cumulative rates, transforms them into spot rates, then smooths these spot rates using a 4th degree fit.
- R^2 range from 51% to 99%, with 12 of the rating classes having an R^2 of 90% and higher, more than any of the other methods tested, and with a simple average R^2 of 89%.

Smoothed Logarithmic Spot Rates-4th Degree

- This method uses the observed cumulative rates, transforms them into spot rates, takes the natural log of the (spot rate/(1-spot rate)), smooths these modified spot rates using a 4th degree fit, then reverses the natural log function by the quantity $1/(1+e^{-\text{fitted value}})$.
- R^2 range from 63% to 98%, with a simple average R^2 of 88%.

In order to select a smoothing method, we looked for the model that had the best fit to the original data. To do this, we found the correlation coefficient between each modified rate and its respective fitted rate for each rating. We compared these values across methods. Smoothed Spots Rates with a 4th degree fit have the closest fit to the raw data.

Table A2. Comparison of R^2 Values Across All Smoothing Methods

Rating	Smoothed Spot Rates-3rd Degree	Smoothed Logarithmic Spot Rates-3rd Degree	Smoothed Cumulative Rates-4th Degree	Smoothed Logarithmic Cumulative Rates-4th Degree	**Smoothed Spot Rates-4th Degree**	Smoothed Logarithmic Spot Rates-4th Degree
Aaa	62%	63%	62%	81%	**78%**	70%
Aa1	43%	54%	58%	20%	**51%**	63%
Aa2	83%	86%	95%	33%	**85%**	82%
Aa3	57%	60%	54%	12%	**74%**	75%
A1	93%	91%	92%	88%	**94%**	96%
A2	95%	95%	97%	88%	**99%**	98%
A3	90%	86%	93%	86%	**96%**	96%
Baa1	67%	67%	65%	15%	**83%**	79%
Baa2	91%	95%	95%	94%	**96%**	96%
Baa3	94%	92%	95%	67%	**95%**	93%
Ba1	93%	93%	94%	71%	**96%**	93%
Ba2	82%	79%	81%	94%	**91%**	95%
Ba3	89%	84%	89%	87%	**96%**	98%
B1	82%	78%	91%	44%	**86%**	83%
B2	81%	80%	93%	74%	**98%**	97%
B3	94%	94%	96%	77%	**95%**	95%
Caa1	88%	85%	86%	86%	**89%**	85%
Caa2	88%	87%	89%	95%	**91%**	91%
Caa3	89%	91%	93%	90%	**93%**	81%
Ave	82%	82%	85%	68%	**89%**	88%

2. Second Iteration Smoothing Attempt

Due to anomalies in the resulting C1 factors at certain ratings, smoothing across ratings for each duration, rather than the first stage smoothing across durations for each rating, was performed. Smoothing of spot rates using a 4th-degree polynomial was again done. Weights by credit rating were developed based on judgment so that the resulting smoothed default rates were a reasonable fit to the underlying data and the anomalies in the C1 factors would be minimized.

3. Third Iteration Attempt: final

Additional review of the default rates identified some weaknesses in the smoothing process. The weights by rating class used in the second iteration smoothing were judgmental; weights increased as credit quality decreased and a better approach was deemed necessary in order to improve the fit to the underlying data.

Several approaches were tested and an approach labeled "Alt 4" was selected. Alt 4 started, as did all the new approaches tested, with the existing Second Stage results. Alt 4 made two changes. First, weights for all rating classes were made equal to 1. Second, a dummy variable was introduced into the regression equation, 0 for investment grade classes, and 1 for below investment grade. The resulting smoothed default rates provided a better fit to the underlying data while providing appropriate smoothing, continuing to avoid the anomalies of the First Stage smoothing within a rating class. Alt 4 smoothed default rates are the basis of our C1 factor recommendation.

Appendix B - Recovery

Similar to the current C1 RBC factors, the proposed C1 bond factors use historical assumptions to project future losses given default. As per the historical default model, the loss given default model assumes past experience is a reliable predictor of future loss. Default and recovery rates are combined to project periodic losses. Note that loss given default (LGD) is equal to one minus the recovery rate.

In the last twenty years, significantly more recovery experience has been tabulated. Although there are a number of factors that can affect recovery rates (e.g., the security's position in the creditor's capital structure, industry), practical constraints in the calculation of C1 RBC dictated a simplistic formulation of recovery rates in the C1 bond model.

A key factor eliminated from consideration of the recovery rates was instrument type, (also known as lien position) which indicates the security's position in the creditor's capital structure. S&P and Moody's studies both show that instrument type (lien position) affects LGD, particularly in the tails of the loss distribution. Generally, the degree of seniority and security of a bond correlate with increased recovery or lower LGD. The following chart is taken from Moody's "Annual Default Study: Corporate Default and Recovery Rates, 1920-2012."

Chart B1. Corporate Debt Recovery Rates

EXHIBIT 8

Average Corporate Debt Recovery Rates Measured by Ultimate Recoveries, 1987-2012

	Emergence Year			Default Year		
Lien Position	2012	2011	1987-2012	2012	2011	1987-2012
Loans	87.3%	73.2%	80.6%	76.8%	89.5%	80.6%
Sr. Secured Bonds	79.8%	53.4%	63.7%	73.1%	65.3%	63.7%
Sr. Unsecured Bonds*	42.4%	13.0%	48.6%	69.6%	27.7%	48.6%
Subordinated Bonds**	27.1%	12.0%	28.5%	27.1%	24.1%	28.5%

* The recovery rate for 2011's senior unsecured bonds was based on three defaults. Five defaults in 2012 held unsecured bonds in their debt structures.

** Includes senior subordinated, subordinated and junior subordinated bonds.

Theoretically, the combination of issuer rating for default rate experience and instrument type related to LGD could be combined to define expected total loss. Interim discussions with regulators, rating agencies, and interested parties highlighted some practical considerations in using instrument type in the calculation of C1 RBC. We considered the use of a mechanical rule (e.g., notching) to identify the issuer rating from the issue rating and instrument type by following published guidelines, (Moody's Senior Ratings Algorithm & Estimated Senior Ratings, February 2009). However, this mechanical rule could introduce error in identifying the actual issuer rating. Further, applying the aggregate LGD experience of an instrument type to a given bond could also introduce loss estimation error. Using the issue rating combined with a senior unsecured LGD assumption averts these two potential error sources and reinforces reliance on the accuracy of the rating agency ratings. The rating agency process is assumed to capture the loss differential of different instrument types and other specific attributes of each bond in its issue rating.

The above rationale also explains why bond rating is excluded as a LGD assumption input. Empirical data shows that LGD does not vary significantly across issuer rating. The following chart is from Moody's "Annual Default Study: Corporate Default and Recovery Rates, 1920-2012."

Chart B2. Unsecured Bond Recovery Rates

EXHIBIT 21

Average Sr. Unsecured Bond Recovery Rates by Year Prior to Default, 1982-2012

	Year 1	Year 2	Year 3	Year 4	Year 5
Aaa**	n.a.	3.33%	3.33%	61.88%	75.58%
Aa	37.24%	39.02%	38.08%	43.95%	42.27%
A	31.77%	42.68%	44.28%	42.87%	42.87%
Baa	40.59%	42.00%	42.18%	42.77%	42.93%
Ba	46.82%	44.91%	43.85%	43.12%	42.65%
B	38.14%	37.27%	37.37%	37.63%	38.19%
Caa-C	36.14%	36.02%	35.73%	35.81%	35.80%
Investment Grade	38.50%	41.85%	42.57%	42.96%	43.19%
Speculative Grade	37.64%	37.45%	37.49%	37.74%	38.07%
All Rated	37.68%	37.78%	37.95%	38.29%	38.69%

* Issuer-weighted, based on post default trading prices

** The Aaa recovery rates are based on five observations, three of which are Icelandic banks that have an average recovery rate of 3.33%.

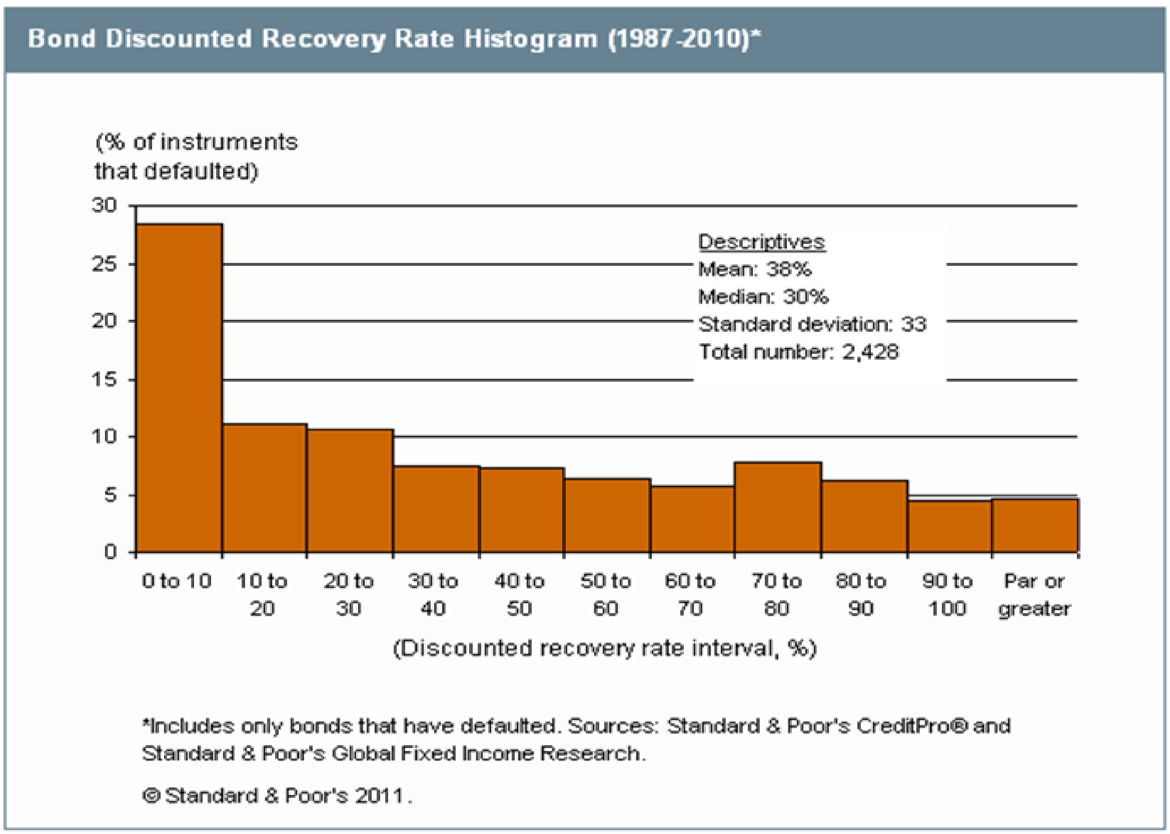
Recovery rates are provided by the issuer, not by issue. However, because the LGD by issuer rating are stable, it is reasonable to assume that the variability in recovery would be observed at the issue level. Consequently, it would be reasonable to consider recovery rates that vary by issue type, or more specifically, by instrument type. Discussions with the rating agencies confirmed that the ratings factored the instrument type into the issue rating; consequently, using a different LGD by rating, (higher LGD for lower issue ratings), to determine total expected loss would duplicate the effect captured in the rating. Accordingly, the baseline senior unsecured expected recovery rates are used as input to the C1 bond model.

Empirical studies from S&P, Moody's, Fitch, and Altman have stated other factors affect LGD. Attributes such as type of collateral, type of settlement, variation or the depth of capital layers, industry and region can all affect LGD. But consideration of limited credible data and the practical limitations of unwarranted complexity in the RBC calculation preclude the use of these bond attributes to define recovery assumptions. Based on discussions with the rating agencies, these attributes are reflected in their ratings process.

The LGD assumption is based on proprietary data provided by S&P from S&P CreditPro® LossStats data covering the period 1987-2012. Data covering all instrument types includes 4412 defaults. Senior Unsecured instrument type bonds comprise 1260 of those defaults. Only Senior Unsecured data was used for the LGD assumption. Loss data based on ultimate recovery rates was provided separately for each calendar year, grouped by cells of LGD ranging in 10% increments from less than 0%, (recovery greater than par value), to 100% loss. Each cell included the average percentage LGD within the cell and the number of occurrences in each cell. From S&P, “We define recovery as the ultimate recovery rates following emergence from three types of default: bankruptcy filings, distressed exchanges, and non-bankruptcy restructurings. Unless specified otherwise, we base recoveries at the instrument level, and we discount them by using each instrument's effective interest rate."

The data was used to construct a histogram similar to the one below published by S&P, "Recovery Study (U.S.): Piecing Together the Performance of Defaulted Instruments After the Recent Credit Cycle, December 2011."

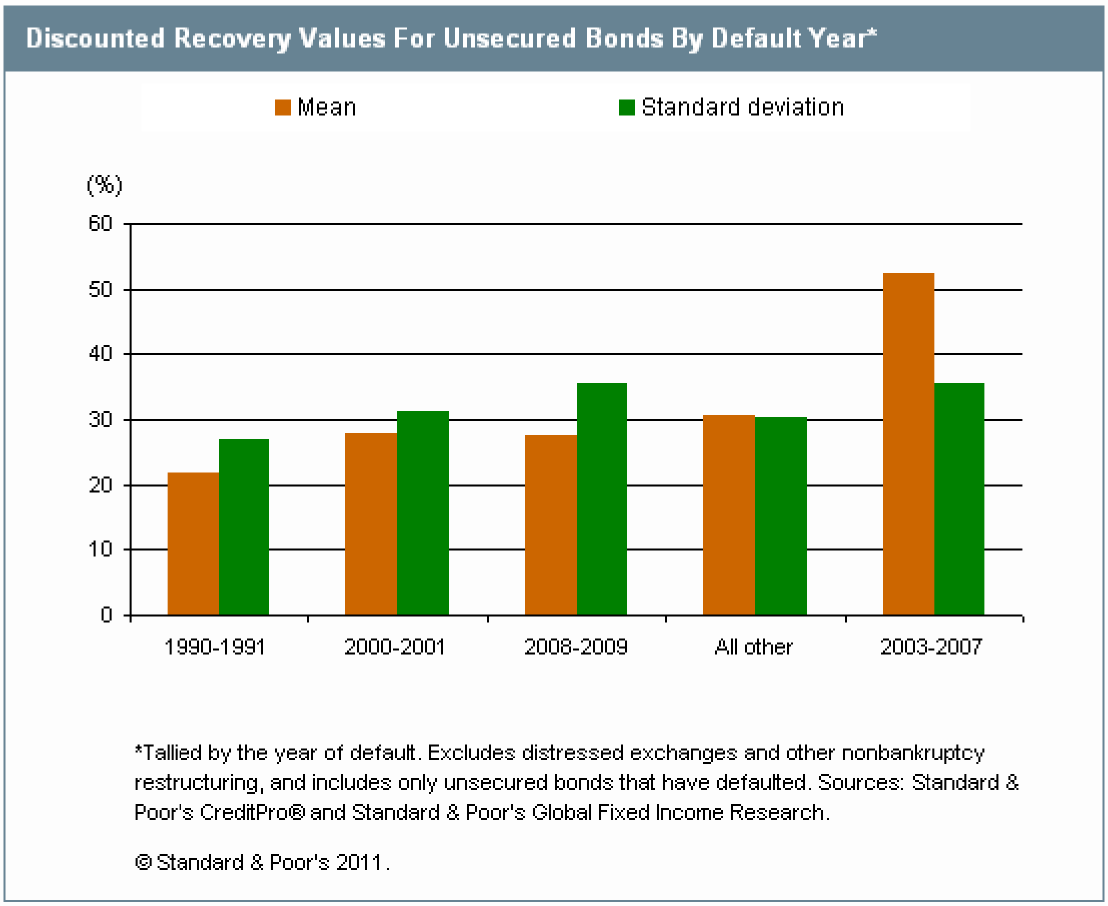
Chart B3. Bond Discounted Recovery Rates



Generally the actual model assumption is less skewed to the left because it is based on senior unsecured LGD as compared to the above histogram which includes all bond instrument types where lower subordinated bonds have worse LGD than senior unsecured bonds. LGD is determined separately for each bond default in the modeled scenarios.

Two random inputs affect the modeled LGD. The most significant variable is the loss variation defined by the LGD histogram. The second and less significant variable is the effect of the economic state. The model uses a separate LGD histogram for recession and non-recession economic states. The chart below from the same report as the above chart is representative of the average variation between the two economic states. The first three sets of bars are recession periods; the latter two sets are non-recession periods.

Chart B4. Discounted Recovery Values



The LGD histograms for each economic state produced by the data are used without further adjustment. Similar to default rates smoothing of the data was considered. As per the default assumption, a fourth degree polynomial smoothing method was applied to the data. But because the fitted curve did not reasonably approach recoveries expected at the high end of the range, the smoothed data was not used.

The LGD assumptions used in the development of the 2015 C1 bond factors are significantly different from those used for the 2002 C1 factors. There are three dimensions to the assumption, 1) average LGD, 2) variation around the average and 3) the effect of economic conditions. The 2015 model assumes the same LGD for all ratings whereas the 2002 model varies average LGD significantly by rating. Baseline LGD for the 2002 model is lower at higher issue ratings and higher at lower issue ratings. The 2015 model loss variation to the average has larger losses in the tail vs. the 2002 histogram which, given an average loss, is bell shaped. Last, the effect of economic conditions on the average LGD is more muted in the 2015 model vs. the 2002 model. As a result of updating the model, the recovery rate assumption contributes to a higher C1 factor for higher issue ratings and lower C1 factors for lower ratings. Appendix E Reconciliation of Bond Factors expands on this discussion.

Appendix C - Economic Model

Executive Summary

Default probability and recovery rate are the two key assumptions used to develop C1 capital charges for corporate bonds. Historical data and associated research indicate that default probabilities are strongly influenced by the economy, with recovery rates less influenced by the economic state. A high degree of correlation exists between bond defaults and economic downturns. The bond recovery rate is pro-cyclical and also positively correlated with the real GDP growth.[6]

Baseline bond default probabilities are developed using 1983 to 2012 corporate bond historical data and baseline recovery rates are developed from 1987 – 2012 data. The same data was used to evaluate how default and recovery rates vary by different economic states within this time horizon.

The National Bureau of Economic Research's (NBER) classification of economic states was used. This data classifies 1991, 2001, 2008 and 2009 as "Contraction" years within the study period (1983 to 2012). The differences of default and recovery experiences among different economic states were analyzed. Relative "scalars" were developed to quantify how default probabilities and recovery rates vary by identified economic states; these scalars are applied to the base default and recovery rates in the C1 bond model.

For higher rated (AAA, AA and A) corporate bonds, historical default incidence was limited; consequently, the default experience was combined and develop the consolidated 2-state economic scalars. For lower rated (BBB and below) corporate bonds, due to more observed default data points, economic scalars were developed for each letter rating category.

In addition, the 2-state economic scalars were expanded to 4-state economic scalars for the lower rated corporate bonds. However, the 4-economic state approach does not result in similarly meaningful scalars for AAA/AA/A rated corporate bonds; therefore, the 2-state economic scalars are used for AAA/AA/A corporate bonds.

For recovery rates, the proprietary S&P recovery data by calendar year is used. The 2-state approach (expansion and contraction) is used to develop recovery rates by two economic states. The same 2-state economic scalars are used for all the rating categories.

A. Introduction

This section analyzes historical default data of corporate bonds and quantifies the default rate differentials among different states of the economic cycle. The recovery rate differentials are developed from proprietary S&P recovery data.

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[6]N. Mora, 2012, "*What Determines Creditor Recovery Rates?"*- Federal Reserve Bank of Kansas City *Economic Review*, Volume 97, Second quarter.

B. Economic Data Source

We utilized two sources of economic data for this study:

- Bureau of Economic Analysis (BEA) is a US government agency delegated with the task of maintaining national economic accounts including National Accounts, Regional Accounts, Industry Accounts and International Accounts. It is the official source of data used by the White House, Federal Reserve Banks, Congress and other government bodies. (www.bea.gov)
- National Bureau of Economic Research (NBER) is a private, nonprofit and nonpartisan research organization. It is a highly regarded organization for economic research and has produced twenty two Economics Nobel Laureates. (www.nber.org/cycles)

Historical economic data is available from 1930 to the latest quarter. Economic data encompassing the same time periods as the default and recovery rates were used.

C. Economic State Definition

National Bureau of Economic Research (NBER) explicitly classifies a period as either “Expansion” or “Contraction”. Within the time period from 1983 to 2012, NBER had classified 1991, 2001, 2008 and 2009 as “Contraction” years.

Bureau of Economic Analysis (BEA), on the other hand, does not explicitly classify economic state, but provides GDP data that can be used to classify a period as either “Expansion” or “Contraction”. We use the logic whereby if GDP of the current period is higher than that of the previous period, then we classify the current period as an “Expansion;” otherwise, we will treat it as a “Contraction.” Applying this logic, during the time period from 1983 to 2012, we classify only three years as “Contraction” i.e., 1991, 2008 and 2009. Although the year 2001 has two quarters of GDP contraction, the entire year as a whole has a higher annual GDP than that of the previous year 2000. As a result, the year 2001 was not classified as “Contraction” by BEA, under this GDP comparison approach.

As NBER’s economic state classification is declared by a panel of economic experts and considered more authoritative, we have decided to follow NBER’s system of classification and treat **1991, 2001, 2008 and 2009** as “Contraction” years in our study. (See section N(1) below for detailed comparisons of BEA and NBER economic data)

Extending the two-state model to a four-state model

The classification of each year’s economic state as either an “expansion” or “contraction” provides a foundation for a two-state economic model. However, given that the economy usually undergoes troughs and peaks of GDP growth, we can further consider a four-state economic model.

The four-state economic model is an expanded version of the two-state model where each year is classified as one of four states based on the following definition:

- Continued Expansion: If the previous year was an "Expansion" and the present year is also an "Expansion."
- Expansion: If the previous year was a "Contraction" and the present year is an "Expansion."
- Contraction: If the previous year was an "Expansion" and the present year is a "Contraction."
- Continued Contraction: If the previous year was a "Contraction" and the present year is also a "Contraction."

Applying the above defined economic state classifications, the probability distribution of each economic state under the two-state model and four-state model can be calculated:

Table C1: 2-state unconditional probability distribution

State	Expansion	Contraction
Probability	86.67%	13.33%

Table C2: 4-state conditional probability distribution

State/Prob	Expansion	Contraction
Expansion	88.00%	12.00%
Contraction	80.00%	20.00%

D. Default Rate – Data Source and Calculations

The corporate bond default data is based on "Moody's Annual Default Study 2012, Exhibit 41 – Cumulative Issuer weighted default rates by Annual Cohort." We utilize the "cumulative" default rate from this exhibit and calculate the corresponding "spot" default rate in the "n^{th}" year, using the following formula:

$$\text{Spot Default Rate (n)} = \frac{\text{Cumulative Default Rate (n)} - \text{Cumulative Default Rate (n}-1)}{1 - \text{Cumulative Default Rate (n}-1)}$$

The annual spot default rates are calculated by rating categories for a period of 10 years for each of the annual cohort from 1983 to 2012.

The following example shows how the annual spot default rates are calculated from the cumulative issuer weighted default rates:

Table C3: Cumulative Issuer Weighted default Rates Baa: Moody's Annual Default Study 2012, Exhibit 41

Year / Duration	1	2	3	4	5	6	7	8	9	10
1990	0.00%	0.657%	0.657%	0.657%	0.657%	0.657%	0.657%	0.657%	0.657%	1.252%

For 2nd Duration

Spot Default Rate (2) $= \frac{Cumulative\ Rate\ (2) - Cumulative\ Rate\ (1)}{1 - Cumulative\ Rate\ (1)}$

$= \frac{0.657\% - 0.00\%}{1 - 0.00\%}$

$= 0.657\%$

The following table shows the calculated annual spot default rates of the 10 durations for Baa cohort year 1990

Table C4: Annual Spot Default Rates Baa:

Year / Duration	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1990	0.00%	0.657%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.599%

To confirm consistency, we compare these calculated annual spot default rates with baseline default rates, which are developed from Exhibit 34 (Average Cumulative Issuer-Weighted Global Default Rates by Letter Rating, 1983-2012 of the same Moody's Annual Default Study 2012. Although annual spot default rates calculated from exhibit 41 do not match exactly with baseline default rates, they do follow similar patterns over the 10-year time horizon. Given that our goal is to develop economic scalars that will be applied to the baseline default rate for different economic states, we conclude that it is reasonable to use data from Exhibit 41(Cumulative Issuer-Weighted Default Rates by Annual Cohort, 1970-2012) for the development of these economic scalars. (Please see section N(2) below for a comparison between default rates between exhibit 41 and exhibit 34.)

E. Differentiate Spot Default Rate by Economic State

This section describes how we have differentiated annual spot default rates by our previously defined 2 and 4 economic states' models.

b) Cohort year, durational year and calendar year.

As the economic states are identified and expressed in calendar years, we first translate "durational" years of each cohort year into "calendar" years.

Table C5: Cohort year, durational year and calendar year

Cohort Year/ Duration	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1983	1983	1984	1985	1986	1987	1988	1989	1990	**1991**	1992
1984	1984	1985	1986	1987	1988	1989	1990	**1991**	1992	1993
1985	1985	1986	1987	1988	1989	1990	**1991**	1992	1993	1994

Equivalent Calendar Years

According to NBER, 1991 is classified as a “Contraction” year. A bond included in the cohort year 1983 would have encountered this contraction state in its 9th duration while a bond included in the cohort year of 1984 would have faced this contraction state in its 8th duration.

We further map the “calendar” year into an “economic state” grid as shown in the following table.

Table C6:

Cohort Year/ Duration	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1983	Expansion	Expansion	Expansion	Expansion	Expansion	Expansion	Expansion	Expansion	**Contraction**	Expansion
1984	Expansion	Expansion	Expansion	Expansion	Expansion	Expansion	Expansion	**Contraction**	Expansion	Expansion
1985	Expansion	Expansion	Expansion	Expansion	Expansion	Expansion	**Contraction**	Expansion	Expansion	Expansion

Please see Section N(3) and N(4) for the two-state and four-state tables.

c) Spot Default Rates by Duration and Economic States

For each of the durations from one to ten, we calculate the "average" spot default rates for each economic state and also for all the economic states combined.

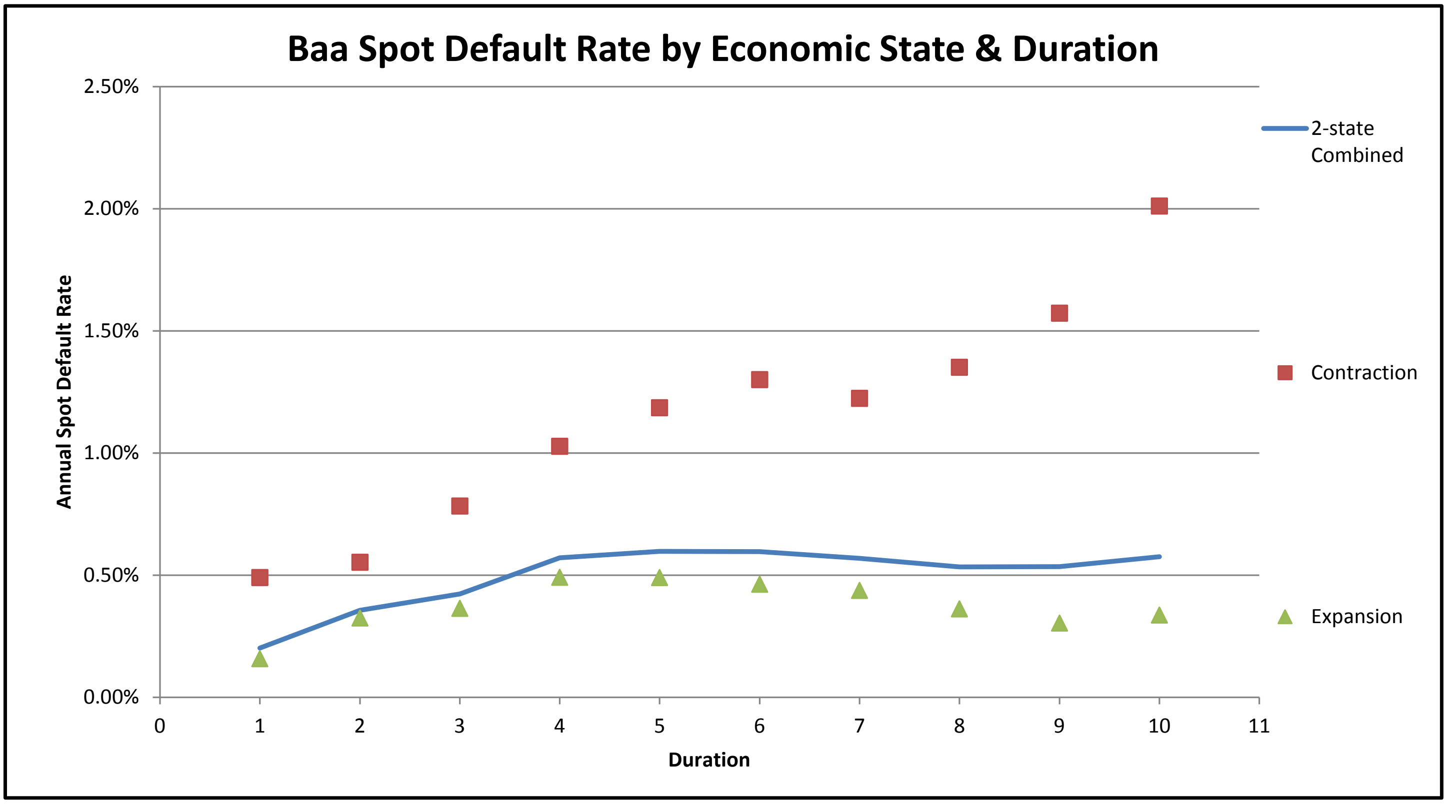
Here are the calculated spot default rates by duration and economic state for Baa.

Two-state economic model:

Table C7: 2-state Baa Average Spot Default Rate by Economic State and Duration

Baa	Duration 1	Duration 2	Duration 3	Duration 4	Duration 5	Duration 6	Duration 7	Duration 8	Duration 9	Duration 10
Contraction	0.490%	0.552%	0.783%	1.027%	1.185%	1.301%	1.223%	1.351%	1.572%	2.011%
Expansion	0.157%	0.324%	0.363%	0.491%	0.490%	0.462%	0.438%	0.362%	0.304%	0.336%
Combined	0.201%	0.356%	0.423%	0.571%	0.597%	0.596%	0.569%	0.534%	0.534%	0.575%

Chart C1

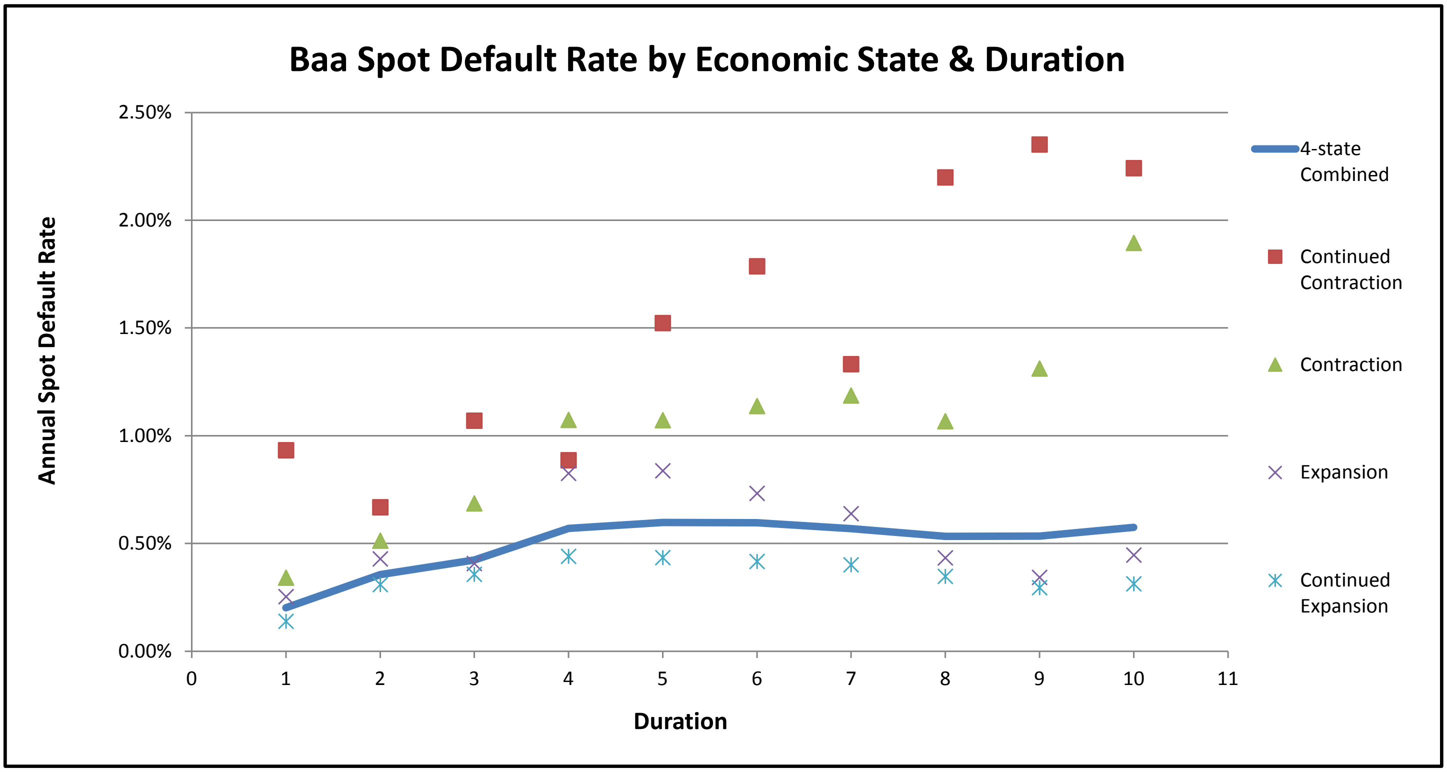


Four-state economic model:

Table C8: 4-state Baa Average Spot Default Rate by Economic State and Duration

Baa	Duration 1	Duration 2	Duration 3	Duration 4	Duration 5	Duration 6	Duration 7	Duration 8	Duration 9	Duration 10
Continued Contraction	0.933%	0.668%	1.071%	0.887%	1.523%	1.787%	1.332%	2.199%	2.352%	2.242%
Contraction	0.342%	0.513%	0.687%	1.074%	1.072%	1.138%	1.187%	1.068%	1.312%	1.895%
Expansion	0.254%	0.429%	0.407%	0.826%	0.838%	0.732%	0.639%	0.434%	0.343%	0.446%
Continued Expansion	0.139%	0.310%	0.357%	0.441%	0.435%	0.417%	0.402%	0.348%	0.296%	0.314%
Combined	0.201%	0.356%	0.423%	0.571%	0.597%	0.596%	0.569%	0.534%	0.534%	0.575%

Chart C2



F. Issues with AAA, AA and A

Historically, the number of instances of default for AAA, AA and A has been fairly low. This causes our approach to further distinguish defaults of AAA, AA and A rated bonds by economic states to produce conflicting results.

For AAA rated bonds, given the limited set of data points, the results of the default rate by economic states are counterintuitive. For example, the default rates under continued expansion state are higher than other economic states and there are only five non-zero values in the underlying forty-cell grid under the four-state model.

Table C9: 2-state Aaa Spot Default Rate by Economic State and Duration

Aaa	Duration 1	Duration 2	Duration 3	Duration 4	Duration 5	Duration 6	Duration 7	Duration 8	Duration 9	Duration 10
Contraction	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Expansion	0.000%	0.000%	0.000%	0.062%	0.107%	0.076%	0.081%	0.069%	0.000%	0.000%
Combined	0.000%	0.000%	0.000%	0.053%	0.091%	0.063%	0.067%	0.057%	0.000%	0.000%

Chart C3

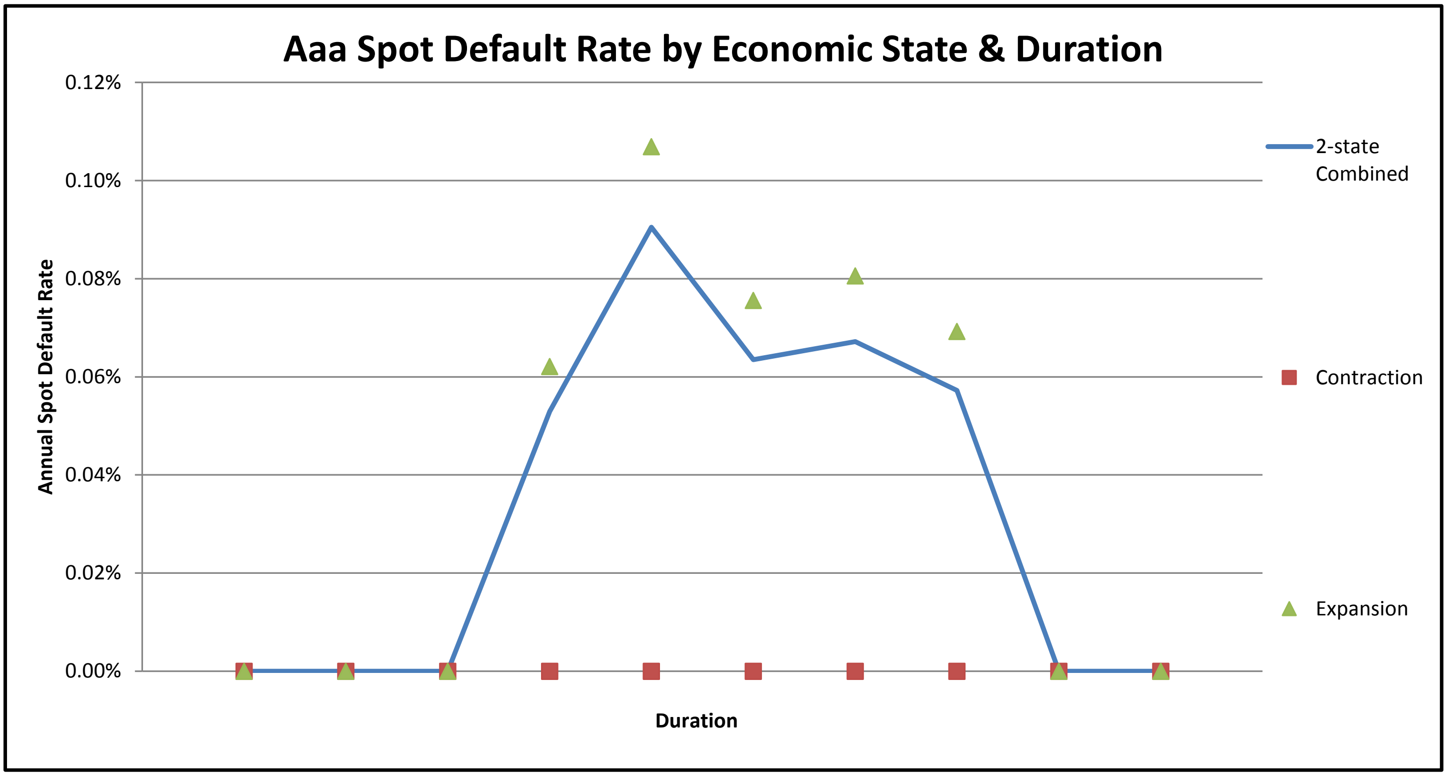
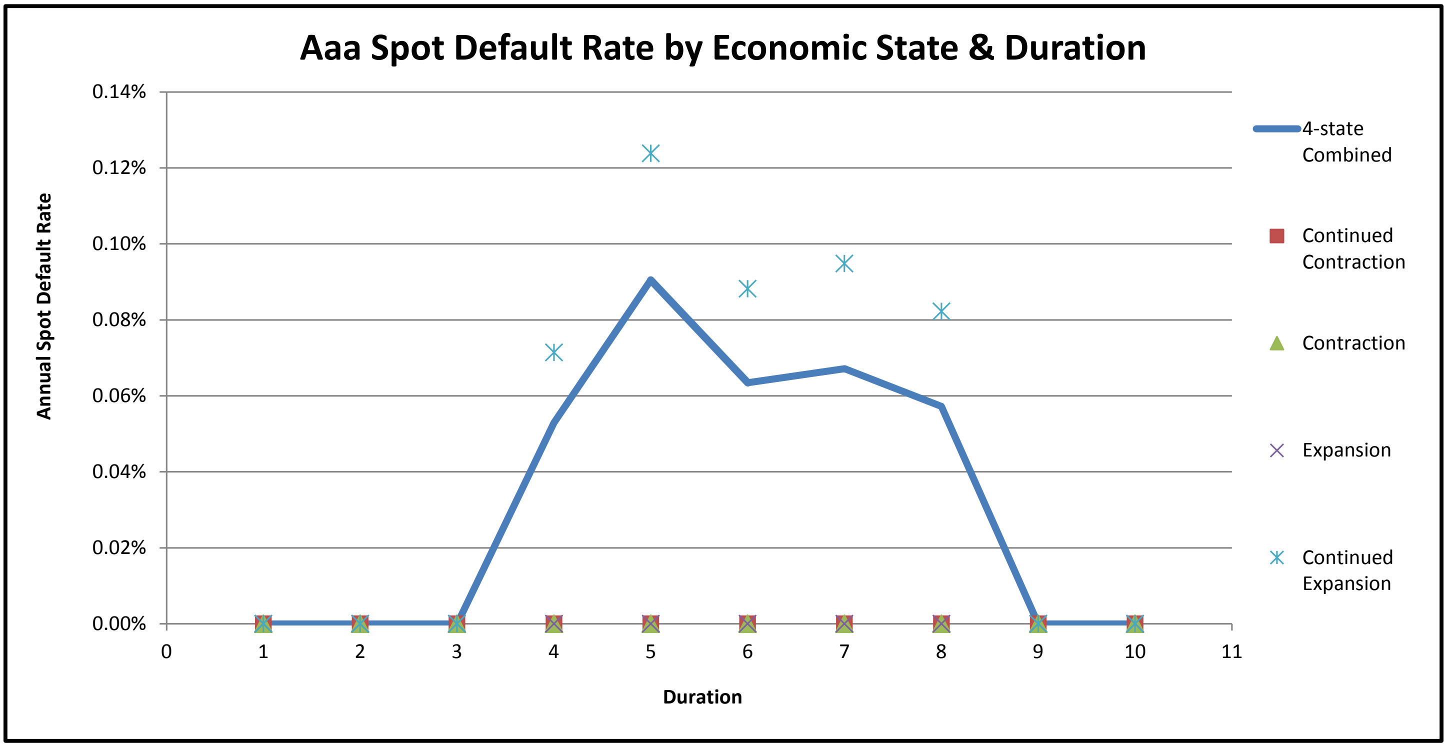


Table C10: 4-state Aaa Spot Default Rate by Economic State and Duration

Aaa	Duration 1	Duration 2	Duration 3	Duration 4	Duration 5	Duration 6	Duration 7	Duration 8	Duration 9	Duration 10
Continued Contraction	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Contraction	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Expansion	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Continued Expansion	0.000%	0.000%	0.000%	0.071%	0.124%	0.088%	0.095%	0.082%	0.000%	0.000%
Combined	0.000%	0.000%	0.000%	0.053%	0.091%	0.063%	0.067%	0.057%	0.000%	0.000%

Chart C4



Similar problems exist for AA and A rated bonds due to the limited instances of historic defaults. One approach commonly used in actuarial experience study is to group cohorts so that the combined observed instances of default (or instances of mortality in the context of Life insurance) are deemed sufficient enough to produce credible results. Given limited default instances for AAA, AA and A rated bonds, we group these three categories together for the purpose of distinguishing default rates by economic states. In addition, the two-state model, rather than the four-state model, is used as it produces more meaningful and credible results.

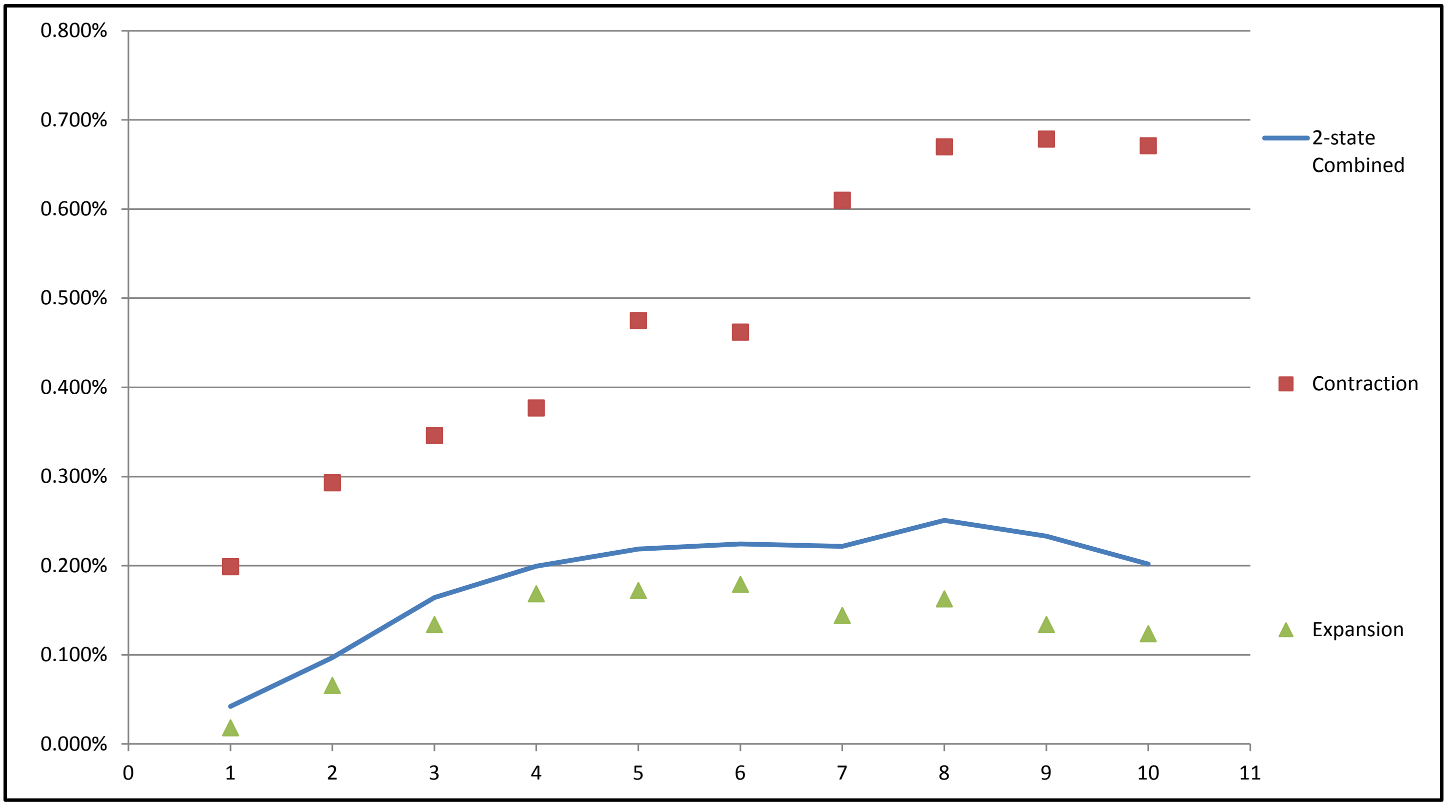
G. AAA, AA and A combined spot default rates

The combined spot default rates of AAA, AA and A rated bonds are calculated using the starting cohort size from Moody's exhibit 41. These cohort sizes serve as weights in the weighted calculations. We further calculate the spot default rates by each economic state following the same approach. As shown below, we find that the results now are comparatively more intuitive as the default rates under the "contraction" state are consistently higher than the default rates under the "expansion" state and overall combined state.

Table C11: 2-state Aaa/Aa/A Spot Default Rate by Economic State and Duration

Aaa/Aa/A combined	Duration 1	Duration 2	Duration 3	Duration 4	Duration 5	Duration 6	Duration 7	Duration 8	Duration 9	Duration 10
Contraction	0.199%	0.293%	0.346%	0.377%	0.475%	0.462%	0.610%	0.670%	0.678%	0.671%
Expansion	0.018%	0.066%	0.134%	0.168%	0.172%	0.179%	0.144%	0.163%	0.134%	0.124%
Combined	0.042%	0.097%	0.164%	0.199%	0.219%	0.224%	0.222%	0.251%	0.233%	0.202%

Chart C5: 4-state Aaa/Aa/A Spot Default Rate by Economic State and Duration



H. Baa and Lower Rated Bonds

For Baa and lower rated bonds, we are able to use the four-state model to differentiate their spot default rates as there are more observed default instances to produce meaningful results. Please see section N(5) for the calculated spot default rates.

I. Economic Scalars

Once annual spot default rates by rating category are calculated (see Section N(5)), we are able to develop the corresponding “Economic Scalars.” An Economic Scalar is calculated by dividing the spot default rate in each economic state by the corresponding aggregated combined spot default rate.

For example, the table below shows the calculated spot default rate for Baa rated bonds under the 4-state model.

Table C12

		Duration 1	Duration 2	Duration 3	Duration 4	Duration 5	Duration 6	Duration 7	Duration 8	Duration 9	Duration 10
Baa	Continued Contraction	0.933%	0.668%	1.071%	0.887%	1.523%	1.787%	1.332%	2.199%	2.352%	2.242%
	Contraction	0.342%	0.513%	0.687%	1.074%	1.072%	1.138%	1.187%	1.068%	1.312%	1.895%
	Expansion	0.254%	0.429%	0.407%	0.826%	0.838%	0.732%	0.639%	0.434%	0.343%	0.446%
	Continued Expansion	0.139%	0.310%	0.357%	0.441%	0.435%	0.417%	0.403%	0.348%	0.296%	0.314%
	Combined	0.201%	0.356%	0.423%	0.571%	0.597%	0.596%	0.569%	0.534%	0.534%	0.575%

The scalars for duration 1 are a straight division of spot default rates for each economic states by the combined default rate; i.e. 0.933% / 0.201% = 463% for continued contraction. Here are the economic scalars for Baa:

Table C13

		Duration 1	Duration 2	Duration 3	Duration 4	Duration 5	Duration 6	Duration 7	Duration 8	Duration 9	Duration 10
Baa	Continued Contraction	463%	188%	253%	155%	255%	300%	234%	412%	440%	390%
	Contraction	170%	144%	162%	188%	180%	191%	209%	200%	246%	329%
	Expansion	126%	121%	96%	145%	140%	123%	112%	81%	64%	78%
	Continued Expansion	69%	87%	84%	77%	73%	70%	71%	65%	55%	55%
	Combined	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

We follow the same approach and calculate the economic scalars for the rest of rating categories (See Section N(6)).

J. Leveled Economic Scalars

The Economic Scalars developed earlier exhibit a wide range of values among different durations. For example, for Baa, the Economic Scalars of "continuous contraction state" range from 463 percent in duration one to 155 percent in duration four. These wide –ranging factors within the same economic state produce counter-intuitive results when used in our C1 bond model. To solve this problem, the economic scalars are level across all durations.

We use the previously developed Two and Four Economic State models by duration for each cohort year (Sections N(2) and N(3)) to identify the observed economic states for cohort year 1983 to 2012 combined. The following tables show the observations for two and four Economic State models.

Table C13

Observed Econ States for 1983-2012 Cohort Yrs		Duration 1	Duration 2	Duration 3	Duration 4	Duration 5	Duration 6	Duration 7	Duration 8	Duration 9	Duration 10
2 States	Contraction	4	4	4	4	4	4	4	4	4	3
	Expansion	26	25	24	23	22	21	20	19	18	18
	Subtotal	30	29	28	27	26	25	24	23	22	21
4 States	Continued Contraction	1	1	1	1	1	1	1	1	1	1
	Contraction	3	3	3	3	3	3	3	3	3	2
	Expansion	4	3	3	3	3	3	3	3	3	3
	Continued Expansion	22	22	21	20	19	18	17	16	15	15
	Subtotal	30	29	28	27	26	25	24	23	22	21

We use these economic states as weights to calculate the weighted average combined Economic Scalars (see Section N(6) for Economic Scalars by rating category and duration) for each rating category.

Table C14

2-state	Aaa	Aa	A	Combined
Contraction	0.00%	62.40%	304.87%	263.27%
Expansion	118.06%	106.79%	63.01%	70.52%
Combined	100.00%	100.00%	100.00%	100.00%
4-state	Baa	Ba	B	Caa-C
Continued Contraction	308.85%	287.67%	215.40%	218.68%
Contraction	205.82%	187.94%	145.70%	176.23%
Expansion	108.29%	81.10%	115.92%	88.89%
Continued Expansion	70.73%	79.24%	83.93%	83.50%
Combined	100.00%	100.00%	100.00%	100.00%

K. Recovery Rate by Economic State

For the case of recovery rates, we utilize the proprietary calendar year S&P recovery data and then assign it to the expansion and contraction years to derive recovery rates varying by the two economic states.

L. Model Calibration

The default rate scalars are calibrated in the bond engine such that the average 10 year total loss matches the deterministic mean loss using the baseline default and recovery assumptions. Increasing or decreasing the scalars for all economic states achieves the objective of having the bond engine's average loss match the independent deterministic calculation. This adjustment is made on a letter modifier basis. Thus, while the scalars are developed on a letter only rating basis, they are slightly different within the same letter rating across its numeric modifiers. Generally, the degree of this adjustment is small and deemed reasonable in its objective and preservation of the underlying development of the default rate scalars. Because bond engine results vary by the number of trials, the calibration is specific to the assumed number of trials. The calibrated scalars below are the final default rate scalars that were used running 10,000 trials.

Table C15. Economic State Default Rate Scalar

Rating	Continued Contraction	Contraction	Expansion	Continued Expansion
Aaa	274.95%	274.95%	73.65%	73.65%
Aa1	274.09%	274.09%	73.42%	73.42%
Aa2	274.82%	274.82%	73.61%	73.61%
Aa3	273.78%	273.78%	73.34%	73.34%
A1	272.87%	272.87%	73.09%	73.09%
A2	272.14%	272.14%	72.90%	72.90%
A3	272.52%	272.52%	73.00%	73.00%
Baa1	322.31%	214.79%	113.01%	73.81%
Baa2	322.24%	214.75%	112.99%	73.80%
Baa3	322.79%	215.11%	113.18%	73.92%
Ba1	297.28%	194.22%	83.81%	81.89%
Ba2	297.38%	194.29%	83.84%	81.92%
Ba3	297.27%	194.21%	83.81%	81.89%
B1	221.14%	149.58%	119.01%	86.17%
B2	221.22%	149.64%	119.05%	86.20%
B3	221.14%	149.58%	119.01%	86.17%
Caa1	223.88%	180.42%	91.00%	85.49%
Caa2	223.71%	180.28%	90.93%	85.42%
Caa3	223.56%	180.16%	90.87%	85.36%

M. Summary and Conclusion

Our initial preference was to use a four-state model for all rating categories. However, for higher rated bonds such as Aaa, Aa and A rated categories, given their fairly limited instances of default, the two-state model is a more appropriate modeling approach.

We summarize the economic modeling approach for our default and recovery rate as follows:

3. Default Rate:
   a. 2-state model for Aaa, Aa, A with the same Economic Scalar for all the three categories.
   b. 4-state model for Baa, Ba, B and Caa-C rating categories. Each rating category has its own unique Economic Scalar.

4. Recovery Rate:
   b. 2-state model with the same Economic Scalar for all the rating categories.

N. Supporting Data

1. **Comparison of BEA and NBER Economic Data**

Table C16. Correlation between Bond Default Rate and GDP Growth Rate

From	To	Correlation	P Value
1930	**1983**	-0.27703385	0.0426
1983	**2012**	-0.66583766	0.0001
1970	**2012**	-0.41252574	0.006
1930	**2012**	-0.2871232	0.0085
1970	**1983**	-0.3276434	0.2528

Bureau of Economic Analysis (BEA)

Bureau of Economic Analysis (BEA) is the government agency delegated with task of maintaining national economic accounts including National Accounts, Regional Accounts, Industry Accounts and International Accounts. It is the official source of data used by the White House, Federal Reserve Banks, Congress and other government bodies. www.bea.gov

BEA does not explicitly classify periods by their economic state. Hence, for data obtained from BEA we have defined the economic state as:

- Contraction: If the present year GDP is lower than the previous year GDP
- Expansion: If the present year GDP is higher than previous year GDP

National Bureau of Economic Research (NBER)

NBER is a private, nonprofit, nonpartisan research organization. It is a highly regarded organization for economic research and has produced twenty two Economics Nobel Laureates. www.nber.org

NBER explicitly defines a period to be "Expansion" or "Contraction (Recession)." This identification is done by the NBER committee and they employ their own logic in identifying a year to be an "Expansion" or a "Contraction." They do this by first identifying a period to be a "trough" or a "peak." After deciding whether a period is "trough" or "peak;" an NBER panel also analyzes behavior of a variety of economic activities like the Real GDP measured on the product and income sides, unemployment and real income. The NBER panel, if necessary, may also consider other indicators like Real Sales, Industrial Production index etc.

NBER Methodology of Classification:

NBER first defines a period to be Trough or Peak for the present half of the cycle. Then, every quarter (month) from Trough to Peak would be termed as "Expansion." Similarly, every quarter (month) from Peak to Trough would be termed as "Contraction."

We use the NBER definition of identifying a year as Contraction or Expansion as this task is already carried out by an expert NBER panel.

Every year that falls under expansion is classified as “expansion,” two consecutive expansions is classified as “continued expansion.” Likewise, every year that falls under contraction is classified as “contraction;” two consecutive contractions classified as “continued contraction.”

Applying the above logic, the years from 1983 to 2012 were classified by economic states. The classification is as follows:

Table C17. Economic States from 1983 to 2012

Year	Two-State Economic State	Four State Economic State
1983	Expansion	Expansion
1984	Expansion	Continued Expansion
1985	Expansion	Continued Expansion
1986	Expansion	Continued Expansion
1987	Expansion	Continued Expansion
1988	Expansion	Continued Expansion
1989	Expansion	Continued Expansion
1990	Expansion	Continued Expansion
1991	Contraction	Contraction
1992	Expansion	Expansion
1993	Expansion	Continued Expansion
1994	Expansion	Continued Expansion
1995	Expansion	Continued Expansion
1996	Expansion	Continued Expansion
1997	Expansion	Continued Expansion
1998	Expansion	Continued Expansion
1999	Expansion	Continued Expansion
2000	Expansion	Continued Expansion
2001	Contraction	Contraction
2002	Expansion	Expansion
2003	Expansion	Continued Expansion
2004	Expansion	Continued Expansion
2005	Expansion	Continued Expansion
2006	Expansion	Continued Expansion
2007	Expansion	Continued Expansion
2008	Contraction	Contraction
2009	Contraction	Continued Contraction
2010	Expansion	Expansion
2011	Expansion	Continued Expansion
2012	Expansion	Continued Expansion

Source: NBER, www.nber.org

Table C18: Economic States Comparison between NBER and BEA from 1983 to 2012

Year	BEA	NBER
1983	Expansion	Expansion
1984	Expansion	Expansion
1985	Expansion	Expansion
1986	Expansion	Expansion
1987	Expansion	Expansion
1988	Expansion	Expansion
1989	Expansion	Expansion
1990	Expansion*	Expansion*
1991	Contraction*	Contraction*
1992	Expansion	Expansion
1993	Expansion	Expansion
1994	Expansion	Expansion
1995	Expansion	Expansion
1996	Expansion	Expansion
1997	Expansion	Expansion
1998	Expansion	Expansion
1999	Expansion	Expansion
2000	Expansion	Expansion
2001	**Expansion****	**Contraction****
2002	Expansion	Expansion
2003	Expansion	Expansion
2004	Expansion	Expansion
2005	Expansion	Expansion
2006	Expansion	Expansion
2007	Expansion	Expansion
2008	Contraction	Contraction
2009	Contraction	Contraction
2010	Expansion	Expansion
2011	Expansion	Expansion
2012	Expansion	Expansion

NOTE:

*In the years 1990 and 1991, NBER classified 1990(Q4) and 1991(Q1) as Contraction quarters. We could categorize either 1990 or 1991 as a Contraction year; we decided to select 1991 as a Contraction year because according to the BEA statistics, 1991 had a lower GDP than 1990 whereas 1990 has a higher GDP than 1989.

GDP in Billions

1989	7,879.20
1990	8,027.10
1991	8,008.30

**According to the BEA's logic, which determines the economic state purely by GDP trends, the year 2001 would be an expansion year. But NBER data indicate that 2001's Q2 to Q4 were contraction quarters. As we follow NBER classification in this study, we have classified 2001 as a Contraction year even though the GDP in 2001 was slightly higher than the GDP in 2000.

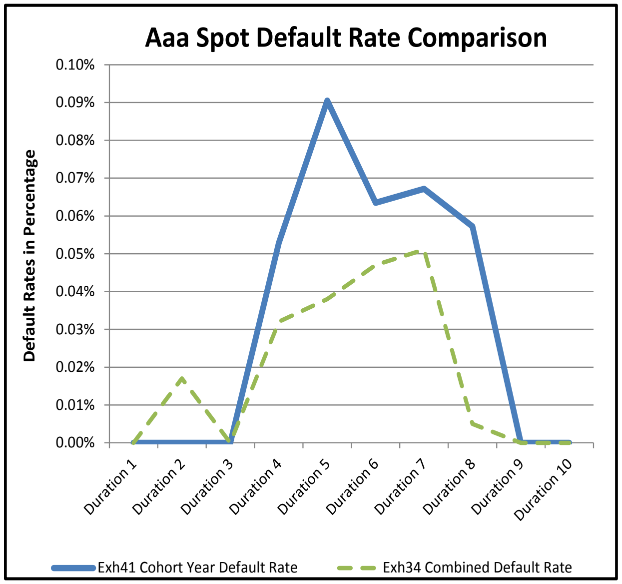
GDP in Billions

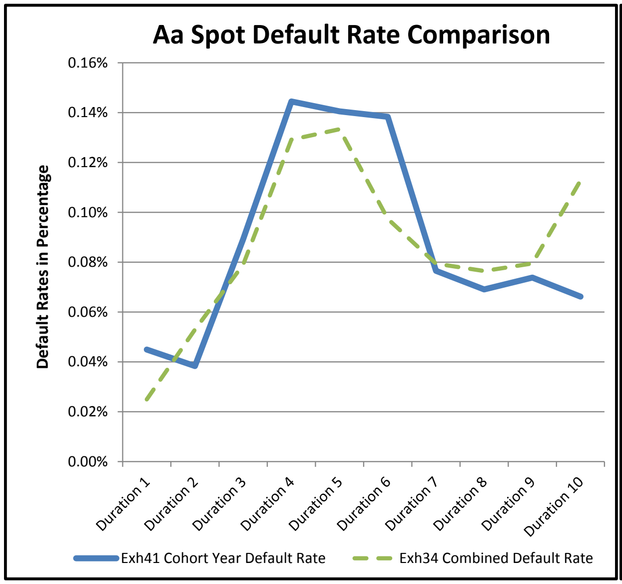
2000	11,216.40
2001	11,337.50

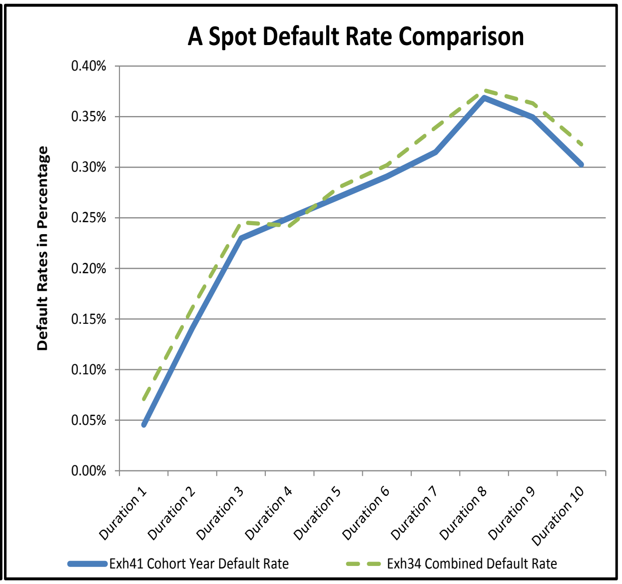
2. **<u>Comparison of Exhibit 34 an Exhibit 41 Default Rates</u>**

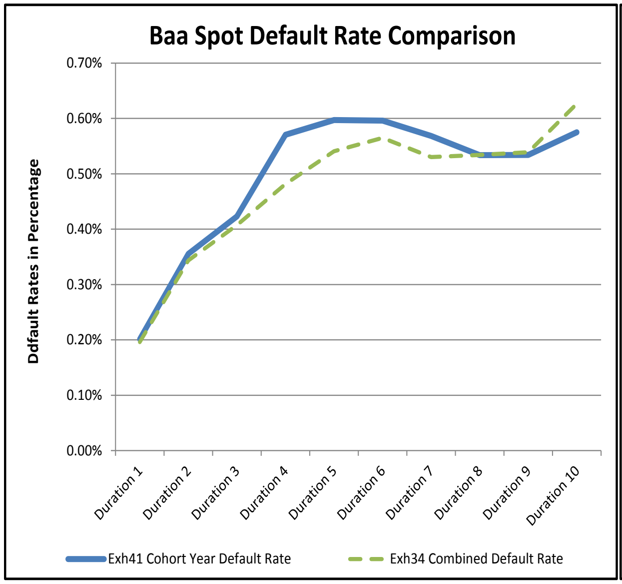
Table C19

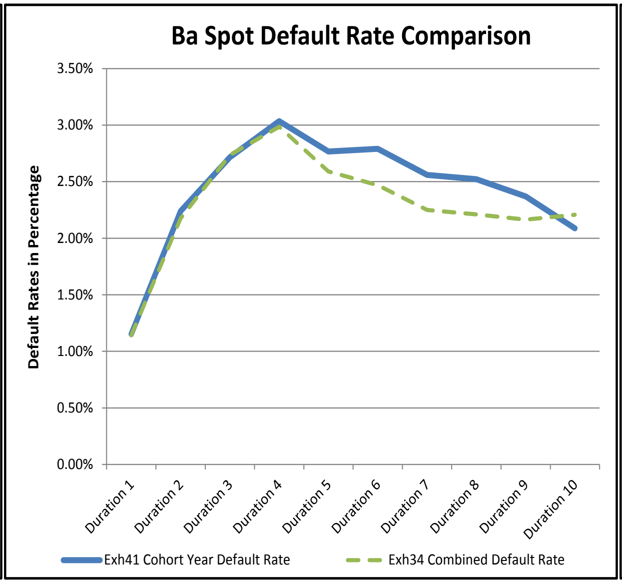
Rating Category	Duration	Duration 1	Duration 2	Duration 3	Duration 4	Duration 5	Duration 6	Duration 7	Duration 8	Duration 9	Duration 10
Aaa	Exh41 - Cohort Yr Default Rates	0.000%	0.000%	0.000%	0.053%	0.091%	0.063%	0.067%	0.057%	0.000%	0.000%
	Exh34 - Combd Default Rates	0.000%	0.017%	0.000%	0.032%	0.038%	0.047%	0.051%	0.005%	0.000%	0.000%
Aa	Exh41 - Cohort Yr Default Rates	0.045%	0.038%	0.089%	0.145%	0.140%	0.138%	0.077%	0.069%	0.074%	0.066%
	Exh34 - Combd Default Rates	0.025%	0.053%	0.079%	0.129%	0.133%	0.097%	0.079%	0.076%	0.080%	0.113%
A	Exh41 - Cohort Yr Default Rates	0.046%	0.141%	0.230%	0.250%	0.270%	0.291%	0.315%	0.369%	0.349%	0.303%
	Exh34 - Combd Default Rates	0.071%	0.161%	0.246%	0.242%	0.280%	0.302%	0.339%	0.376%	0.363%	0.323%
Baa	Exh41 - Cohort Yr Default Rates	0.201%	0.356%	0.423%	0.571%	0.597%	0.596%	0.569%	0.534%	0.534%	0.575%
	Exh34 - Combd Default Rates	0.196%	0.344%	0.407%	0.482%	0.541%	0.565%	0.530%	0.534%	0.539%	0.626%
Ba	Exh41 - Cohort Yr Default Rates	1.151%	2.240%	2.715%	3.034%	2.767%	2.790%	2.560%	2.522%	2.369%	2.088%
	Exh34 - Combd Default Rates	1.142%	2.174%	2.735%	2.985%	2.591%	2.468%	2.249%	2.211%	2.164%	2.208%
B	Exh41 - Cohort Yr Default Rates	5.097%	6.211%	6.380%	5.981%	5.934%	6.061%	6.281%	5.573%	5.362%	4.751%
	Exh34 - Combd Default Rates	4.043%	5.866%	6.297%	5.873%	5.704%	5.708%	5.659%	5.094%	4.766%	4.510%
Caa-C	Exh41 - Cohort Yr Default Rates	22.938%	12.347%	9.671%	9.160%	8.390%	7.012%	6.536%	10.070%	7.211%	5.185%
	Exh34 - Combd Default Rates	13.756%	13.051%	12.127%	11.264%	10.872%	8.901%	7.362%	8.849%	11.711%	12.587%

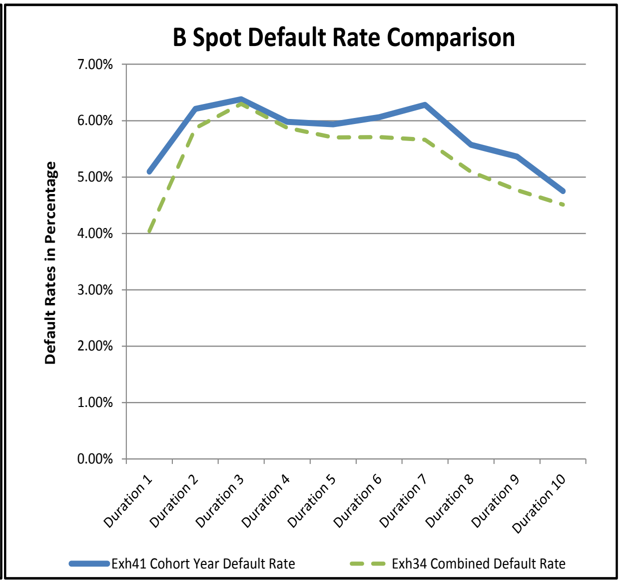

Aaa Spot Default Rate Comparison
Default Rates in Percentage
0.10%
0.09%
0.08%
0.07%
0.06%
0.05%
0.04%
0.03%
0.02%
0.01%
0.00%
Duration 1
Duration 2
Duration 3
Duration 4
Duration 5
Duration 6
Duration 7
Duration 8
Duration 9
Duration 10
Exh41 Cohort Year Default Rate
Exh34 Combined Default Rate

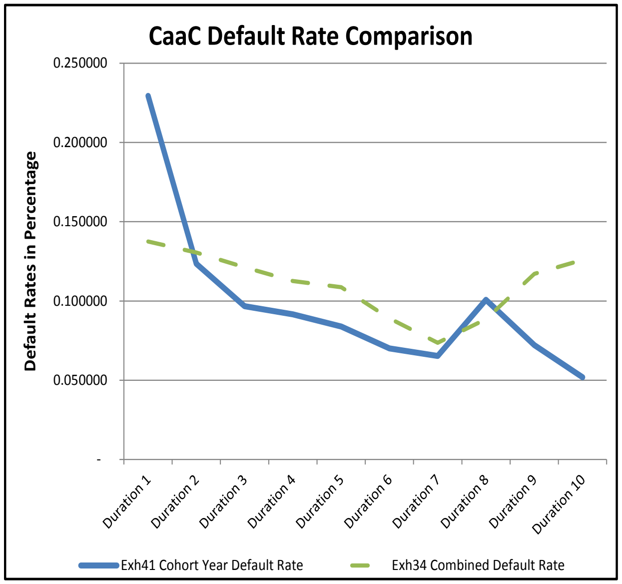

Aa Spot Default Rate Comparison
Default Rates in Percentage
0.16%
0.14%
0.12%
0.10%
0.08%
0.06%
0.04%
0.02%
0.00%
Duration 1
Duration 2
Duration 3
Duration 4
Duration 5
Duration 6
Duration 7
Duration 8
Duration 9
Duration 10
Exh41 Cohort Year Default Rate
Exh34 Combined Default Rate


A Spot Default Rate Comparison
Default Rates in Percentage
0.40%
0.35%
0.30%
0.25%
0.20%
0.15%
0.10%
0.05%
0.00%
Duration 1
Duration 2
Duration 3
Duration 4
Duration 5
Duration 6
Duration 7
Duration 8
Duration 9
Duration 10
Exh41 Cohort Year Default Rate
Exh34 Combined Default Rate


Baa Spot Default Rate Comparison
Ddfault Rates in Percentage
0.70%
0.60%
0.50%
0.40%
0.30%
0.20%
0.10%
0.00%
Duration 1
Duration 2
Duration 3
Duration 4
Duration 5
Duration 6
Duration 7
Duration 8
Duration 9
Duration 10
Exh41 Cohort Year Default Rate
Exh34 Combined Default Rate


Ba Spot Default Rate Comparison
Default Rates in Percentage
3.50%
3.00%
2.50%
2.00%
1.50%
1.00%
0.50%
0.00%
Duration 1
Duration 2
Duration 3
Duration 4
Duration 5
Duration 6
Duration 7
Duration 8
Duration 9
Duration 10
Exh41 Cohort Year Default Rate
Exh34 Combined Default Rate


B Spot Default Rate Comparison
Default Rates in Percentage
7.00%
6.00%
5.00%
4.00%
3.00%
2.00%
1.00%
0.00%
Duration 1
Duration 2
Duration 3
Duration 4
Duration 5
Duration 6
Duration 7
Duration 8
Duration 9
Duration 10
Exh41 Cohort Year Default Rate
Exh34 Combined Default Rate


CaaC Default Rate Comparison
Default Rates in Percentage
0.250000
0.200000
0.150000
0.100000
0.050000
-
Duration 1
Duration 2
Duration 3
Duration 4
Duration 5
Duration 6
Duration 7
Duration 8
Duration 9
Duration 10
Exh41 Cohort Year Default Rate
Exh34 Combined Default Rate

3. <u>2 State Model</u>

Table C20. Economic State by Calendar Year and Duration – 2-State Model

Year / Duration	Dur1	Dur2	Dur3	Dur4	Dur5	Dur6	Dur7	Dur8	Dur9	Dur10
1983	Expansion	Expansion	Expansion	Expansion	Expansion	Expansion	Expansion	Expansion	Contraction	Expansion
1984	Expansion	Expansion	Expansion	Expansion	Expansion	Expansion	Expansion	Contraction	Expansion	Expansion
1985	Expansion	Expansion	Expansion	Expansion	Expansion	Expansion	Contraction	Expansion	Expansion	Expansion
1986	Expansion	Expansion	Expansion	Expansion	Expansion	Contraction	Expansion	Expansion	Expansion	Expansion
1987	Expansion	Expansion	Expansion	Expansion	Contraction	Expansion	Expansion	Expansion	Expansion	Expansion
1988	Expansion	Expansion	Expansion	Contraction	Expansion	Expansion	Expansion	Expansion	Expansion	Expansion
1989	Expansion	Expansion	Contraction	Expansion	Expansion	Expansion	Expansion	Expansion	Expansion	Expansion
1990	Expansion	Contraction	Expansion	Expansion	Expansion	Expansion	Expansion	Expansion	Expansion	Expansion
1991	Contraction	Expansion	Expansion	Expansion	Expansion	Expansion	Expansion	Expansion	Expansion	Expansion
1992	Expansion	Expansion	Expansion	Expansion	Expansion	Expansion	Expansion	Expansion	Expansion	Contraction
1993	Expansion	Expansion	Expansion	Expansion	Expansion	Expansion	Expansion	Expansion	Contraction	Expansion
1994	Expansion	Expansion	Expansion	Expansion	Expansion	Expansion	Expansion	Contraction	Expansion	Expansion
1995	Expansion	Expansion	Expansion	Expansion	Expansion	Expansion	Contraction	Expansion	Expansion	Expansion
1996	Expansion	Expansion	Expansion	Expansion	Expansion	Contraction	Expansion	Expansion	Expansion	Expansion
1997	Expansion	Expansion	Expansion	Expansion	Contraction	Expansion	Expansion	Expansion	Expansion	Expansion
1998	Expansion	Expansion	Expansion	Contraction	Expansion	Expansion	Expansion	Expansion	Expansion	Expansion
1999	Expansion	Expansion	Contraction	Expansion	Expansion	Expansion	Expansion	Expansion	Expansion	Contraction
2000	Expansion	Contraction	Expansion	Expansion	Expansion	Expansion	Expansion	Expansion	Contraction	Contraction
2001	Contraction	Expansion	Expansion	Expansion	Expansion	Expansion	Expansion	Contraction	Contraction	Expansion
2002	Expansion	Expansion	Expansion	Expansion	Expansion	Expansion	Contraction	Contraction	Expansion	Expansion
2003	Expansion	Expansion	Expansion	Expansion	Expansion	Contraction	Contraction	Expansion	Expansion	Expansion
2004	Expansion	Expansion	Expansion	Expansion	Contraction	Contraction	Expansion	Expansion	Expansion	
2005	Expansion	Expansion	Expansion	Contraction	Contraction	Expansion	Expansion	Expansion		
2006	Expansion	Expansion	Contraction	Contraction	Expansion	Expansion	Expansion			
2007	Expansion	Contraction	Contraction	Expansion	Expansion	Expansion				
2008	Contraction	Contraction	Expansion	Expansion	Expansion					
2009	Contraction	Expansion	Expansion	Expansion						
2010	Expansion	Expansion	Expansion							
2011	Expansion	Expansion								
2012	Expansion									

4. **4 State Model**

Table C21. Economic State by Calendar Year and Duration – 4-State Model

Year / Duration	Dur1	Dur2	Dur3	Dur4	Dur5	Dur6	Dur7	Dur8	Dur9	Dur10
1983	Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Contraction	Expansion
1984	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Contraction	Expansion	Continued Expansion
1985	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Contraction	Expansion	Continued Expansion	Continued Expansion
1986	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Contraction	Expansion	Continued Expansion	Continued Expansion	Continued Expansion
1987	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Contraction	Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion
1988	Continued Expansion	Continued Expansion	Continued Expansion	Contraction	Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion
1989	Continued Expansion	Continued Expansion	Contraction	Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion
1990	Continued Expansion	Contraction	Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion
1991	Contraction	Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion
1992	Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Contraction
1993	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Contraction	Expansion
1994	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Contraction	Expansion	Continued Expansion
1995	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Contraction	Expansion	Continued Expansion	Continued Expansion
1996	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Contraction	Expansion	Continued Expansion	Continued Expansion	Continued Expansion
1997	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Contraction	Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion
1998	Continued Expansion	Continued Expansion	Continued Expansion	Contraction	Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion
1999	Continued Expansion	Continued Expansion	Contraction	Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Contraction
2000	Continued Expansion	Contraction	Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Contraction	Contined Contraction
2001	Contraction	Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Contraction	Contined Contraction	Expansion
2002	Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Contraction	Contined Contraction	Expansion	Continued Expansion
2003	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Contraction	Contined Contraction	Expansion	Continued Expansion	Continued Expansion
2004	Continued Expansion	Continued Expansion	Continued Expansion	Continued Expansion	Contraction	Contined Contraction	Expansion	Continued Expansion	Continued Expansion	
2005	Continued Expansion	Continued Expansion	Continued Expansion	Contraction	Contined Contraction	Expansion	Continued Expansion	Continued Expansion		
2006	Continued Expansion	Continued Expansion	Contraction	Contined Contraction	Expansion	Continued Expansion	Continued Expansion			
2007	Continued Expansion	Contraction	Contined Contraction	Expansion	Continued Expansion	Continued Expansion				
2008	Contraction	Contined Contraction	Expansion	Continued Expansion	Continued Expansion					
2009	Contined Contraction	Expansion	Continued Expansion	Continued Expansion						
2010	Expansion	Continued Expansion	Continued Expansion							
2011	Continued Expansion	Continued Expansion								
2012	Continued Expansion									

5. **Annual Spot Default Rates by Rating Category, Economic State and Duration**

Table C22.

Spot Default Rate by Rating and Economic State												
			Duration 1	Duration 2	Duration 3	Duration 4	Duration 5	Duration 6	Duration 7	Duration 8	Duration 9	Duration 10
2 State Model	Aaa	Contraction	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
		Expansion	0.000%	0.000%	0.000%	0.062%	0.107%	0.076%	0.081%	0.069%	0.000%	0.000%
		Combined	0.000%	0.000%	0.000%	0.053%	0.091%	0.063%	0.067%	0.057%	0.000%	0.000%
	Aa	Contraction	0.177%	0.054%	0.060%	0.066%	0.073%	0.000%	0.000%	0.000%	0.000%	0.141%
		Expansion	0.025%	0.036%	0.094%	0.158%	0.153%	0.165%	0.092%	0.084%	0.090%	0.054%
		Combined	0.045%	0.038%	0.089%	0.145%	0.140%	0.138%	0.077%	0.069%	0.074%	0.066%
	A	Contraction	0.236%	0.460%	0.546%	0.595%	0.744%	0.751%	1.008%	1.107%	1.136%	1.018%
		Expansion	0.016%	0.090%	0.177%	0.190%	0.184%	0.203%	0.176%	0.213%	0.174%	0.183%
		Combined	0.046%	0.141%	0.230%	0.250%	0.270%	0.291%	0.315%	0.369%	0.349%	0.303%
	Aaa/Aa/A combined	Contraction	0.199%	0.293%	0.346%	0.377%	0.475%	0.462%	0.610%	0.670%	0.678%	0.671%
		Expansion	0.018%	0.066%	0.134%	0.168%	0.172%	0.179%	0.144%	0.163%	0.134%	0.124%
		Combined	0.042%	0.097%	0.164%	0.199%	0.219%	0.224%	0.222%	0.251%	0.233%	0.202%
			Duration 1	Duration 2	Duration 3	Duration 4	Duration 5	Duration 6	Duration 7	Duration 8	Duration 9	Duration 10
4 state model	Baa	Continued Contraction	0.933%	0.668%	1.071%	0.887%	1.523%	1.787%	1.332%	2.199%	2.352%	2.242%
		Contraction	0.342%	0.513%	0.687%	1.074%	1.072%	1.138%	1.187%	1.068%	1.312%	1.895%
		Expansion	0.254%	0.429%	0.407%	0.826%	0.838%	0.732%	0.639%	0.434%	0.343%	0.446%
		Continued Expansion	0.139%	0.310%	0.357%	0.441%	0.435%	0.417%	0.403%	0.348%	0.296%	0.314%
		Combined	0.201%	0.356%	0.423%	0.571%	0.597%	0.596%	0.569%	0.534%	0.534%	0.575%
	Ba	Continued Contraction	2.281%	6.232%	7.113%	7.884%	6.343%	6.297%	6.313%	7.348%	9.708%	9.806%
		Contraction	2.558%	4.106%	4.648%	5.219%	4.670%	5.249%	4.424%	4.682%	5.361%	4.299%
		Expansion	0.677%	1.259%	1.886%	2.184%	2.327%	2.787%	2.230%	2.338%	2.178%	2.105%
		Continued Expansion	0.995%	1.938%	2.348%	2.592%	2.347%	2.186%	2.069%	1.849%	1.320%	1.275%
		Combined	1.151%	2.240%	2.715%	3.034%	2.767%	2.790%	2.560%	2.522%	2.369%	2.088%
	B	Continued Contraction	7.434%	11.928%	12.901%	12.733%	13.455%	12.971%	13.755%	14.657%	13.596%	11.215%
		Contraction	8.064%	9.048%	9.436%	9.565%	9.505%	7.891%	9.016%	7.298%	8.141%	5.301%
		Expansion	5.173%	7.966%	8.330%	8.219%	6.678%	6.957%	7.539%	5.707%	4.910%	6.110%
		Continued Expansion	4.573%	5.325%	5.355%	4.769%	4.856%	5.222%	5.137%	4.657%	4.347%	3.974%
		Combined	5.097%	6.211%	6.380%	5.981%	5.934%	6.061%	6.281%	5.573%	5.362%	4.751%
	Caa-C	Continued Contraction	34.432%	28.020%	28.191%	24.810%	23.673%	20.689%	14.471%	17.361%	12.500%	20.000%
		Contraction	30.646%	23.495%	19.570%	12.140%	13.542%	10.800%	14.167%	23.863%	4.166%	33.333%
		Expansion	28.161%	10.399%	9.619%	7.040%	7.846%	5.623%	4.961%	11.111%	0.000%	0.000%
		Continued Expansion	20.414%	10.379%	7.383%	8.249%	6.858%	5.852%	5.001%	6.833%	8.909%	1.482%
		Combined	22.938%	12.347%	9.671%	9.160%	8.390%	7.012%	6.536%	10.070%	7.211%	5.185%

6. **Economic Scalars by Rating Category and Duration**

Table C23.

Economic Scalars by Rating Category / Duration /Economic State												
			Duration 1	Duration 2	Duration 3	Duration 4	Duration 5	Duration 6	Duration 7	Duration 8	Duration 9	Duration 10
2 State Model	Aaa	Contraction				0%	0%	0%	0%	0%		
		Expansion				117%	118%	119%	120%	121%		
		Combined				100%	100%	100%	100%	100%		
	Aa	Contraction	393%	140%	67%	46%	52%	0%	0%	0%	0%	213%
		Expansion	55%	94%	106%	109%	109%	119%	120%	121%	122%	81%
		Combined	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	A	Contraction	518%	326%	238%	238%	275%	258%	320%	300%	325%	336%
		Expansion	36%	64%	77%	76%	68%	70%	56%	58%	50%	61%
		Combined	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	Aaa/Aa/A combined	Contraction	471%	302%	211%	189%	217%	206%	275%	267%	291%	332%
		Expansion	43%	68%	82%	85%	79%	80%	65%	65%	58%	61%
		Combined	93%	69%	71%	80%	81%	77%	70%	68%	67%	67%
			Duration 1	Duration 2	Duration 3	Duration 4	Duration 5	Duration 6	Duration 7	Duration 8	Duration 9	Duration 10
4 state model	Baa	Continued Contraction	463%	188%	253%	155%	255%	300%	234%	412%	440%	390%
		Contraction	170%	144%	162%	188%	180%	191%	209%	200%	246%	329%
		Expansion	126%	121%	96%	145%	140%	123%	112%	81%	64%	78%
		Continued Expansion	69%	87%	84%	77%	73%	70%	71%	65%	55%	55%
		Combined	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	Ba	Continued Contraction	198%	278%	262%	260%	229%	226%	247%	291%	410%	470%
		Contraction	222%	183%	171%	172%	169%	188%	173%	186%	226%	206%
		Expansion	59%	56%	69%	72%	84%	100%	87%	93%	92%	101%
		Continued Expansion	86%	87%	86%	85%	85%	78%	81%	73%	56%	61%
		Combined	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	B	Continued Contraction	146%	192%	202%	213%	227%	214%	219%	263%	254%	236%
		Contraction	158%	146%	148%	160%	160%	130%	144%	131%	152%	112%
		Expansion	101%	128%	131%	137%	113%	115%	120%	102%	92%	129%
		Continued Expansion	90%	86%	84%	80%	82%	86%	82%	84%	81%	84%
		Combined	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	Caa-C	Continued Contraction	150%	227%	291%	271%	282%	295%	221%	172%	173%	386%
		Contraction	134%	190%	202%	133%	161%	154%	217%	237%	58%	643%
		Expansion	123%	84%	99%	77%	94%	80%	76%	110%	0%	0%
		Continued Expansion	89%	84%	76%	90%	82%	83%	77%	68%	124%	29%
		Combined	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Appendix D - Representative Portfolio

A. General

The representative portfolio is a generic portrayal of a bond portfolio structure that captures key features which differentiate C1 risk. This approach is used because it would be impractical to model every life company portfolio. The portfolio relies on the assumption that all bonds are generic and produce the same result given the same rating. Thus, all bonds of a given rating using the same default and recovery assumption.

The main factors affecting a generic analysis of corporate bond portfolio risk are the mix of ratings, size distribution and numbers of bonds held. The representative portfolio captures these variables to evaluate aggregate portfolio risk. This process can also be thought of as using "modeling cells" or "model points" to represent a portfolio. While the term representative portfolio is used in the singular, this process defines a family of portfolios that are characterized by those seen in actual life company portfolios.

The NAIC supplied comprehensive data covering the bond portfolios of every life company as of December 31, 2011 (no company identifying data was provided). The data comprising over 287,000 positions and 782 companies was anonymous as to company and non-cusip specific. The data was adjusted to remove bonds guaranteed by the full faith and credit (FFC) of the US government, affiliate bonds and also zero value bonds. These bonds were excluded because US FFC bonds and zero value bonds generate no C1 charge and affiliate bonds have their own C1 classification that looks through to the holdings of the affiliate.

An averaging process, described later, was used to define a given representative portfolio. Because meaningful differences could get lost with too broad an averaging of the data, the portfolios were developed with respect to size categories. The categories roughly corresponded to breakpoints of industry bond portfolio sizes. The categories are shown below.

Table D1. Life Company Representative Portfolio Size Categories

Size	$Billion		$Billion	Count
1	0.0	-	0.5	503
2	0.5	-	1.0	54
3	1.0	-	2.5	70
4	2.5	-	5.0	35
5	5.0	-	10.0	32
6	10.0	-	25.0	24
7	25.0	-	80.0	16

A consolidated view of each company's bond portfolio rating and size distribution was used to develop an average portfolio for each size category. Each company's bonds were rank-ordered by Book Adjusted Carrying Value (BACV). Given an ascending sort order of the bonds, eighteen groups or bins were created such that the first two and last two bins hold 1/32nd of the BACV and the other bins, 3 - 16, each hold 1/16th of the BACV. The average BACV of each bin is taken as the set of model points to define the overall size distribution. The actual distribution by rating is determined by assigning the bonds in a given size bin to their associated rating categories.

The average portfolio for a size category is determined by combining the consolidated portfolios for each company in the category. Each bin size amount, which defines the bin model point, is the average of all companies' BACV held in the same associated bin number. In other words, after each company's assets are assigned to a bin, those assets for all companies in aggregate are used to define the average company size amount for that bin. The average number of bonds held in each bin and rating category defines the model points of the average portfolio for the size category. As an example, the average portfolio for size category 6 is shown below. The portfolios for all categories are shown in Section C.

Table D2. Category 6 Portfolio Size and Rating Distribution

	NAIC Rating					
Bin	**1**	**2**	**3**	**4**	**5**	**$Million**
1	82	76	47	35	8	2.013
2	37	36	15	10	1	5.062
3	56	53	13	6	2	7.789
4	39	42	7	2	1	11.108
5	30	34	5	1	0	14.229
6	25	30	3	1	0	17.209
7	21	26	2	0	0	20.336
8	19	22	2	0	0	23.561
9	16	20	1	0	0	26.895
10	15	17	1	0	0	30.664
11	13	15	1	0	0	34.746
12	13	12	0	0	0	39.485
13	11	11	0	0	0	46.288
14	8	9	0	0	0	55.684
15	8	7	0	0	0	65.445
16	6	6	0	0	0	81.004
17	3	2	0	0	0	95.349
18	3	1	0	0	0	142.017
Issuer Count	405	419	97	55	12	
Coefficient of Variation	1.13	1.00	1.02	0.83	0.77	
Issuer Count %	41%	42%	10%	6%	1%	
Amount %	47%	47%	4%	1%	0%	

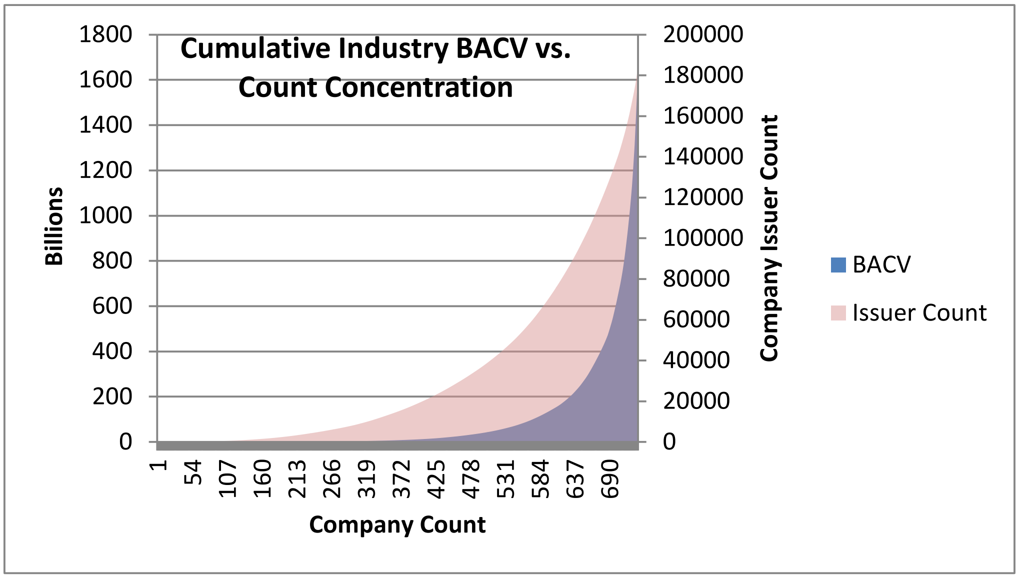
Average Portfolio Size ($Millions)	16,009.9
Average Issuer Size ($Millions)	16.2
Portfolio Coefficient of Variation	1.14

The shaded areas of the Category 6 chart are used as the size distribution for all ratings to determine the preliminary C1 factors at the 92nd percentile confidence level. Those factors are then used in the full portfolio as per the above distribution to derive the implied confidence level of a full portfolio. The implied confidence of the full portfolio will vary from the preliminary 92% confidence baseline depending on its structure. For example in the full size category six portfolio which has a similar coefficient of variation, (a measure of size distribution), but a greater number of issuers, 988 vs. 405, we expect a higher confidence level. Portfolios with a low number of issuers and/or a high coefficient of variation could have a portfolio confidence level less than 92% without adjustments to the factors. Generally, a greater number of bonds and lower coefficient of dispersion each contribute to reducing risk.

The same distribution was used for each rating to have consistency between the factors even though they have varying size distributions. Arguably, the actual distributions could have been used. But, using actual distributions would also suggest using smaller numbers of bonds in those ratings, resulting in increased portfolio risk. On a standalone basis (i.e., for each separate rating), actual distributions make sense. However, the use of actual distributions for each rating class will overstate risk on a portfolio basis. Consequently, the same distribution was assumed for each rating category.

The category 6 portfolio size was chosen for the basis of the ratings factors because it contains the 50% cumulative BACV point with a range of 33% - 56% of industry BACV. While the category 6 companies are much bigger than the average industry size, they represent portfolios that are central in size to the greatest proportion of industry assets that are concentrated in category sizes 5 - 7. The chart below shows asset concentration by issuer counts and BACV for all companies in ascending order of their portfolio size.

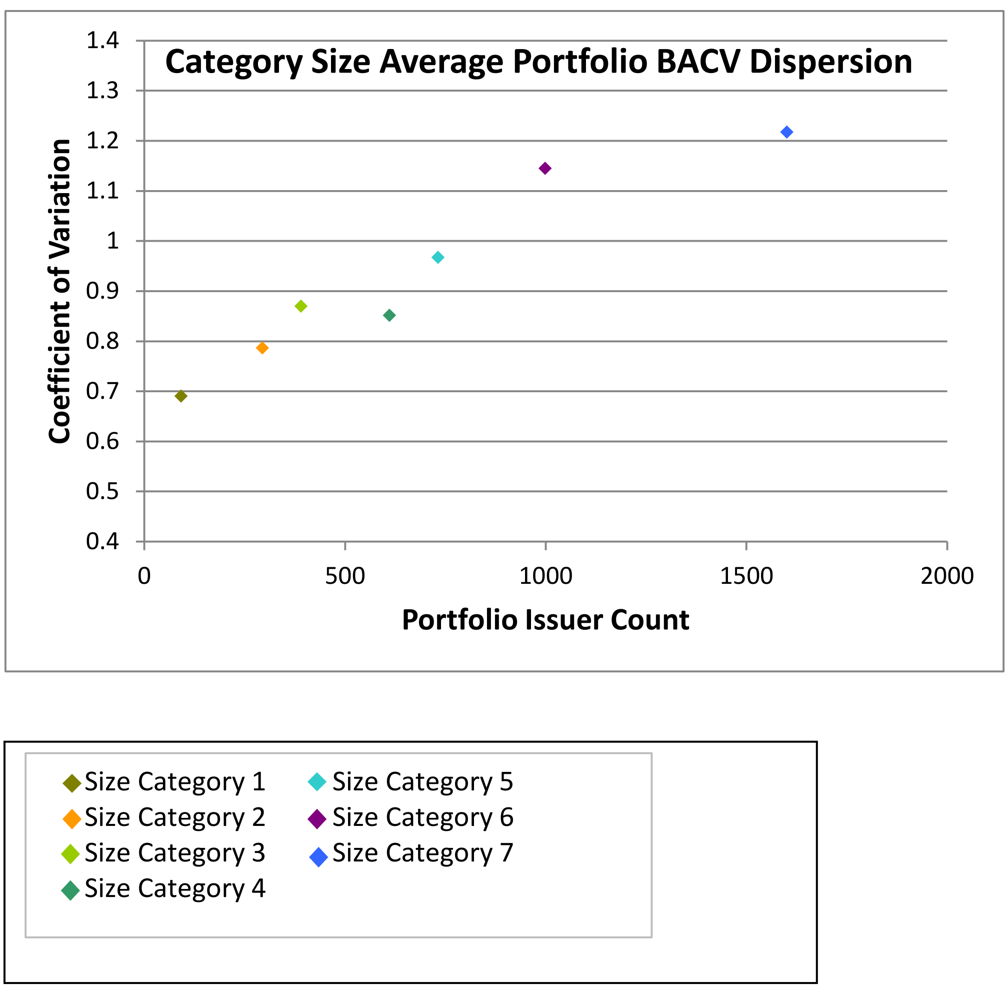
Chart D1.



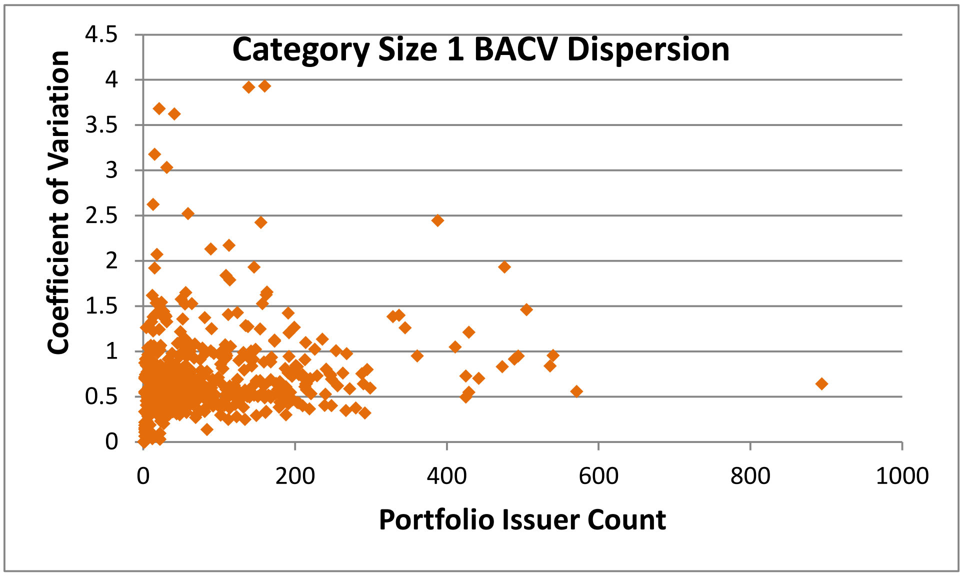
B. Company Specific Adjustments

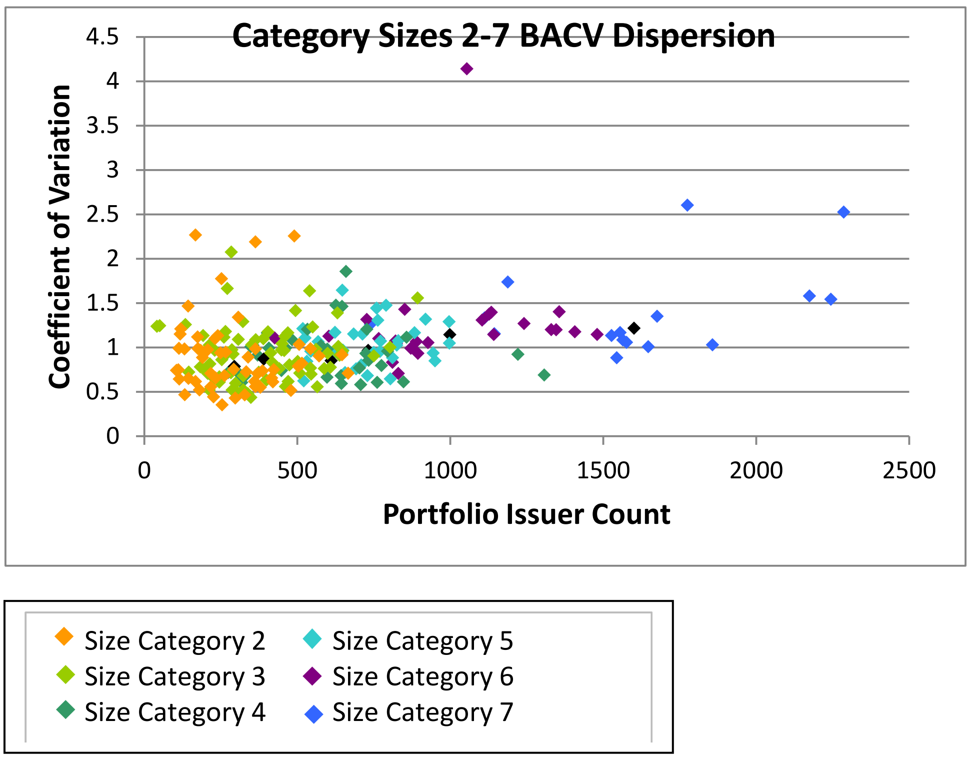
Two key portfolio characteristics accounted for on an average basis vary significantly among companies; size distribution and number of issuers. The current C1 factors reflect concentration risk by doubling the C1 of the 10 largest issuers held across all debt related asset classes. The initial filter excludes bonds with C1 RBC equal to 0 and NAIC 1 bonds. As applicable after the first filter, if a top ten issuer has NAIC 1 bonds, they are added back. Up to 10 bond issuers of a bond portfolio can be subject to the top 10 doubling rule for concentration risk. Size variation can be measured with respect to the bond portfolio on a standalone basis as the coefficient of variation. The coefficient of variation is the standard deviation divided by the mean expressed as, (σ_{BACV}/μ_{BACV}). Generally a higher/lower coefficient of variation and lower/higher number of issuers held will produce higher/lower risk. The chart below shows the coefficient of variation and number of issuers for each of the size category average portfolios. Generally, the coefficient of variation and number of issuers increase with size category.

Chart D2.



There is significant variation in the size distribution and the number of issuers held across companies within each category. Adjustment formulas applied to the base C1 factors, yet to be determined, will need to accommodate this variety of portfolio structures. A condensed view of these portfolios is given below for category 1 companies and for category 2 - 7 companies combined. Category 1 companies are shown separately here because they comprise two thirds of the number of companies with the bulk of those companies holding 300 or fewer issuers, (excluding US FFC bonds). The corresponding graphs for each size category are provided in Section C.





C. Additional Data

Average Portfolios by Size Category

Category Size 7

Rounded Average Issuer Counts

	Rating					
Bin	1	2	3	4	5	$Millions
1	159	120	63	58	20	3.304
2	62	56	19	15	5	8.991
3	78	81	25	17	2	13.916
4	60	60	15	10	2	19.409
5	47	52	10	4	1	25.010
6	39	43	8	2	1	30.675
7	34	36	5	2	1	36.349
8	31	32	3	1	0	42.080
9	28	26	3	0	0	48.760
10	24	24	2	0	0	55.833
11	23	20	2	0	0	63.547
12	20	17	1	0	0	72.550
13	19	15	0	0	0	83.359
14	16	13	0	0	0	96.977
15	15	10	0	0	0	116.763
16	13	5	0	0	0	150.028
17	4	2	0	0	0	209.337
18	4	1	0	0	0	316.080
Issuer Count	676	613	156	109	32	
Coefficient of Variation	1.21	1.04	0.98	0.90	1.02	
Issuer Count %	43%	39%	10%	7%	2%	
Amount %	51%	42%	5%	2%	1%	

Average Portfolio Size ($Millions)	45,125.8
Average Issuer Size ($Millions)	28.5
Portfolio Coefficient of Variation	1.22

Category Size 6

Rounded Average Issuer Counts

	Rating					
Bin	1	2	3	4	5	$Millions
1	82	76	47	35	8	2.013
2	37	36	15	10	1	5.062
3	56	53	13	6	2	7.789
4	39	42	7	2	1	11.108
5	30	34	5	1	0	14.229
6	25	30	3	1	0	17.209
7	21	26	2	0	0	20.336
8	19	22	2	0	0	23.561
9	16	20	1	0	0	26.895
10	15	17	1	0	0	30.664
11	13	15	1	0	0	34.746
12	13	12	0	0	0	39.485
13	11	11	0	0	0	46.288
14	8	9	0	0	0	55.684
15	8	7	0	0	0	65.445
16	6	6	0	0	0	81.004
17	3	2	0	0	0	95.349
18	3	1	0	0	0	142.017
Issuer Count	405	419	97	55	12	
Coefficient of Variation	1.13	1.00	1.02	0.83	0.77	
Issuer Count %	41%	42%	10%	6%	1%	
Amount %	47%	47%	4%	1%	0%	

Average Portfolio Size ($Millions)	16,009.9
Average Issuer Size ($Millions)	16.2
Portfolio Coefficient of Variation	1.14

Category Size 5

Rounded Average Issuer Counts

	Rating					
Bin	1	2	3	4	5	$Millions
1	53	46	28	24	4	1.306
2	28	24	9	5	1	2.989
3	40	38	9	4	1	4.402
4	31	29	5	2	0	6.030
5	24	26	4	1	0	7.480
6	21	21	3	1	0	8.955
7	18	19	2	0	0	10.465
8	16	16	2	0	0	11.970
9	14	14	1	0	0	13.661
10	13	13	1	0	0	15.330
11	11	12	1	0	0	17.086
12	11	9	1	0	0	19.189
13	10	9	0	0	0	21.660
14	9	7	0	0	0	24.570
15	8	6	0	0	0	27.934
16	7	5	0	0	0	33.089
17	3	2	0	0	0	41.415
18	3	1	0	0	0	61.528
Issuer Count	320	297	66	37	6	
Coefficient of Variation	0.95	0.86	0.93	0.78	0.57	
Issuer Count %	44%	41%	9%	5%	1%	
Amount %	50%	44%	5%	1%	0%	

Average Portfolio Size ($Millions)	6,519.2
Average Issuer Size ($Millions)	9.0
Portfolio Coefficient of Variation	0.97

Category Size 4

Rounded Average Issuer Counts

	Rating					
Bin	1	2	3	4	5	$Millions
1	39	36	20	16	3	.951
2	21	22	6	4	1	2.035
3	33	33	6	2	1	2.953
4	26	25	3	1	0	4.014
5	21	21	3	0	0	4.826
6	18	19	2	0	0	5.676
7	15	17	2	0	0	6.569
8	15	14	1	0	0	7.329
9	11	14	2	0	0	8.211
10	11	11	1	0	0	9.117
11	11	10	1	0	0	10.126
12	10	9	1	0	0	11.169
13	9	8	1	0	0	12.415
14	8	7	0	0	0	13.967
15	7	6	0	0	0	16.231
16	7	4	0	0	0	19.032
17	3	2	0	0	0	23.063
18	3	1	0	0	0	30.218
Issuer Count	268	259	49	23	5	
Coefficient of Variation	0.83	0.77	0.89	0.58	0.52	
Issuer Count %	44%	43%	8%	4%	1%	
Amount %	50%	45%	5%	1%	0%	

Average Portfolio Size ($Millions)	3,509.3
Average Issuer Size ($Millions)	5.8
Portfolio Coefficient of Variation	0.85

Category Size 3

Rounded Average Issuer Counts

	Rating					
Bin	1	2	3	4	5	$Millions
1	26	24	10	8	1	.690
2	15	14	3	2	0	1.439
3	22	20	4	2	0	1.981
4	17	16	3	1	0	2.667
5	15	12	2	1	0	3.266
6	12	12	1	0	0	3.828
7	11	11	1	0	0	4.363
8	10	9	1	0	0	4.956
9	9	7	0	0	0	5.715
10	8	7	0	0	0	6.363
11	8	6	0	0	0	7.010
12	7	5	0	0	0	7.686
13	7	4	0	0	0	8.696
14	6	4	0	0	0	9.370
15	5	3	0	0	0	11.085
16	5	2	0	0	0	12.910
17	2	1	0	0	0	14.839
18	2	1	0	0	0	24.597
Issuer Count	187	158	25	14	1	
Coefficient of Variation	0.85	0.82	0.67	0.64	0.00	
Issuer Count %	49%	41%	6%	4%	0%	
Amount %	55%	41%	3%	1%	0%	

Average Portfolio Size ($Millions)	1,547.4
Average Issuer Size ($Millions)	4.0
Portfolio Coefficient of Variation	0.88

Category Size 2

Rounded Average Issuer Counts

	Rating					
Bin	1	2	3	4	5	$Millions
1	21	15	5	4	1	.466
2	12	10	2	1	0	.910
3	18	14	2	1	0	1.262
4	14	12	1	1	0	1.594
5	12	10	1	0	0	1.900
6	11	8	0	0	0	2.251
7	9	8	1	0	0	2.555
8	9	6	0	0	0	2.890
9	8	6	0	0	0	3.182
10	7	5	0	0	0	3.489
11	7	4	0	0	0	3.826
12	6	4	0	0	0	4.282
13	6	4	0	0	0	4.681
14	5	3	0	0	0	5.286
15	5	2	0	0	0	5.978
16	4	2	0	0	0	6.775
17	2	1	0	0	0	8.443
18	2	1	0	0	0	12.816
Issuer Count	158	115	12	7	1	
Coefficient of Variation	0.79	0.77	0.62	0.54	0.00	
Issuer Count %	54%	39%	4%	2%	0%	
Amount %	59%	39%	2%	1%	0%	

Average Portfolio Size ($Millions)	715.5
Average Issuer Size ($Millions)	2.4
Portfolio Coefficient of Variation	0.81

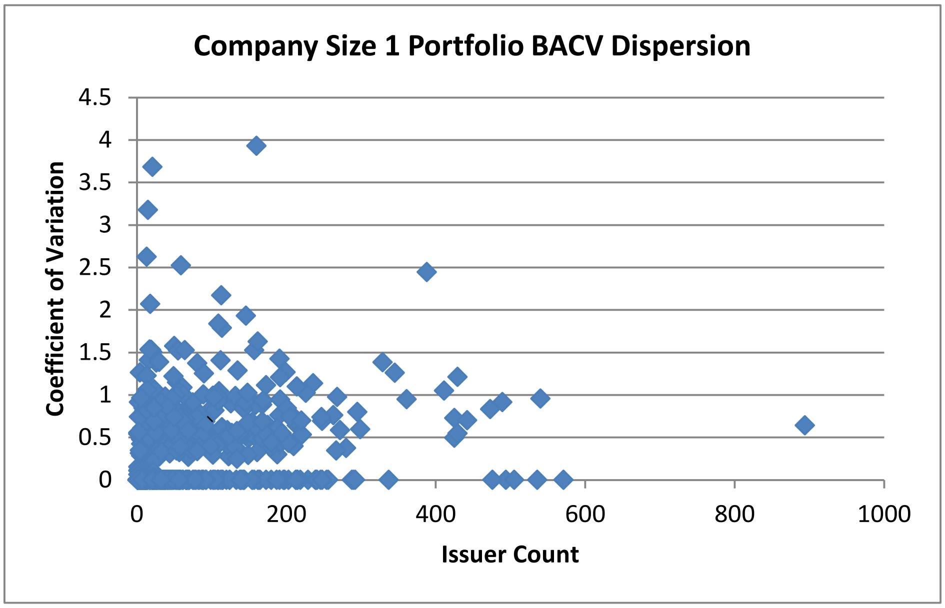
Category Size 1

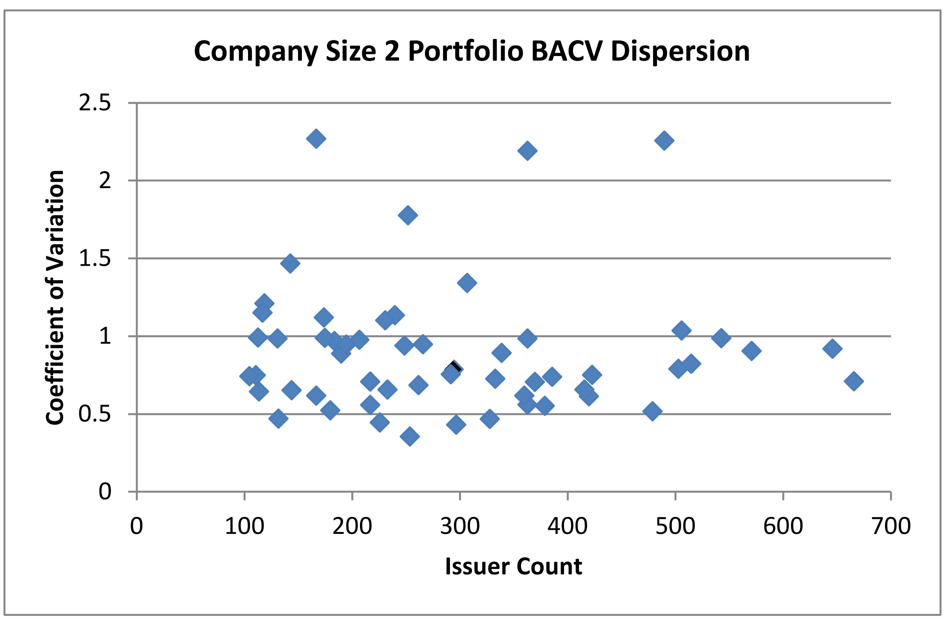
Rounded Average Issuer Counts

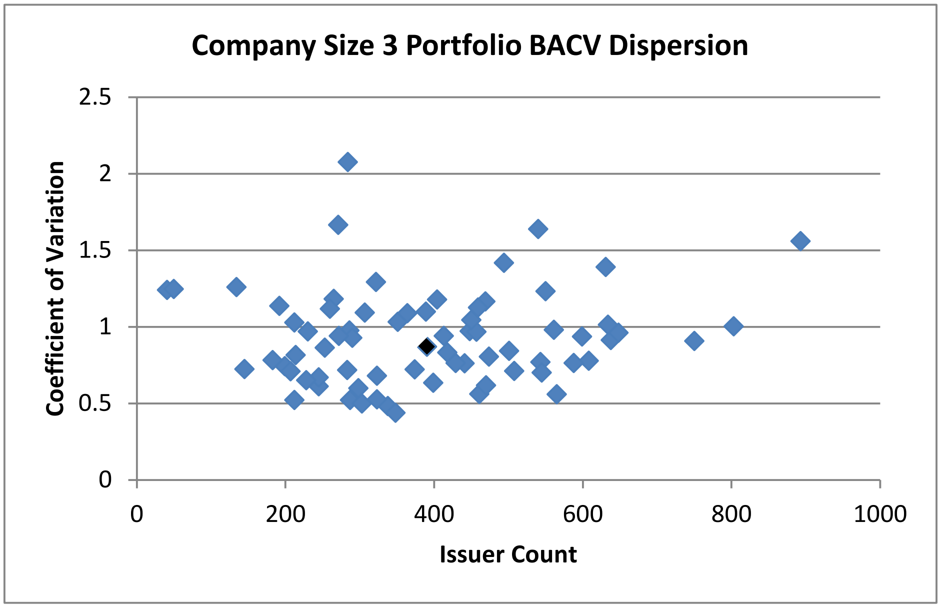
	Rating					
Bin	1	2	3	4	5	$Millions
1	6	4	1	1	0	.205
2	4	2	1	0	0	.373
3	6	3	1	0	0	.498
4	5	3	0	0	0	.628
5	4	2	0	0	0	.735
6	4	2	0	0	0	.832
7	4	2	0	0	0	.908
8	4	2	0	0	0	1.001
9	3	1	0	0	0	1.100
10	3	1	0	0	0	1.198
11	3	1	0	0	0	1.314
12	2	1	0	0	0	1.441
13	2	1	0	0	0	1.643
14	2	1	0	0	0	1.773
15	2	1	0	0	0	1.995
16	2	1	0	0	0	2.255
17	1	0	0	0	0	2.498
18	1	0	0	0	0	3.788
Issuer Count	58	28	3	1	0	
Coefficient of Variation	0.67	0.62	0.34	0.00	0.00	
Issuer Count %	64%	31%	3%	1%	0%	
Amount %	69%	29%	1%	0%	0%	

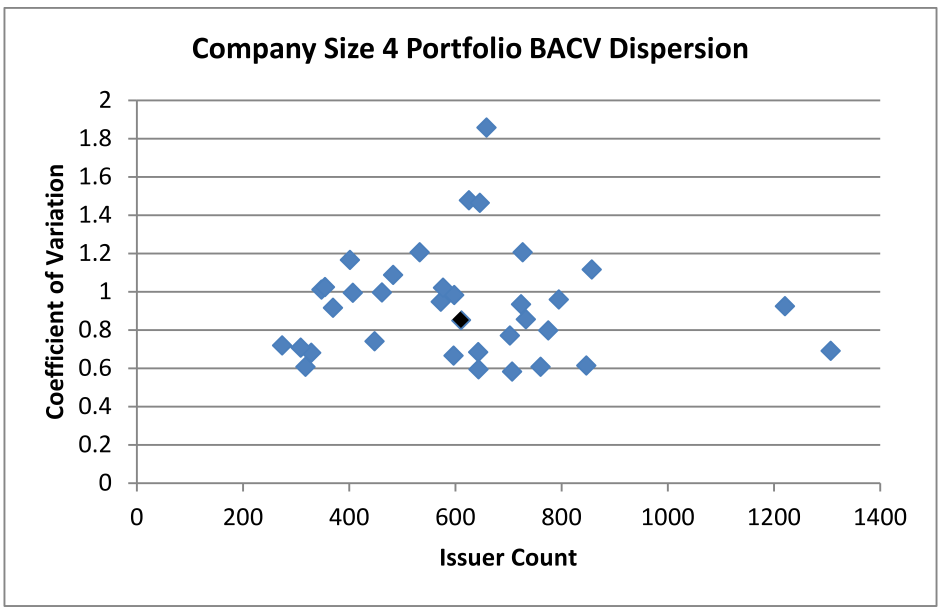
Average Portfolio Size ($Millions)	84.0
Average Issuer Size ($Millions)	.9
Portfolio Coefficient of Variation	0.68

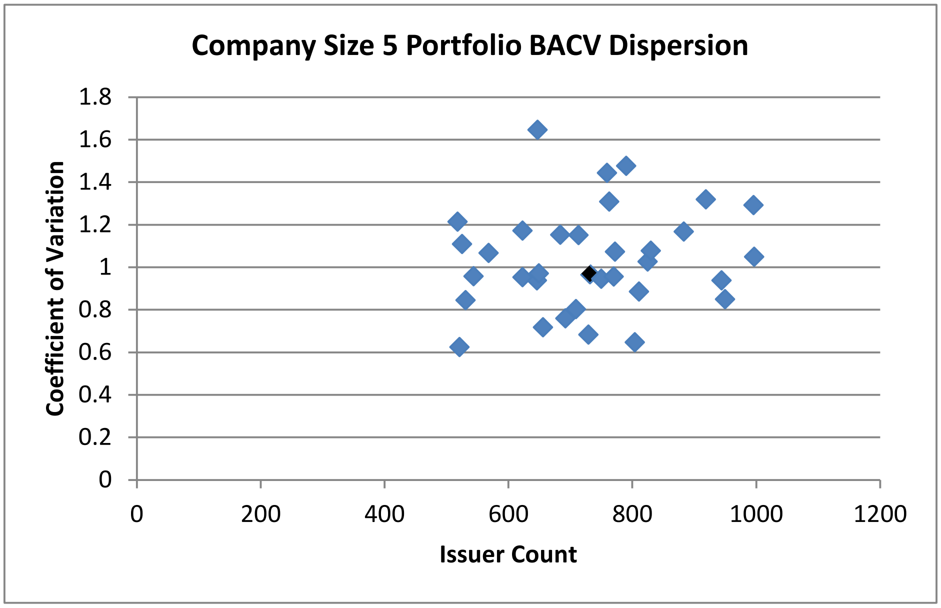
Size Category Portfolio Dispersion and Number of Issuers Held

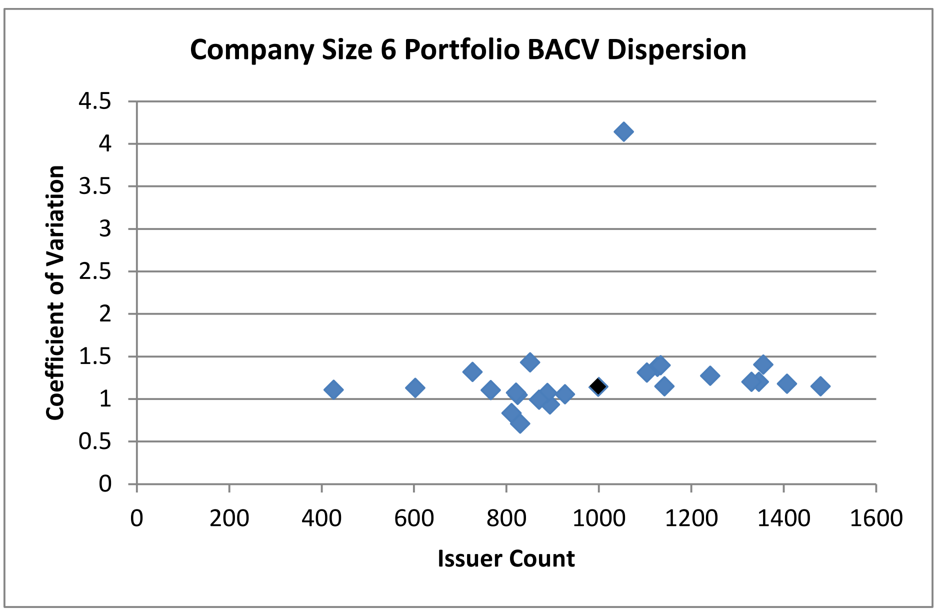


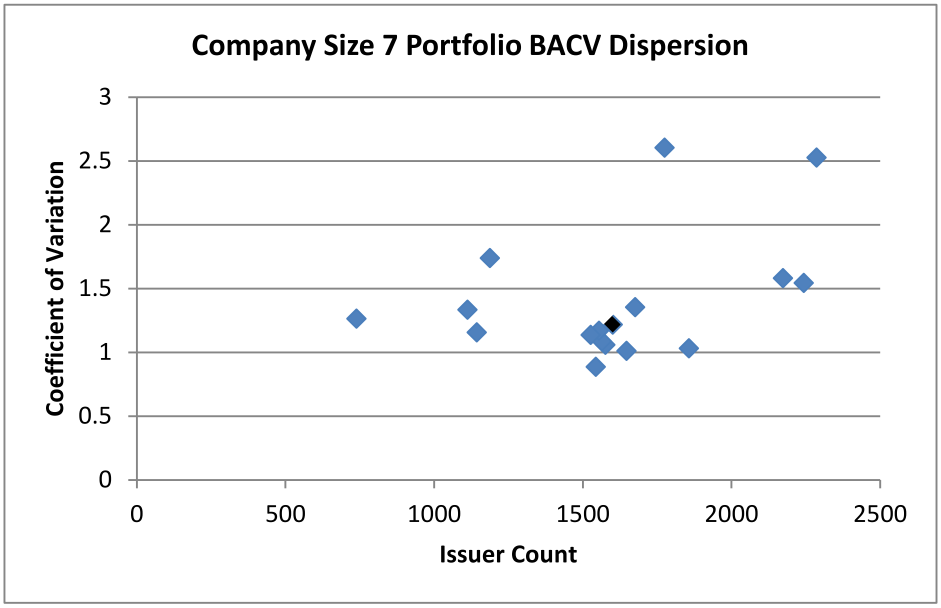



Company Size 3 Portfolio BACV Dispersion
2.5
2
1.5
1
0.5
0
0
200
400
600
800
1000
Coefficient of Variation
Issuer Count


Company Size 4 Portfolio BACV Dispersion
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
200
400
600
800
1000
1200
1400
Coefficient of Variation
Issuer Count


Company Size 5 Portfolio BACV Dispersion
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
200
400
600
800
1000
1200
Issuer Count
Coefficient of Variation


Company Size 6 Portfolio BACV Dispersion
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0
200
400
600
800
1000
1200
1400
1600
Issuer Count
Coefficient of Variation


Company Size 7 Portfolio BACV Dispersion
Coefficient of Variation
Issuer Count
0
0.5
1
1.5
2
2.5
3
0
500
1000
1500
2000
2500

Appendix E – Reconciliation of Factors

In order to compare the recommended factors to the current factors, a stepping process (i.e., changing one assumption at a time) was used to derive the isolated effect on the C1 factors. Because there are five bond factors currently, excluding in or near default bonds, the proposed factors on a letter modifier basis were converted to the same five categories using industry weightings of the underlying letter modifier ratings to facilitate the comparison. All comparative runs were produced on an after tax basis and then converted to pre-tax factors by dividing the after tax factor by one minus the applicable capital loss tax recovery rate.

The main difference from any single assumption is caused by changes in the assumed interest rate, default rates and recovery rates. The effects captured as "Other" in the body of the report (i.e., portfolio, methods, granularity and rounding) are detailed in Table 1 below.

Table E1 - Attribution of Change in 2002 vs. 2015 C1 Factors

		2002 Pre-tax C1	Interest	Recovery	Default	Portfolio	Methods	Aaa-A Granularity	Other	Total Change	**2015 Pre-tax C1**
	Aaa	0.40%	0.05%	0.11%	(0.04%)	(0.01%)	0.00%	(0.30%)	0.07%	(0.12%)	0.28%
	Aa	0.40%	0.09%	0.23%	(0.08%)	0.04%	0.01%	(0.09%)	0.07%	0.27%	0.67%
	A	0.40%	0.15%	0.25%	0.03%	0.05%	0.01%	0.20%	0.07%	0.76%	1.16%
NAIC 1	Aaa-A	0.40%	0.11%	0.21%	(0.02%)	0.04%	0.01%	0.00%	0.07%	0.42%	0.82%
NAIC 2	Baa	1.30%	0.21%	0.20%	0.06%	(0.06%)	(0.01%)	0.00%	(0.03%)	0.37%	1.67%
NAIC 3	Ba	4.60%	0.52%	(0.65%)	(0.23%)	(0.05%)	0.08%	0.00%	0.02%	(0.31%)	4.29%
NAIC 4	B	10.00%	0.84%	(2.56%)	(2.35%)	0.65%	0.78%	0.00%	0.21%	(2.43%)	7.57%
NAIC 5	Caa	23.00%	1.41%	(5.01%)	(6.76%)	(0.04%)	4.13%	0.00%	0.58%	(5.69%)	17.31%

The above table shows the separate effects, or sources of change, that when added together explain the difference between the 2002 and 2015 pre-tax C1 factors. The amount of an effect in a step wise attribution derivation is dependent on the order of the steps. The actual process started with the 2015 factors and stepped back to the 2002 factors in the order of the effects shown above. The order of the steps was chosen with an aim to derive amounts that are most closely associated with their impact and with respect to particular model features. For example, interest is the first tested step because the current lower interest rate is associated with 2015 rather than 2002. Other effects, such as changes in method from the 2002 model, were derived relative to the 2002 model factors.

<u>Interest</u>: Lowering the after tax discount rate to 3.25 percent from 6.00 percent causes a consistent increase in the C1 factors from higher to lower asset quality. This increase occurs because C1 RBC is pre-funding the high water loss mark over the ten year time horizon, where the loss is the total loss minus the expected loss, as represented by the risk premium. The discount rate has a comparatively minor effect on the risk premium. Explaining the impact of the change in the discount rate requires an explanation of the impact on the total loss, the timing of the loss, and the offsetting risk premium. The proportionality of the increase in the C1 factor can vary across ratings because the loss is dependent on the particular high water mark year. Although the difference of high water mark years can affect this proportionality, the amount of the increase due to the lower interest rate increases monotonically across all five rating categories.

Recovery – As discussed in the Recovery Appendix, both average recovery rates and recovery rates in the tails changed between the 2002 and 2015 analysis. Further, recovery rates in different economic states also changed based on experience. Quantifying the impact of different recovery rates requires an analysis of the impact on LGD, as LGD equals one minus the recovery rate. The following section quantifies the change in C1 factors due to changes in the base recovery rates, recovery rates adjusted for the economic environment, and the impact of issuer size within a portfolio.

The varying baseline LGD for 2002 vs. one LGD for all ratings in 2015 increases the factor for all letter ratings. The economic state modification of LGD and baseline differences both play a role in explaining material changes. The effect of economic state modification of LGD in 2002 is greater than that of 2015 particularly in the below investment grade ratings. Table E2 below quantifies the effect of removing the 2002 economic effect, adding the 2015 economic effect and adding the 2015 vs. 2002 baseline difference to explain the total change due to recovery assumption differences.

Table E2 - Decomposition of LGD Change 2002 vs. 2015

		(1) Eliminate 2002 Recovery Econ State Effect	(2) Add 2015 Econ State Recovery Effect	(3) (1) + (2) Net Economic Effect	(4) 2015 vs. 2002 Baseline Recovery	(5) (3) + (4) Total
	Aaa	(0.01%)	0.00%	(0.01%)	0.12%	0.11%
	Aa	(0.02%)	0.00%	(0.02%)	0.25%	0.23%
	A	(0.04%)	0.01%	(0.03%)	0.28%	0.25%
NAIC 1	Aaa-A	(0.03%)	0.01%	(0.02%)	0.23%	0.21%
NAIC 2	Baa	(0.15%)	0.01%	(0.14%)	0.34%	0.20%
NAIC 3	Ba	(1.12%)	0.06%	(1.06%)	0.41%	(0.65%)
NAIC 4	B	(2.88%)	0.05%	(2.83%)	0.27%	(2.56%)
NAIC 5	Caa	(6.21%)	0.38%	(5.83%)	0.82%	(5.01%)

Table E3 below provides distribution statistics of the 2002 and 2015 recovery assumptions. The distributions, which are derived similarly for 2002 and 2015, are the LGD distributions for each period including economic state adjustments. The LGD amounts are produced on a marginal basis. In other words, special modeling forced the occurrence of default at a fixed rate to derive the LGD distribution. The 2002 distribution is derived assuming the 2015 issuer size distribution. This adjustment is made because in the progression of extracting attribution changes, the portfolio effect was downstream from determining recovery effects.

It is important to note that these distributions are from the LGD amounts for a rating category for each year tested. Because the bonds in a rating category can default independently of one another, there is an averaging effect on the combined rating category LGD. The distributions below are different from a single bond distribution, but explain most elements of change except for the larger changes in the lowest rating categories. Other than the means, the statistics are fairly similar. Qualitatively, we can conclude differences not explained in these statistics are occurring in the tail of the distribution where those differences are not captured by the combination of standard deviation, kurtosis and skew. The kurtosis[2] value greater than 0 implies both the 2002 and 2015 LGDs show significant peakedness of the distribution. The positive skew values imply a bunching of the distribution with more large losses than a normal distribution.

Table E3 – 2002 vs. 2015 LGD Distributions with 2015 Portfolio

		2002				**2015**			
		Mean	**Std Dev**	**Skew[1]**	**Kurtosis[2]**	**Mean**	**Std Dev**	**Skew[1]**	**Kurtosis[2]**
	Aaa	29.10%	16.25%	1.05	1.66	53.02%	32.86%	1.13	1.90
	Aa	33.79%	18.98%	1.07	1.74	53.02%	32.86%	1.13	1.90
	A	43.05%	24.44%	1.09	1.85	53.02%	32.86%	1.13	1.90
NAIC 1	Aaa-A[3]	37.25%	21.03%	1.07	1.77	53.02%	32.86%	1.13	1.90
NAIC 2	Baa	52.17%	29.25%	1.05	1.67	53.02%	32.86%	1.13	1.90
NAIC 3	Ba	56.67%	31.75%	1.04	1.62	53.02%	32.86%	1.13	1.90
NAIC 4	B	56.67%	31.75%	1.04	1.62	53.02%	32.86%	1.13	1.90
NAIC 5	Caa3	56.67%	31.75%	1.04	1.62	53.02%	32.86%	1.13	1.90

[1] Skew sets all LGD losses to positive amounts.

[2] Kurtosis uses Microsoft™ Excel definition where the Normal Distribution kurtosis = 0.

[3] Statistics are arithmetically weighted by the assumed Aaa, Aa, and A distribution (i.e., 25%, 25%, 50%). This approximates the result of using a single blended default rate for the combined rating categories.

The LGD distributions are dependent on the issuer size mix. The same statistics for the LGD distribution based on equal issuer sizes reveals portfolio independent differences between the 2002 and 2015 assumptions. The standard deviation as a percentage of the mean, coefficient of variation, is similar for all ratings and both sets of years. The kurtosis and skew values indicate a flatter and slightly less positively skewed distribution in 2015. Despite the relative symmetrical appearance of the 2002 assumptions, when they are combined with economic state adjustments they produce distributions that are similar, except for the mean, though not identical to the 2015 assumptions.

Table E4 – 2002 vs. 2015 LGD Distributions with Equal Size Issuers in a Portfolio

		2002				2015			
		Mean	**Std Dev**	**Skew[1]**	**Kurtosis[2]**	**Mean**	**Std Dev**	**Skew[1]**	**Kurtosis[2]**
	Aaa	30.01%	11.56%	0.57	0.53	53.06%	21.74%	0.44	0.17
	Aa	35.00%	13.61%	0.59	0.56	53.06%	21.74%	0.44	0.17
	A	45.00%	17.70%	0.61	0.61	53.06%	21.74%	0.44	0.17
NAIC 1	Aaa-A[3]	38.75%	15.14%	0.60	0.58	53.06%	21.74%	0.44	0.17
NAIC 2	Baa	55.01%	21.02%	0.56	0.53	53.06%	21.74%	0.44	0.17
NAIC 3	Ba	60.02%	22.79%	0.55	0.49	53.06%	21.74%	0.44	0.17
NAIC 4	B	60.02%	22.79%	0.55	0.49	53.06%	21.74%	0.44	0.17
NAIC 5	Caa3	60.02%	22.79%	0.55	0.49	53.06%	21.74%	0.44	0.17

[1] Skew sets all LGD losses to positive amounts.

[2] Kurtosis uses Microsoft Excel definition where the Normal Distribution kurtosis = 0.

[3] Statistics are arithmetically weighted per 25%, 25%, 50% assumed Aaa, Aa and A distribution. This approximates the result of using a single blended default rate for the combined rating categories.

Default – The 2002 and 2015 models use a similar approach to modifying default rates by economic state, but with different scalars and economic state transitions models. The models also use different base default rates. Table E5 below decomposes those effects where successive steps of running the model produced incremental changes due to one effect at a time. With the exception of the Caa rating, the economic adjustments by each model to the average default rate have a similar effect. There is a significant difference in the baseline default effect between the two models. The baseline default effect is lower for every rating in 2015 vs. 2002. But as discussed further below, the difference is not totally indicative of the average default rate difference for all ratings. The pattern of the spot default rates by duration influences the resulting C1 factor. Overall, the change in the default rate assumption has a small effect on investment grade ratings and a significant effect for below investment grade ratings.

Table E5 - Decomposition of Default Rate Change 2002 vs. 2015

		(1) Eliminate 2002 Default Econ State Effect	(2) Add 2015 Econ State Default Effect	(3) (1) + (2) Net Economic Effect	(4) 2015 vs. 2002 Baseline Default	(5) (3) + (4) Total
	Aaa	0.01%	0.01%	0.02%	(0.06%)	(0.04%)
	Aa	0.01%	0.02%	0.03%	(0.11%)	(0.08%)
	A	0.00%	0.04%	0.04%	(0.01%)	0.03%
NAIC 1	Aaa-A	0.00%	0.03%	0.03%	(0.05%)	(0.02%)
NAIC 2	Baa	(0.02%)	0.17%	0.15%	(0.09%)	0.06%
NAIC 3	Ba	(0.80%)	1.08%	0.28%	(0.51%)	(0.23%)
NAIC 4	B	(2.75%)	2.27%	(0.48%)	(1.87%)	(2.35%)
NAIC 5	Caa	(9.20%)	6.73%	(2.47%)	(4.29%)	(6.76%)

The pattern of the default rates influences the size of the C1 factor, assuming other assumptions are held constant. This is caused by interaction of the annual total loss offset by the risk premium. Because the risk premium is a level annual amount, when total losses start high and decline there is a larger uncovered gap, the C1 amount, than if the losses are level or are rising. Even if the average default rate is higher, with a level default pattern the C1 factor may still be lower than another default rate with a rising pattern because the higher average default rate is more closely covered at all points by a higher risk reserve premium which is a proxy for the policy reserve offset.

Table E6 below shows the default rates for each of 2002 and 2015. The rates for 2015 are condensed, using the industry average holdings shown for the ratings in main document, to be comparable to the 2002 letter rating basis. While the holdings of Caa bonds are low, their rate pattern illustrates the effect of the pattern differences. The 2002 Caa rates decline sharply, whereas the effect is less pronounced in the 2015 rates. Even though the average ten year Caa rate is lower for 2002, the pattern creates a bigger initial gap between total losses and the risk premium. That initial gap causes a higher C1 factor and is why the baseline default effect decreases in 2015 even though the average default rate is higher. There is a similar for the B rating, although less pronounced. The differences for the effect of the baseline default rates decline progressively for higher ratings where the pattern differences are less striking and the overall default rates are lower.

Table E6 – 2002 and 2015 Letter Only Default Rates

	1	2	3	4	5	6	7	8	9	10
2002										
Aaa	0.00%	0.00%	0.02%	0.04%	0.06%	0.07%	0.07%	0.07%	0.07%	0.07%
Aa	0.02%	0.04%	0.12%	0.16%	0.20%	0.22%	0.22%	0.22%	0.22%	0.22%
A	0.04%	0.12%	0.20%	0.24%	0.28%	0.30%	0.30%	0.30%	0.30%	0.30%
Baa	0.25%	0.40%	0.50%	0.55%	0.60%	0.65%	0.65%	0.65%	0.65%	0.65%
Ba	1.80%	3.20%	3.00%	2.80%	2.50%	2.00%	2.00%	2.00%	2.00%	2.00%
B	7.50%	6.50%	5.50%	4.50%	4.00%	3.50%	3.50%	3.50%	3.50%	3.50%
Caa	18.00%	13.00%	10.00%	8.00%	6.00%	5.00%	5.00%	5.00%	5.00%	5.00%

	1	2	3	4	5	6	7	8	9	10
2015 Condensed										
Aaa	0.00%	0.00%	0.00%	0.04%	0.04%	0.03%	0.03%	0.03%	0.03%	0.03%
Aa	0.01%	0.03%	0.05%	0.20%	0.13%	0.10%	0.08%	0.09%	0.09%	0.09%
A	0.07%	0.14%	0.26%	0.31%	0.29%	0.27%	0.26%	0.30%	0.30%	0.33%
Baa	0.20%	0.39%	0.40%	0.33%	0.52%	0.58%	0.60%	0.60%	0.58%	0.60%
Ba	0.98%	1.91%	2.26%	2.12%	2.25%	2.27%	2.18%	1.94%	1.84%	1.85%
B	3.35%	5.00%	5.91%	6.95%	5.70%	5.33%	4.75%	4.87%	5.04%	4.91%
Caa	13.24%	13.03%	13.74%	13.21%	11.28%	8.61%	7.83%	9.82%	11.35%	12.50%

Examining results without losses being offset by the risk premium validate that the change in average rates is consistent with the change in modeled losses. When the change in the average default rates is compared to change in total loss, the comparison between the two, higher or lower, is consistent for all ratings. Table E7 below shows this result. The average default rate is the ten year mean rate. The total loss is the present value of losses over ten years without risk premium offsets. The total losses for 2002 and 2015 are the losses at the same attribution step, where the baseline default rate effect is determined. At that point, economic effects are neutralized and the recovery assumption is the same for both steps. When total loss is the comparative point, results are consistent with the change in the average rates. But when the change in the C1 factor is the comparative point there are inconsistencies. That apparent counterintuitive result is caused by the pattern differences in the rates.

Table E7 – 2015 vs. 2002 Trend Similarity of Average Default Rate and Total Loss Change

	Average Default Rate			Total Loss		
	2002	2015	2015 vs 2002	2002	2015	2015 vs 2002
Aaa	0.05%	0.02%	Lower	0.18%	0.17%	Lower
Aa	0.16%	0.09%	Lower	0.57%	0.48%	Lower
A	0.24%	0.25%	Higher	0.99%	1.07%	Higher
Baa	0.56%	0.48%	Lower	2.23%	2.08%	Lower
Ba	2.33%	1.96%	Lower	9.44%	8.26%	Lower
B	4.55%	5.18%	Higher	20.58%	21.68%	Higher
Caa	8.00%	11.46%	Higher	39.15%	47.66%	Higher

Portfolio – The C1 factor varies by the issuer sizes in a portfolio and similarly, in the size distribution assumed for a rating category. While there are different distributions assumed in the development of the 2015 and 2002 factors, the differences are fairly small except for B rated bonds.

Methods – The different treatment of reinvestment, as explained in the body of this document, produces most of the change in the 2015 vs. 2002 assumptions. In 2015 the full par value of a defaulted bond is replaced and reinvested. Only the salvage value was reinvested in the 2002 assumption. The difference is small at higher ratings because fewer bonds default. The higher incidence of default at below investment grade ratings makes the different treatment of reinvestment result in larger differences. The size of the differences increases, with the higher incidence of default, as quality decreases within the below investment grade range of ratings.

Aaa - A Granularity – The decomposition of the combined Aaa – A ratings for the 2002 C1 factor shows the differences between the combined rating to the factors associated with the specific Aaa, Aa and A ratings. This explains a portion of the changes between 2015 and 2002 on a letter only rating basis per the ratings shown in the above chart. For example, the Aaa rating would be 0.30% less than the combined Aaa – A rating if the 2002 C1 factors had not been combined in the NAIC 1 rating category. Similarly, the A rating would have been 0.20 percent more than the 0.47 percent combined 2002 factor.

Rounding – The amounts shown are the pre-tax adjustments from the recommended values when the factors were reviewed in 2002. The amounts are shown to provide a complete reconciliation of the factors. While relatively small for some ratings, the rounding adjustments are a significant percentage of the total change. Except for Baa, all ratings were rounded such that capital was reduced from the unrounded value. For example, NAIC 1, the blended Aaa – A rate, was 0.47 percent on an unrounded basis. Therefore, 0.07 percent is added to the 2002 C1 factor along with the other changes to explain the total difference.

Appendix F – Credit Models

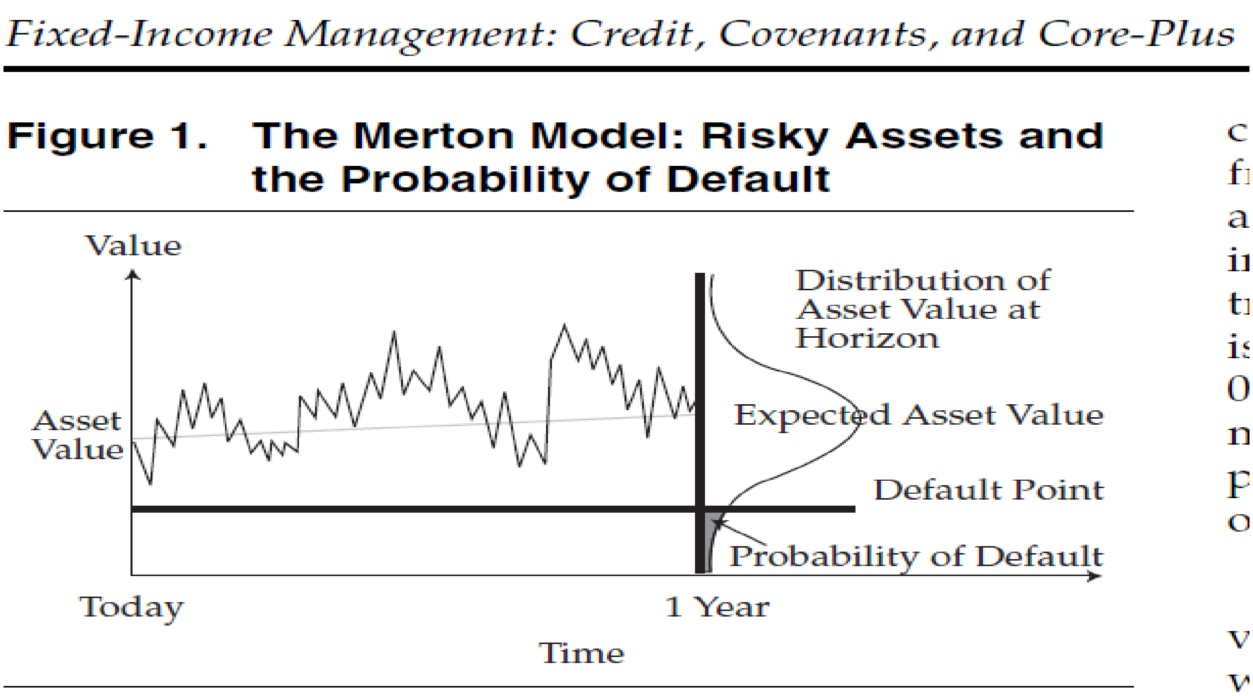
In this Appendix, different types of credit models are discussed. In the first section, the structural and reduced form credit models are described. In the second section, the pros and cons of applying those models to the development of the C1RBC factors is discussed.

A. Default Probability Models: Structural versus Reduced Form

1. Characteristics of Structural Models

Structural models explicitly reflect the dynamics of a company's asset value: Structural models are so called because of the additional “structure” that their assumptions place on the world. In the case of Merton (1974), that structure is geometric Brownian motion for asset value, a given level of leverage, a given asset volatility, and the fact that the firm will default the first instant that its value falls below its liabilities.

Chart F1.



"Portfolio Management of Credit Risk", Stephen Kealhofer, Managing Director, Moody’s KMV, 2003 AIMR. (http://www.cfapubs.org/doi/pdf/10.2469/cp.v2003.n5.3318)

- Developed on the basis of option pricing theory

    - Uses structure or framework of option pricing, frictionless trading, geometric Brownian motion, volatility, etc.
- Modeled as an Option granted to stockholders by the bondholders
    - Stockholders can Put the company back to bondholders
- Company defaults on debt if the value of assets of the company falls below a "default point"
    - Negative market value
- Value of company assets (not readily available) based on value of company's stock equity (readily available)
    - Assets assumed = debt + market value of equity
    - Insight gained from the microeconomic and financial assumptions that are added (the “structure”), but we’re forced to parameterize those objects, which in this case are not observable. Importantly, if we do not use asset volatility and asset value directly, even if the structural framework is *true*, we will not recover the assumptions.
- Presumption is that the stock market provides all needed information: equity = shares outstanding * stock price.
- Probability of default explicitly linked to expected volatility of company assets and leverage
- Merton Model (an example of a structural model)
    - Pros
        - Theory is simple, has intuitive appeal.
        - Basis: well accepted option pricing theory
        - Based on company assets, debt and equity
        - Creates a probability of default
        - Company assets is the single random variable
    - Cons
        - Volatility or value of company assets not readily measurable, yet this is a key input to model
        - Assumes efficient, fully liquid markets with no transaction costs
        - Assumes stock and bond prices based solely on value of company assets
        - Original assumed interest rates constant and debt is constant and has constant maturity (this can be relaxed)
        - Does not include other explanatory variables (e.g., asset volatility, size of debt)
        - Criticism that results are inaccurate due to unrealistic assumptions

2. Characteristics of Reduced Form Models

Reduced form models are based on the assumption that an instantaneous default intensity is random and driven by interest rates and one or more random macroeconomic factors. A good reference describing reduced form models is the following paper: Jarrow/Turnbull model (vanDeventer "An Introduction to Credit Risk Models", 2012, http://www.kamakuraco.com/Blog/tabid/231/EntryId/308/An-Introduction-to-Credit-Risk-Models.aspx)

Further description of reduced form models follows:

- Assumptions:
  - company's choice of capital structure vary dynamically with the credit quality of the firm,
  - Assets they hold are often highly illiquid,
  - Interest rates are random.
  - Bonds are traded in a less liquid market, and
  - Credit spreads have a "liquidity premium"
- Default intensities and the full term structure of default probabilities can be derived in two ways:
  - By implicit estimation, from observable bond prices, credit default swap (CDS) prices, or options prices or any combination of them with some additional assumptions on the components of CDS prices or how option prices are determined.
  - By explicit estimation, using a historical default database – the only assumption here is that the data is a representative sample of what you're going to see in the future. A big assumption, but it's true anywhere that we have to calibrate parameters (even in structural models)
- Model inputs
  - Essentially anything. Given imperfect information, you want to condition on all correlated signals when estimating any parameters, including the probability of default.
  - A set of macro-economic factors that affect some or all risky counterparties.
  - Counterparty specific inputs are financial ratios or inputs related to the counterparty's stock price.
- Estimated default probabilities $P[t]$ are fitted to a historical database with both defaulting and non-defaulting observations and a list of explanatory variables X_i. Logistic Regression is a common example, where one fits the natural log of the odds ratio as a linear function. In the logistic example then, the default probability is given by:

$$P[t] = 1/[1 + \exp(-\alpha - \sum \beta_i X_i)]$$

- Pros
  - Creates a term-structure of default probabilities
  - Can employ any variable, without restriction, that improves the quality of default prediction, because any variable can contribute in the equation above including Merton default probabilities
  - Empirical evidence suggests reduced form models are more accurate than ratings and the Merton approach in predicting default. This is actually by construction!
  - Calibrated to market data (credit spreads) or historical data
- Cons
  - More complicated and data intensive than structural model
  - Does not estimate a value of the firm

3. Best Use of Each Type of Model

Structural models by their nature fit the structure. These models are useful when questions are ask where good data is unobservable or unreliable. The model allows for intuitive reasoning to be validated along with an understanding of cause and effect.

Reduced form models by their nature fit the historical data. With good data, reduced form will perform better than structural models. Without good data, reduced form is less reliable.

4. References

A paper by Don van Deventer, Kamakura Corp, is a source for this summary. Kamakura is a default probability vendor who advocates reduced form models for managing credit risk.

"General Principals of Credit Analysis" from "Fixed Income Analysis for the Chartered Financial Analyst Program" by Frank Fabozzi.

B. Structural and Reduced Form Credit Models for RBC Purposes

"Fundamentally, the purpose of RBC is to provide a quantitative measure to assist in the identification of weakly capitalized companies." (*Report of the American Academy of Actuaries' Invested Assets Work Group regarding the C-1 Framework Presented to the National Association of Insurance Commissioners' Life Risk-Based Capital Working Group June 2011*).

Both structural and reduced form models use more modern credit technology than the current C-1 method that employs a historical model. Both structural and reduced form models produce forward-looking credit assessments based on the current market environment. The current C-1 method uses historical data and assumes the future will be similar to the past.

Modern credit technology is being used by the NAIC for C-1 for MBS and CMBS (more complex securities as compared to corporate bonds) as third-party vendors are calculating intrinsic values for each security based on regulator prescribed assumptions. A mapping process has been designed to align these intrinsic values within the NAIC 1-6 designation scheme for bonds. As such, these modeled values form the basis for the required capital for structured securities. These vendor methodologies utilize sophisticated modeling techniques, appropriate for complex structured securities. Both model types are much more complex than the current C-1 method for bonds and are not as easily explained. In addition, both model types need significantly more data than the current C-1 method for bonds.

Both model types produce forward-looking credit assessments based on the current market environment. In choosing a credit model, one issue to consider is if the C-1 factors should change with the market environment. Because the purpose of RBC is to identify weakly capitalized companies, RBC C1 is essentially a "through the credit cycle" type of analysis. Therefore, current market conditions are not as relevant in developing C1 factors. Both model types are more difficult to apply to private companies due, in part, to the difficulty of obtaining the necessary input data. In addition, both model types produce a default probability. The current RBC C-1 calculation is based on the rating for each security that is not a direct output of either model. Mappings can be done to determine "equivalent agency ratings" but the mappings involve some judgment and frequently, the equivalent rating can be very different from the agency rating

Appendix G – Model Validation

A. Purpose and Scope

The purpose of this Appendix is to summarize the activities, findings and recommendations of the independent validation of the Life Risk Based Capital C1 Bond Factor Model ("Model") that calculates the proposed updates to the C1 factors for public corporate bonds for life insurers. The Model includes all tools, data, assumptions and approaches used to arrive at final factors.

The activities and assessments of this independent validation cover four main areas of scope:

- Structure and methodology
- Calibration and data
- Implementation and results of the Model
- Model documentation

Out of scope of this validation are qualitative and quantitative assessments of the following topics:

- Asset Valuation Reserve (AVR)
- Factors for assets other than public corporate bonds
- Portfolio adjustments beyond base capital factors (i.e., size factors, concentration charges)
- Any potential factor adjustments for bonds at or near default

Validation assessments are both quantitative and qualitative. This Appendix summarized the validation activities.

These quantitative and qualitative assessments support the estimation of the impact of model design decisions and provide an indication of the level of potential misstatement where relevant which are used to qualify the model based on the following materiality thresholds:

- Material weaknesses (Red): There is a high risk that C1 asset risk for public corporate bonds could be significantly misstated. Quantitative and qualitative indicators support the estimation of the impact and indicate a misstatement of more than 50%. Such indicators include:
    - The Model does not cover material relevant risks,
    - The methodology and/or calibration does not meet key statistical standards,
    - The Model is excessively sensitive to minor changes in input data in cases where it is not expected or appropriate, or
    - Underlying data are not appropriate for key assumptions and/or for the underlying methods of the Model.
- Appropriate with recommendations (Yellow): There is risk that C1 asset risk for public corporate bonds could be materially misstated. Quantitative and qualitative indicators support the estimation of the impact and indicate a misstatement of more than 20% but less than 50%. Such indicators include:

- The Model does not cover some non-material risks,
- The Model is sensitive to minor changes in input data where it is not expected or appropriate, or
- Documentation of the Model has material weaknesses.

- Fully appropriate (Green): No or only marginal weaknesses have been identified with the C1 factors and/or model. Quantitative and qualitative indicators support the estimation of the impact and indicate a misstatement of less than 20%.

This independent validation assumes all documentation and information obtained by the validation team regarding the Model is complete and accurate. Information was obtained during the course of the validation through review of model documentation, direct review of the Model, conversations with the C1 WG, weekly meetings with theC1 Work Group, and emails between these groups.

B. Summary of Findings

This summary indicates the conclusion reached by the validation team regarding the appropriateness of the Model and an overview of the assessment of each validation topic as per the scope of the independent validation.

Overall Assessment	Conclusion	
The use of the Model to establish Life RBC C1 factors for public corporate bonds is, overall, fully appropriate and fit for use.	✓ Fully appropriate ☐ Significant deficiencies ☐ Material weaknesses	Green

Model Summary

The Model establishes Life RBC C-1 capital factors for public corporate bonds. The approach measures the amount of capital needed to pre-fund the greatest expected loss (above expectation) over a cumulative 10 year period at a 92nd confidence interval using Monte Carlo simulation techniques. The model establishes capital factors for 13 bond quality groupings, and a qualitative assessment is made to define the capital factor for a 14th grouping. Expected losses are modeled from default and recovery probabilities obtained from rating agencies that are smoothed then scaled and projected over 10 years based on assumed transitions in economic states across various scenarios. The discounted high water mark of loss establishes the amount of capital needed in any given scenario. The 92nd percentile worst loss is defined as the capital requirement for a given bond rating.

Key Findings

The findings identified through the activities of the validation program are not expected to materially impact the results and outcomes of the model. The model can therefore be considered appropriate for its current purpose on the basis of the information provided to the Validation Team, including the documentation, Model, model input and output.

The following key findings were identified:

1) The Model results are determined based on default and recovery experience of public corporate bonds from Moody's and S&P, respectively. Data from other asset classes was not assessed. A quantitative model was not developed to recommend factors for assets other than public corporate bonds. The C1 WG presents qualitative assessments to extend the recommended factors to other asset classes, but these fall outside of the scope of this validation.

2) The Model is a historical model, as opposed to a forward-looking model, that assumes future experience will be similar to past experience. The historical data is at times limited. Default and recovery data is limited to 30 years. The assumed bond portfolio is based on a single point in time.

3) The Model assumes a representative bond portfolio that does not vary by bond size or number of issuers. Deviations from this assumption are accounted for in RBC with adjustments to base C1 factors for bond size mix and number of issuers. The C1WG plans to assess these adjustments in order to ensure default probabilities are not materially misstated for carriers with significantly different portfolios from the assumed representative portfolio. These adjustments are not in scope of this validation.

4) In some cases the bond factor methodology applied within the Model does not align with other NAIC C1 asset factor models (e.g. CML, RMBS, CMBS). This issue has already been acknowledged by the NAIC's IRBC Work group and plans to address potential inconsistencies in 2015 and beyond.

Key Recommendations
1) Generally, the Model produces reasonable results given the historical data currently used for parameterization. Should future events not align with past experience, C1 factors may need to be adjusted. It is recommended that the C1WG consider defining triggers such that, if actual future experience evolves outside the range of historical data used to parameterize the model, the Model would require re-parameterization. 2) We support future efforts to assess the adjustments to the base factors (e.g., concentration charges, bond size adjustments), and we recommend the analysis consider the significant differences in bond size distributions across the industry to adequately account for different risk profiles. 3) We support the efforts to examine potential inconsistencies across different C1 models. It is recommended that rationale for intentional model differences be clearly documented.