Casualty Actuarial Society

Review and Comparison of Rating Agency Capital Models

Joseph R. Lebens, FCAS, MAAA
François Morin, FCAS, MAAA, CFA

November 2006

Table of Contents

1. EXECUTIVE SUMMARY

The Tillinghast business of Towers Perrin was asked by the Dynamic Risk Modeling Committee (DRM) of the Casualty Actuarial Society (CAS) to undertake a research project to review and compare the various capital adequacy models currently employed by rating agencies.

This research project is not intended to opine on the reasonableness of the methods and assumptions used by each of the models. Rather, it is intended to provide professionals interested in the financial strength of property/casualty insurance companies with a reference guide to compare the various models and reconcile the results between them.

Approach

As a starting point, we identified the various models currently in use in the property/casualty insurance industry. While there are more models in use, we limited our review to the following capital adequacy models:

RATING AGENCY CAPITAL ADEQUACY MODELS

List of Models Reviewed

Rating Agency	Model Name
National Association of Insurance Commissioners (NAIC)	Risk-Based Capital (RBC)
A.M. Best Company (A.M. Best)	Best's Capital Adequacy Ratio (BCAR)
Standard and Poor's (S&P)	Standard and Poor's Capital Adequacy Ratio (CAR)
Moody's Investor Service (Moody's)	Moody's P&C Risk Adjusted Capital Model (MRAC)

While the NAIC is not in itself a rating agency, the RBC model introduced in December 1993, effective for the 1994 and subsequent Annual Statements, is generally considered the ancestor of most rating agency models, and as such, provides a good foundation to understand how the models have evolved to their current state.

FitchRatings (Fitch) also provides ratings and research on property/casualty insurance companies worldwide. Their rating process is similar to the other agencies, although they

have not provided details through publicly available documents on how they perform their quantitative analysis. At the time of this writing, it is our understanding that Fitch is currently developing a multi-line capital adequacy model designed to upgrade their current capabilities.

Regulators and rating agencies alike are primarily concerned with insurance company solvency, although the rating agencies' mission is slightly different. A.M. Best's [3] objective is to "provide an opinion of an insurer's financial strength and ability to meet ongoing obligations to policyholders." Hence, while rating agencies may set a higher bar to attain a certain rating, all models are concerned with the evaluation of all sources of risk potentially affecting an insurer.

In order to perform the comparison, we relied on public information as well as proprietary documents that describe in significant detail the various models in use.

Areas of Research

All capital adequacy models attempt to capture the various sources of risk affecting an insurer. In order to perform a meaningful comparison, we developed the following list of items to guide us through this research project:

- Insurance Product Segmentation
- Asset Type Segmentation
- Risk Categories
- Risk Charges (Underwriting, Catastrophe, Credit, etc.)
- Time Horizon
- Risk Metrics
- Risk Tolerance Level
- Data Used in Parameterization
- Diversification of Risk
- Calibration of Results to Rating Levels
- Output and Results

Conclusions

All models share the same basic concepts in determining the amount of required capital. The models differ in their actual implementation of the concepts, either:

- in the underlying factors used to calculate the required capital (e.g., the risk charges applied to the different bond categories), or
- through application of the concept (e.g., calculation of their respective capital adequacy ratios)

With the exception of the MRAC model, all of the models use a factor-based approach; the MRAC model combines the results from a Monte Carlo simulation with a factor-based approach.

All models generally rely on the NAIC Annual Statement for most of the model inputs[1].

The rating agency capital models reviewed are nearly identical in a few aspects:

- Insurance Product Segmentation – Schedule P lines of business are generally used as the basis to segment the business underwritten by the company
- Risk Categories – all models capture the same risk categories, some in slightly greater detail
- Time Horizon – with the exception of the MRAC model, the models measure capital at a point in time (usually as of December 31st)
- Data Used in Parameterization – many of the factors are based on work performed by the American Academy of Actuaries Property/Casualty Risk-Based Capital Task Force in 1993

[1] Throughout this paper, we will describe the models relative to a U.S.-domiciled property and casualty insurance company filing a statutory property and casualty Annual Statement. It is our understanding that the rating agency models have been adapted to meet different data reporting requirements in other countries.

The asset type segmentations defined by the capital adequacy models are also generally consistent with each other, except for slight variations in the segmentations of the bond/fixed income category.

2. OVERALL APPROACHES

The basic concept underlying all models is the same: each model is designed to measure the capital adequacy of a company as of a certain point in time by comparing the calculated risk-based ***required capital*** to the company's ***actual capital***. The company's actual capital is generally based on the company's reported policyholders' surplus, after adjustment for factors such as the equity in loss reserves. These adjustments are designed to level-out the playing field between companies.

The RBC, BCAR and S&P models determine the required capital by applying risk charge factors to annual statement values. All the models rely on the NAIC Statutory Annual Statement for most of the model inputs. In many cases the factors used are very consistent or identical. The source of the factors depends on the risk category; proprietary factors for some risk categories make each model unique. Individual risk charges are calculated for the different risk categories and are then aggregated. The RBC and BCAR models use a square root rule to reflect the diversification benefits of combining the different risk category charges; S&P's model does not explicitly reflect diversification benefits.

The approach underlying the MRAC model is to simulate a one year total profit or loss of the company. Their model produces 60,000 trials and the 99.9% confidence interval is defined to be the company's required capital. While most risk categories in the MRAC model use this stochastic approach, others use a factor-based approach similar to the other models. Their model automatically captures risk diversification.

The models calculate ratios of the company's adjusted capital to the aggregated risk-based capital (post any diversification benefit). The rating agencies have calibrated their models so that ranges of results produced by the models correspond to predetermined ratings under their proprietary rating system. For example, the results of the BCAR model are calibrated such that a result of 175% implies a balance sheet strength rating of A++. Of course, other qualitative factors are considered before making a final determination of the company's rating. Some of the additional qualitative considerations are discussed in more detail in a subsequent section of this report.

Determination of Adjusted Capital

All capital adequacy models, while generally focused on absolute results for a given company (i.e. how much capital do I need to achieve a certain rating?), are calibrated to provide the rating agencies a measurement stick to compare different companies to each other. As such, policyholders' surplus as reported in the annual statement is generally adjusted in order to put companies on a level playing field.

RBC

The RBC formula computes the Total Adjusted Capital (Post-Deferred Tax) by adjusting actual policyholders' surplus for the following items:

- Non-tabular discounts are moved from surplus to reserves
- If the insurer owns a life subsidiary, the following may also be added to surplus:
  - Asset valuation reserve
  - Reserves for voluntary investments
  - 50% of the liability for policyholder dividends
- Capital notes are also added to surplus

BCAR

A.M. Best calculates Adjusted Surplus (APHS) by adjusting a company's reported surplus for the following:

- Unearned Premium Reserve Equity (Net of Tax)
- Loss Reserve Equity (Net of Tax)
- Fixed Income Equity (Net of Tax)

In addition, they make adjustments for the following items:

- Surplus Notes
- Off-Balance Sheet Losses

- Future Dividends
- Potential Losses (incl. natural catastrophes, terrorism)

S&P

S&P's Adjusted Capital takes into account the following items:

- Redundancy/(Deficiency) of Reserves
- Discount for the time value of money
- Statutory Goodwill
- Statement value of subsidiaries
- Analyst's adjustments (e. g., surplus notes)

MRAC

Moody's calculates Adjusted Book Capital by taking into consideration the following:

- Investment Adjustment
  - Bond value – difference between book value and market value
  - One year expected return on the company's invested assets
- Reinsurance
  - Add back Statutory reinsurance recoverable penalty for recoverables overdue by more than 90 days
  - Adjust for Moody's calculated Recoverable penalty
- Reserve Adjustment
  - Core Reserve Redundancy/(Deficiency)
  - A&E Reserve Redundancy/(Deficiency)

Required Capital – Risk Categories

Property/casualty insurance companies are exposed to a variety of risks. These risks can be summarized into three broad categories: investment risks, underwriting risks and other risks. While each capital adequacy model has developed different sub-categories of risks, they can all be assigned to one of the three major categories. The composition of the other risks category varies from one model to the other but normally includes a blend of credit risk (primarily consisting of reinsurance recoverables), business risk and off-balance sheet risk.

RATING AGENCY CAPITAL ADEQUACY MODELS

Major Risk Categories

Risk Type	Sub-Category	RBC	BCAR	CAR	MRAC
Investment	Fixed Income	R1	B1		
Investment	Equities	R2	B2		
Investment	Interest Rate		B3		
Investment				C-1	X
Underwriting	Reserving Risk	R4	B5	C-4	X
Underwriting	Premium Risk	R5	B6	C-3	X
Other	Insurance Affiliates/ Off-Balance Sheet	R0			
Other	Credit	R3	B4	C-2	
Other	Reinsurance				X
Other	Other Business / Operational		B7	C-5	X

Required Capital – Investment Risk

Capital requirements for investment risks are calculated by asset type according to the definition employed by the rating agency.

Under the RBC formula, investment risk is divided into two broad groups: Asset Risk – Fixed Income (R1) and Asset Risk – Equity (R2). The R1 category includes bonds, cash and short-term investments, collateral loans, and mortgage loans. The R2 group includes common stocks, preferred stocks, real estate, investment subsidiaries, non-insurance affiliates, other invested assets, and aggregate write-ins for invested assets.

The BCAR model is based on a similar configuration with their Fixed Income Securities (B1) group including bonds, mortgage loans and cash while their Equity Securities (B2) group includes common stocks, preferred stocks, real estate, and other investments.

S&P's capital requirement related to investment risk (C-1) is not broken out into categories. Since the CAR model does not have an explicit adjustment for diversification, any segmentation into smaller sub-groups would not impact the end result. The CAR model calculates requirements for bonds, preferred stock, common stock, mortgage loans, real estate, cash and short-term investments, other invested assets (Schedule BA), aggregate write-ins for invested assets, receivables for securities, off-balance sheet items, and other asset risks.

The MRAC model is based on the following groupings for the Investments category: bonds, stocks, cash and other short-term investments, other miscellaneous receivables, mortgages, aggregate write-in for invested assets, and various real estate assets.

Required Capital – Investment Risk – Bonds

Within the overall asset risk category, the RBC, BCAR, and CAR models each determine the required capital for bonds by applying risk charge factors to the annual statement values. The table displays the set of risk charge factors currently employed by these models.

RATING AGENCY CAPITAL MODELS

Risk Charge Factors – Bonds

Type	RBC	BCAR	CAR
US Government	0.00%	0.00%	0.00%
NAIC Class 1	0.30%	1.00%	0.51%
NAIC Class 2	1.00%	2.00%	3.91%
NAIC Class 3	2.00%	4.00%	9.36%
NAIC Class 4	4.50%	4.50%	17.40%
NAIC Class 5	10.00%	10.00%	27.56%
NAIC Class 6	30.00%	30.00%	30.00%
Affiliated		100.00%	100.00%

The factors currently used by the NAIC were developed back in 1993 when the RBC formula was introduced. Per the NAIC [5], "the bond factors are based on cash flow modeling, using historically-adjusted default rates for each bond category. For each of the 2,000 trials, annual economic conditions were generated for the ten-year modeling period." When a default takes place, the actual loss considers the expected principal loss, the time until the sale actually occurs and the assumed tax consequences. This analysis was performed by the actuarial advisory committee to the life insurance risk-based capital working group. Since bonds below "investment grade" (Classes 3, 4 and 5) are reported at the lower of market value and amortized cost in property/casualty statutory statements but may be reported at amortized cost in life insurance statutory statements, the risk charges in the property/casualty formula are half as large as those in the life formula for these classes.

As can be observed from the table, the calculated risk charges for a common fixed income investment can vary significantly among the various models. For example, if company has $100,000 invested in NAIC Class 2 bonds, then the calculated risk charges would be $1,000, $2,000, and $3,910 for the RBC, BCAR, and CAR models, respectively.

A.M. Best has implemented slightly higher risk charge factors for bonds in Classes 1 to 3 than those used by the NAIC. These adjustments reflect A.M. Best's view on default rates

for fixed income securities held by property/casualty insurers. In addition, A.M. Best now separates mortgage-backed securities (MBS) from other bonds, and assigns a risk charge of 10% for the entire group.

S&P CAPITAL ADEQUACY RATIO

Risk Charge Factors – Bonds

Asset Class/ Rating	Recovery Rate (@ 6% discount)	Incidence of Default Assumption	Net Factor
Exempt		0.0%	0.00%
Class 1	50.0%	0.115% evenly over 10 years	0.51%
Class 2	45.0%	0.911% evenly over 10 years	3.91%
Class 3	40.0%	2.4% years 1-5 1.6% years 6-10	9.36%
Class 4	40.0%	5% years 1-5 2% years 6-10	17.40%
Class 5	35.0%	8% years 1-5 2% years 6-10	27.56%
Class 6	30.0% net charge		30.00%

Instead of relying on NAIC factors, S&P has developed risk charge factors based on market knowledge of defaults for bonds. As with the NAIC factors, the charges vary with the credit rating on the bond. Expected default losses are assumed to occur over a period of 10 years and are present-valued using a default discount rate of 6%. The gross charges are adjusted for the assumed recovery rate. The default and recovery expectations are based on S&P's analysis of default trends and findings by other studies. These charges are applied for all unaffiliated bonds. Analytical judgment is used in determining appropriate charges for bonds of a parent or affiliate. In the absence of the information necessary to make this judgment, these bonds are assessed a risk charge of 100% of their carrying value. The CAR model also incorporates charges for interest rate risk associated with bonds, particularly mortgage-backed securities (MBS).

Unlike the factor-based approach described above, Moody's uses a Monte Carlo approach to simulate estimated one-year returns for three classes of bonds: US Treasuries, Investment Grade, and High Yield. Each simulation calculates an estimated return that is applied to the market value of the asset, producing either a risk charge (when the estimated return is negative) or a risk credit.

The simulation assumes a normal distribution with parameters specific to each bond type. The parameters for the Investment Grade bonds were primarily derived from the annual returns of the Lehman Aggregate Bond Index while those for the High Yield bonds were primarily based on the Salomon High Yield Bond Index.

MOODY'S RISK ADJUSTED CAPITAL MODEL

Risk Charge Factors – Bonds

Type	Mean	Standard Deviation
US Treasuries	5.0%	5.5%
Investment Grade	6.0%	6.5%
High Yield	7.5%	11.5%

Required Capital – Investment Risk – Preferred Stocks

Very little data exists regarding the expected default risk of preferred stocks. Given that constraint, the NAIC [5] originally assumed that, while highly similar to bonds, "preferred stocks are somewhat more likely to default than bonds and that the loss on default would be somewhat higher than that experienced on bonds." The RBC risk charge factors for preferred stocks were therefore set equal to the risk charges for bonds of a corresponding quality plus 2%, subject to maximum of 30%. Effective with the 2004 Annual Statement, the 2% factor was eliminated, and risk charge factors for preferred stocks under the RBC formula are now equal to the factors for bonds.

The segmentation of preferred stocks used by A.M. Best and S&P is not based on the NAIC classification system. Rather, both models assume a two-tier system, based on whether the investments are with affiliates or not.

RATING AGENCY CAPITAL MODELS

Risk Charge Factors – Preferred Stock

Type	RBC	BCAR	CAR
NAIC Class 1-6	See bonds		
Non-affiliated		15.0%	7.0%
Affiliated		100.0%	100.0%

Required Capital – Investment Risk – Common Stocks

RATING AGENCY CAPITAL MODELS

Risk Charge Factors – Common Stock

Type	RBC	BCAR	CAR
Non-affiliated		15.0%	15.0%
Non-gov't money market funds	0.3%		
All other	15.0%		
Affiliated	Various	100.0%	100.0%

Shares in non-government money market funds are generally reported as common stock in the Annual Statement (except for funds that can be reported through Schedule DA). However, these funds have displayed default characteristics similar to cash. As such, the NAIC [5] believes a risk charge factor similar to cash is appropriate. The factor for other unaffiliated stock is based on "studies which indicate that a 10 percent to 12 percent factor is needed to provide capital to cover approximately 95 percent of the greatest losses in common stock value over a one-year future period." The higher factor of 15 percent contained in the formula reflects the increased risk when testing a period in excess of one year. This factor assumes capital losses are unrealized and not subject to favorable tax treatment at the time loss in fair value occurs.

It is worth noting that while S&P assigns a smaller risk charge for preferred stocks than for common stocks, reflecting the higher level of security offered by preferred stocks, A.M. Best does not differentiate between the two types of instruments.

Moody's approach to determining the risk associated with equities is similar to the approach they use with bonds. Using a Monte Carlo approach, Moody's simulates the returns for two classes of stocks, common and affiliate. Each simulation calculates an estimated return that is applied to the market value of the asset, producing either a risk charge (when the estimated return is negative) or a risk credit. Moody's does not segregate preferred stocks from common stocks and the simulation approach is applied across the entire equity portfolio.

MOODY'S RISK ADJUSTED CAPITAL MODEL

Risk Charge Factors – Equities

Type	Mean	Standard Deviation
Common Stock	8.5%	17.0%
Affiliate Equity	0.0%	37.5%

As with bonds, the simulation approach uses a normal distribution for common stocks. A lognormal distribution is used for affiliate equity. The parameters for the common stock were primarily derived from the historical returns of domestic equity indices. The choice of the lognormal distribution for affiliate equity reflects Moody's view that such invested assets have more downside risk than upside potential.

Risk capital charges for investments in affiliates are handled in a variety of ways. The RBC formula treats investments in subsidiary insurance companies separately, by adding the RBC results from the subsidiaries to the RBC result of the company. A.M. Best assigns a 100% risk charge for bonds and stocks of affiliates (privately held) while stock of affiliates that is publicly traded gets assigned a 15% risk charge. S&P first determines whether the affiliate is considered an insurance entity or not, and whether the affiliate's role is core, strategic, or non-strategic to the ultimate group. Only insurance entities that are deemed to be core or strategic have their assets and liabilities fully consolidated/combined as part of the group, in which case the various charges relating to them will be determined using the CAR model. The capital requirement for other entities can either be calculated (in an amount sufficient to support their assets and liabilities at their rated level if a stand-alone rating exists or at the 'BBB' level when there is no stand-alone rating) or equal to the entity's historical book value on the group's accounts. Common stock of a parent is assessed a 100% charge.

Required Capital – Investment Risk – Other Asset Categories

In addition to the more traditional fixed income and equity asset classes, insurers generally own positions in a variety of asset classes. Since default risk statistics are generally unavailable for these types of investments, the risk charge factors are generally based on the perceived relative risk exposure of each type. For example, the NAIC factor for cash (0.30%) is intended to cover the small risk related to the potential insolvency of the bank where cash deposits are held. Other invested assets (as carried in Schedule BA) are somewhat more speculative and risky that most other investments, supporting the 20% risk charge factor.

RATING AGENCY CAPITAL MODELS

Risk Charge Factors – Other Asset Categories

Type	RBC	BCAR	CAR	MRAC
Cash	0.3%	0.3%	0.3%	0.5%
Short-Term Investments	0.3%	1.0%	0.3%	0.5%
Mortgage Loans	5.0%	5.0%	5.0%	5.0%
Mortgage Backed Securities			5.0%	
Collateral Loans	5.0%	5.0%	5.0%	
Real Estate	10.0%		18.0%	
Company Occupied		10.0%		10.0%
Investments/ Encumbrances		20.0%		12.0%
Other invested assets (Sch. BA)	20.0%	20.0%	20.0%	
Aggregate write-ins	5.0%	20.0%	5.0%	
Other receivables	5.0%			5.0%
Misc. off-balance sheet	1.0%		5.0%	

All rating agency models use factor-based approaches for these other assets classes, and use factors that are fairly similar to those implemented by the NAIC in the RBC formula.

Required Capital – Investment Risk – Adjustments

Once the initial required capital has been calculated according to the risk charges specific to each investment, the capital adequacy models generally refine the indicated capital required for Assets, primarily to account for the size of the investment portfolio and its relative diversification benefit.

The adjustment in the RBC formula consists of two factors. The first, the "Asset Concentration Factor", adjusts the initial risk charge by doubling the calculated charges for the ten largest asset exposures, excluding those assets already receiving either no charge or a 30% charge (e.g., Class 6 bonds). There is a maximum equity charge of 30%. The second, the "Bond Size Adjustment Factor", adjusts the calculated risk charge for the size of the portfolio, based on the number of bond issuers. For a bond portfolio with less than 50 issuers, the factor is 2.50. The factor decreases to 1.00 for a portfolio with 1,300 issuers, and has an absolute minimum of 0.90, in the event of an infinite number of issuers. The risk increases with fewer issuers.

The BCAR model also makes adjustments, which are similar in concept to those implemented by the NAIC. Their implementation of the "Asset Concentration Factor" doubles the risk charge for the excess portion of all large investments (not only the ten largest), where large investments are defined as those greater than 10% of surplus. The BCAR model also has a portfolio size adjustment, based on the value of the portfolio, not the number of bond issuers as used by the NAIC. The "Spread of Risk Factor" calculation does not generate an additional capital requirement for companies with $500 million or more in invested assets. The maximum adjustment factor can be as high as 50% for companies with less than $5 million in invested assets. Finally, A.M. Best introduced a "High Investment Leverage" factor whereby the baseline risk charge for common stocks (15%) is increased to 20% or 30% if the value of these stocks represents more than 50% or 100% of reported surplus, respectively.

S&P has two adjustment factors, one for size and one for concentration. The "Size Factor" is intended to adjust the C-1 charge for the risk associated with the size of a company's portfolio. The factor is based on total invested assets and is multiplied by the total asset default risk charge for the insurer, subject to a minimum of 1x. It is equal to:

$$\text{Size Factor} = \frac{(\text{First \$100M inv. assets} \times 2.5) + (\text{next \$100M} \times 1.5) + (\text{over \$200M} \times 0.8)}{\text{Total Invested Assets}}$$

With this adjustment, the largest insurers will be subject to the full asset charges as determined in the CAR model without a surcharge for the size of their portfolios, while

smaller insurers will be subject to a surcharge based on the lack of diversification in their portfolios.

The S&P "Concentration Factor" adjusts the capital requirement for single-issuer concentrations of more than 15% of total adjusted capital for investment-grade bonds and 10% for other types of assets. Assets associated with a single issuer that exceed the applicable concentration are assessed a graded charge based on the size of the concentration. All assets of a single-issuer-bearing credit risk are aggregated for this assessment.

Required Capital – Underwriting Risk

Reserve Risk

RBC

The NAIC uses a factor-based approach to quantifying the risk associated with loss and loss adjustment expense (LAE) reserves.

The baseline risk charge factors used by the NAIC are based on a detailed analysis of the historical reserve development patterns from Schedule P, Parts 2 and 3. The factors are published for each line of business in Schedule P, with the exception of other liability and products liability (where the industry factors do not differentiate between occurrence and claims made coverages) and financial lines reinsurance (which is combined with property reinsurance.

The baseline risk charge factors are first adjusted to reflect the company's historical *incurred* loss development relative to the industry's historical *reserve* loss development. The company's *incurred* loss development is defined as "the ratio of the sum of the developed incurred losses and defense and cost containment (DCC) expense from prior accident years evaluated as of the current year to the sum of the initial evaluations of these incurred losses and DCC expense, capped at 400%. The industry's *reserve* development for each line is based on "the average loss and DCC expense reserve development of all reporting companies over the past nine years." A credibility weighting procedure is then applied, with 50% given to the ratio of the company's development to the industry development and 50% given to unity. In this way, each company's experience has some influence on the final results.

A second adjustment is made to the baseline risk charge factors to take into account the time value of money. This adjustment uses a 5% interest rate and an IRS-type methodology applied to the industry Schedule P data by line of business, except for workers' compensation and the excess reinsurance lines, where a loss payment curve is used. These factors are provided by the NAIC.

The baseline risk charge for the eighteen major lines is calculated by multiplying the respective adjusted risk charge factor by the Schedule P net reserves (after adjustments for any discount). The baseline risk charge for each line is then further adjusted to account for loss-sensitive business. The adjustment is calculated as the percentage of loss and LAE reserves attributable to direct business times 30% plus the percentage of loss and LAE reserves attributable to assumed business times 15%.

After the adjusted baseline risk charges have been aggregated for the entire company across all Schedule P lines, a discount is given for spread of business. The "Loss Concentration Factor", calculated as 0.70 plus 30% of the ratio between the largest line's reserves and total company reserves, is applied as a final adjustment to the baseline risk charges. When determining the largest line for this calculation, claims made and occurrence loss and LAE reserves are combined for other liability and products liability.

Studies have suggested that rapid growth has often been the prime cause of insurance company insolvencies. After much deliberation, the final RBC formula was therefore amended to include a risk charge for excessive growth. The excessive growth charge for loss and LAE reserves, which is added to the reserve risk charge, is derived as the product of the loss and LAE reserves from Schedule P times the excessive growth factor. The current factor is equal to 45% of the three-year average written premium growth rate (capped at 40%) in excess of a 10% "normal" growth rate.

BCAR

A.M. Best also uses a factor-based approach to quantify the risk associated with loss and LAE reserves. While highly similar to the RBC formula, the BCAR model is different in the following respects:

- A.M. Best uses distinct risk charges for 20 lines of business versus the 18 used in the RBC formula. In the BCAR model, the other liability and products liability segments are broken out between occurrence policies and claims made policies and the financial reinsurance line of business (Reinsurance C) is analyzed on its own. On the other hand, mortgage guaranty is grouped with the "Other" category.

- Reserves as published in Schedule P by the company are adjusted for reserve adequacy. This adjustment can be significant; both because of its potential impact on the overall capital requirement but also because it represents one of the few inputs in BCAR that does not take Annual Statement amounts at face value. The reserve deficiency factors are derived by A.M. Best for each line of business through its proprietary loss reserve adequacy model and qualitative assessment.
- In addition to assessing the company's core reserves, A.M. Best also performs a separate analysis for asbestos and environmental (A&E) liabilities. Using a survival ratio method, a premium market share approach, and a paid-loss-share method, A.M. Best develops an initial view of these liabilities. This view is supplemented via discussions with company management and when available, a current, third party analysis of the liabilities.
- Similar to the RBC formula, the BCAR model takes into account the time value of money. A.M. Best also uses an IRS-type methodology with a 5% interest rate, but only for the workers' compensation line of business do they use a loss payment curve to calculate the appropriate amount of discount.
- The baseline risk charge factors by line of business used by A.M. Best are based on the methodology developed by the American Academy of Actuaries' Property/Casualty RBC Task Force ("the AAA Report") [2]. These baseline factors are adjusted to reflect company size, as measured by adjusted policyholders' surplus. (A.M. Best has found that bigger companies have experienced less variation and therefore require relatively less capital than smaller companies.)
- A.M. Best further modifies their baseline factors to reflect the stability of each company's loss development pattern relative to the industry pattern. This factor, which can vary by line of business, usually ranges from 0.70 to 1.30.

A.M. Best also notes that if a company provides additional insight regarding its loss reserves, then A.M. Best will take this information into account when determining the appropriate risk charge factors.

The aggregate initial unadjusted risk charge is calculated by summing across all lines of business the product of adjusted reserves, reserve deficiency factors, discount factors, company stability factors and company size factor.

Similar to the RBC formula, the BCAR model adjusts the risk charge for growth and diversification. The "Growth Charge" is based on the company's exposures (when available); otherwise it is based on the company's growth in unaffiliated gross written premium. Unlike the RBC formula, which has an additive excessive growth charge, the charge in BCAR is multiplicative. This charge only applies if the growth in exposure is greater than 8%.

The "Diversification Credit" factor calculation is identical to the calculation included in the RBC formula.

S&P

Similar to the NAIC and A.M. Best, S&P also uses a factor-based approach to quantifying the risk associated with loss and loss adjustment expense reserves. However, S&P's approach is somewhat simplified, given the following observations:

- S&P's reserve risk charge for a given company is simply the company's *net* reserves by line of business multiplied by the appropriate risk charge factor for each line. S&P uses the net reserves from Schedule P grouped into 21 distinct lines of business.
- The risk charge factors used by S&P are those that were developed as part of the AAA Report, without modification. S&P feels that these factors were designed to measure reserve volatility, not reserve adequacy, and that these factors already take into account the time value of money.

MRAC

Moody's quantifies the reserve risk, both for core exposures (separated into 11 lines of business) and A&E exposures, within the framework of its simulation model. Each simulation produces a risk charge that measures the difference between the simulated reserve need and the company's held reserves. Each simulation actually produces five reserve risk

charges: one for each of the most recent four accident years and one for the preceding six accident years combined.

For each of the five risk charge groups, ultimate losses are simulated using a lognormal distribution. The parameters for each risk charge group within each line of business are derived by Moody's as follows:

- Mean – Initial company-based expected losses are calculated by using the data from all but the two most recent accident years and applying the chain-link method to "square the triangle" for both paid and paid plus case incurred losses. The expected ultimate losses for the two most recent accident years are derived using the Bornhuetter-Ferguson method. These initial company-based expected loss ratios are then credibility weighted with industry-based expected loss ratios, also developed by Moody's.
- Standard Deviation – Initial company-based ultimate loss standard deviations are derived using the Thomas Mack method for the most current accident year. The same credibility formula is used to combine the company-based and industry-based standard deviations, and then decay factors are used to determine the standard deviations for the older years.

The time value of money is explicitly calculated by the model using industry payout patterns developed by Moody's.

Moody's methodology for quantifying reserve risk also explicitly takes into account correlations across accident years and across lines of business. Their model assumes a 60% correlation across accident years, and Moody's has derived correlation across lines by analyzing historical loss development by line, supplemented with judgment.

Moody's model also quantifies the reserve risk associated with A&E, again using lognormal distributions. For asbestos, the mean funding ratio is assumed to be 15 with a standard deviation of 3. For environmental, the mean funding ratio is assumed to be 10, also with a standard deviation of 3. The simulated funding ratio is capped at 20. Both the A&E reserve risk charges are equal to the difference between the simulated and actual funding ratio, multiplied against the average asbestos (or environmental) payment during the most recent

three years. The risk charges are assumed to be uncorrelated with each other as well as with all other risk charges.

Premium Risk

RBC

The NAIC uses a factor-based approach to quantifying the risk associated with written premium is similar to their approach to quantifying the risk associated with loss and LAE reserves.

The baseline risk charge factors used by the NAIC are based on the industry's historical loss LAE ratio experience. These factors are then adjusted to reflect the ratio of the company's average historical loss and LAE ratio to the industry's average historical ratio. A 50/50 credibility weighting procedure is then used between the resulting ratio and unity in order to give each company's experience some influence in the final results.

There is also an adjustment to recognize the time value of money; the same procedure that was described in the reserve risk section is used for the premium risk.

By line of business, the baseline risk charge is calculated by multiplying the current year's net written premium by the excess over 100% of the sum of the respective adjusted loss and LAE factor and the company's underwriting expense ratio.

As with reserve risk, adjustments are made for loss-sensitive business. The adjustment is 30% for business written directly and 15% for assumed business.

A "Premium Concentration Factor" is applied to recognize the diversification of the premium across the lines of business. Similar to the reserve risk diversification calculation, the factor here is equal to 0.70 plus 30% of the ratio between the largest line's net written premium to the total company net written premium. Claims-made and occurrence premium are combined for this calculation.

As identified earlier, the NAIC applies an additional premium risk charge for excessive growth equal to 22.5% of the excessive growth multiplied by the total net written premium.

BCAR

A.M. Best uses a similar factor-based approach to quantify the risk associated with written premium; A.M. Best applies risk charge factors to the company's Schedule P net written premium for 20 lines of business.

The baseline risk charge factors used by A.M. Best are based on a methodology developed as part of the AAA Report [2].

A "Premium Adequacy" factor specific to the company for each line of business is used to adjust the baseline risk charge. The factor reflects the company's most recent three-year accident year combined ratio relative to that of the industry. This is further adjusted by A.M. Best to reflect their view on the impact of current pricing trends on underwriting risk. This factor ranges from 0.80 to 1.20.

A.M. Best also makes an adjustment based on the size of the company, similar to the adjustment they make when quantifying reserve risk.

An initial unadjusted risk charge is calculated by multiplying the net written premium (by line of business) by the respective adjusted risk charge factor. The same Growth Charge that is used with reserve risk is applied to premium risk. Similarly, a "Diversification Credit" comparable to that for reserve risk is applied to this risk. A.M. Best uses the same calculation as that used by the NAIC for this purpose.

A.M. Best notes that if a company provides more detail regarding its premium writings, then they will take that information into consideration and therefore apply more appropriate risk charge factors.

S&P

S&P's approach to quantifying the capital required for premium risk is a simpler factor based approach than those used by the NAIC or A.M. Best. The premium risk charge is simply the company's net written premium multiplied by the appropriate line of business risk charge factor. As with the reserve risk charge factors used by S&P, the source of the premium risk

charge factors is the AAA Report, without modification. These are designed to measure the variability of the profitability by line of business.

MRAC

Unlike the other models reviewed, the Moody's model treats premium risk as a function of *unearned premium* rather than written premium. Continuing with their simulation technique, Moody's calculates the amount of risk (or benefit) by comparing simulated discounted combined ratios (excluding commissions) to unity. In their simulation of the combined ratio, only the loss ratios are simulated; underwriting and unallocated loss adjustment expense are held constant. Using the same parameters that were developed as part of the reserve risk quantification, lognormal distributions by line of business are assumed for the loss ratios. The selected mean ultimate loss ratios reflect current pricing and loss trends. Additionally, the same across line of business correlations as those developed as part of the reserve risk quantification are assumed here as well.

Another difference from the other models reviewed is the manner in which the Moody's model treats the risk from catastrophe losses. Moody's uses seven industry exceedence curves (e. g., South Atlantic Wind, Gulf Wind, etc) that Moody's has estimated. Based on a company's market share by state, by line of business, Moody's derives the individual company's exceedence curve by adjusting the overall industry curve. Moody's assumes that each company insures 90% of the layer between the 1-in-25 year loss level and the 1-in-100 year loss level, and that each company retains the remainder of the simulated event loss. The calculated ceded amounts enter into the model's treatment of reinsurance recoverables and also the calculation of the reinsurance risk previously discussed.

Required Capital – Other Risks

Credit Risk – Reinsurance Recoverables

Reinsurance recoverables generally constitute the single largest credit risk exposure for property/casualty insurers, outside of invested assets.

The RBC, BCAR, and CAR models each determine the required capital by applying risk charge factors to the reinsurance recoverables reported in the Annual Statement, similar to their approach with investment risk. The RBC formula uses a 10% risk charge for this risk. Feldblum [1] notes that no statistical rationale has been put forward by the NAIC to justify this factor. One of the major criticisms that have been made about the RBC charge relate to the fact that it does not differentiate by type of reinsurer. While the NAIC has not implemented a graded approach for reinsurance recoverables for fear of becoming a de facto rating agency, the rating agencies have reflected this distinction in their models.

RATING AGENCY CAPITAL MODELS

Risk Charge Factors – Reinsurance Recoverables

A.M. Best Rating	Factor	S&P Rating	Factor
A++	2.0%	AAA	0.5%
A+	4.0%	AA	1.2%
A	6.0%	A	1.9%
A-	8.0%	BBB	4.7%
B++/B+	10.0%	BB	9.6%
B	20.0%	B	23.8%
B-	40.0%	CCC	49.7%
C++/Non-Rated	100.0%	U/NR	25.0%
		S/R	50.0%

A.M. Best generally sets their risk charge for reinsurance recoverables at 10%, unless additional detail is available from the company. For recoverable from affiliates, the 10% charge may be adjusted based on an assessment of the affiliate's creditworthiness. For non-affiliates, the charge can range from a low of 2% for A++ (Superior) reinsurers to a charge of 100% non-rates or suspect reinsurers. Funds withheld or other forms of collateral are generally recognized as an offset to reinsurance recoverable balances in the BCAR charge for credit risk.

The BCAR model also includes a surcharge for insurers that are considered to be excessively dependent on unaffiliated reinsurance, given their lines of business and financial resources. This additional charge reflects the increased exposure to reinsurance disputes and cash-flow problems the insurer might face as a result of the higher dependence on reinsurance. A.M. Best uses two dependence tests to recognize this risk. The first test compares the company's recoverable-to-surplus ratio to an industry benchmark. The second test examines the company's total ceded leverage to thresholds of five, seven and 10 times surplus, resulting in charges of 15%, 20% and 25% of non-affiliated recoverables.

S&P uses their own ratings on domestic and international reinsurance companies to assess credit risk on reinsurance recoverables. The reinsurance recoverable charge is applied to the recoverables from reinsurers that fall into the specific rating category to derive a total charge. Reinsurers under some form of regulatory control are deemed to be similar to a 'CCC' reinsurer; reinsurers that are not rated are deemed to be similar to 'B' reinsurers.

Moody's defines credit risk solely as "Reinsurance Exposure". As they do with most of the asset risk category, Moody's uses a stochastic approach to determining credit risk. To do so, their model simulates reinsurance risk from four categories:

1) Paid Loss Recoverables and Ceded Reserves;
2) Ceded Reserve Development;
3) Ceded Underwriting; and
4) Ceded Catastrophes.

Each recoverable is identified with the Moody's Insurance Financial Strength Rating (IFSR) of the responsible reinsurer. All Lloyd's syndicates are assigned to the Baa category while involuntary reinsurance facilities are assigned to the Aa rating category. The simulation approach assumes a normal distribution.

MOODY'S RISK ADJUSTED CAPITAL MODEL

Risk Charge Factors – Reinsurance Recoverables

Moody's IFSR	Mean Unrecoverable	Standard Deviation
Aaa	1.0%	1.0%
Aa	2.0%	2.0%
A	5.0%	5.0%
Baa	10.0%	10.0%
All Other	25.0%	25.0%

The model provides an offset collateral equal to 95% or 100% of the Schedule F Part 5 detail for a letter of credit or funds withheld, respectively.

Additionally, Moody's Reinsurance Exposure considers contingent liabilities associated with reinsurance recoverables. These consist of contingent exposure to ceded reserve development (adverse net reserve development implies a corresponding adverse ceded reserve development) and contingent reinsurance assets (ceded underwriting and ceded catastrophes).

Credit Risk – Other

For the Credit risk category, the NAIC, A.M. Best, and S&P each determine the required capital applying risk charge factors to the annual statement values, similar to their approach with asset risk. The following table displays the current set of risk charge factors.

Note that many of the factors used are consistent across the rating agencies.

RATING AGENCY CAPITAL MODELS

Risk Charge Factors – Credit Risk – Other

Type	RBC	BCAR	CAR
Agent's Balances			
In course of collection or deferred		5%	2%
Accrued retros or collateralized balances		10%	2%
Funds held by reinsurers		5%	
Bills receivable		5%	
Federal income tax recoverable	5%	5%	5%
Accrued investment income	1%	2.5%	1%
Receivable from affiliates	5%	5%	5%
Equity in pools and associations		5%	
Uninsured A&H plans	5%	5%	5%
Write-ins	5%	5%	5%
Other		5%	

Other Risks

RBC

In addition to the core risk categories discussed above, the NAIC also has an extensive calculation to include the risk associated with a property/casualty company's Accident & Health (A&H) business. This is applicable if the company has written 5% or more of its premium in A&H lines during any of the three most recent calendar year periods. The risk charge factors apply to medical, disability income, long-term care insurance, and other types of health insurance premium and claim reserves. An offset is allowed for premium stabilization reserves associated with this business.

BCAR

The A.M. Best model includes two additional risk categories: Interest Rate Risk (B3) and Business Risk (B7).

Interest Rate Risk is intended to measure the risk that exists if liquid assets must be sold in a short period of time to fund obligations (e. g., immediately following a catastrophe). The risk charge compares a company's 100-year PML to its liquid assets and then relates this factor to the company's decline in market value following a 120 basis point rise in interest rates.

Business Risk consists of a 1% risk charge factor applied against several off-balance sheet items including guarantees for affiliates and contingent liabilities. There is a qualitative aspect to this risk category, and the analyst may use a risk charge factor as high as 100% as the item warrants.

S&P

The CAR model includes an additional risk category they call, "Other Business Risk". Included in this category are risk charges for guaranty fund assessments, other lines of business not already captured, and all other appropriate charges. The risk charge is calculated by applying state-specific risk charge factors against the projected written premium by state. The risk charge factors range from 1.0% to 2.0%, with most at 2.0%.

MRAC

Moody's approach explicitly takes into account operational risk, including fraud, systems failure, and litigation risk. The risk charge for operational risk is equal to 15% of the company's total risk charge from the other categories. Moody's recognizes that this approach is simplistic; however, client feedback has indicated that it is not an unreasonable approach.

Results and Interpretation

RBC

Once the individual risk charges have been calculated by the NAIC, they use a covariance formula to reflect the expected benefit from combining the different risk categories (the diversification benefit). The NAIC formula used to determine the "Total Risk Based Capital after Covariance" is:

$$= R0 + Sqrt(R1^2 + R2^2 + R3^2 + R4^2 + R5^2)$$

where:

- R0 is the risk charge for insurance affiliates and off-balance sheet risks,
- R1 is the risk charge for fixed income securities,
- R2 is the risk charge for equity investments,
- R3 is the risk charge for credit risk,
- R4 is the risk charge for loss and LAE reserve risk, and
- R5 is the risk charge for premium risk

The total RBC after covariance is compared to the aforementioned "Total Adjusted Capital (Post Deferred Tax)" to determine the appropriate "level of action", if any. Depending on the result of this comparison, the commissioner of the state of domicile may need to take certain actions.

RBC

RBC Action Levels

Action Level	Adjusted Capital/RBC	Comments
None	Greater than 200%	98.5% of companies are in this category
Company Action Leve	200%	Company submits plan, commissioner approves or disapproves
Regulatory Action Level	150%	Company submits plan, commissioner issues an order specifying corrective actions
Authorized Control Level	100%	Commissioner takes necessary actions to protect policyholders and creditors
Mandatory Control Level	70%	Commissioner places the company under regulatory control

BCAR

The BCAR model sums up the capital requirements from its seven risk categories in order to obtain the Gross Required Capital (GRC).

GRC = B1 + B2 + B3 + B4 + B5 + B6 + B7

where: B1 is the risk charge for fixed income securities
B2 is the risk charge for equity securities
B3 is the risk charge for interest rate risk
B4 is the risk charge for credit risk
B5 is the risk charge for loss and LAE reserve risk
B6 is the risk charge for premium risk
B7 is the risk charge for business risk

In order to recognize diversification benefits and obtain Net Required Capital (NRC), the model uses a covariance formula similar to that used by the NAIC.

$$\mathbf{NRC} = \sqrt{B1\text{^}2 + B2\text{^}2 + B3\text{^}2 + (1/2 \text{ x } B4)\text{^}2 + (1/2 \text{ x } B4 + B5)\text{^}2 + B6\text{^}2} + B7$$

Finally, the BCAR result is derived as the ratio of the adjusted surplus (APHS), described earlier, to the NRC:

BCAR = APHS / NRC

The Best Capital Adequacy Ratio (BCAR) is the ratio of the company's aforementioned adjusted policyholder surplus (APHS) to Net Required Capital. A company's BCAR is one factor A.M. Best uses when rating a company.

BCAR

BCAR Scores Associated with Ratings

Category	Implied Balance Sheet Strength Rating	Minimum BCAR
Secure	A++	175
	A+	160
	A	145
	A-	130
	B++	115
	B+	100
Vulnerable	B	90
	B-	80
	C++	70
	C+	60
	C	50
	C-	40
	D	0

S&P

A major difference with the S&P model compared to the NAIC or A.M. Best's model is that there is not a covariance adjustment used in the determination of required capital. The CAR is computed as follows:

$$\text{CAR Ratio} = \frac{\text{Risk Adjusted Capital}}{\text{Required Capital}}$$

Where: Risk Adjusted Capital = Total Adjusted Capital – C1 – C2
Required Capital = C3 + C4 + C5

and: C1 is the risk charge for asset risk
C2 is the risk charge for credit risk
C3 is the risk charge for underwriting risk
C4 is the risk charge for reserve risk
C5 is the risk charge for other business risk

An S&P Capital Adequacy Ratio of 175% or more represents an "extremely strong" level of capital adequacy.

S&P CAPITAL ADEQUACY RATIO

CAR Scores Associated with Ratings

Capital Adequacy Ratio	Assessment of Capital Adequacy	Letter Rating
Below 100%	Marginal	Ba – C
100% – 124%	Good	Baa
125% – 149%	Strong	A
150% – 174%	Very Strong	Aa
175% and above	Extremely Strong	Aaa

MRAC

Moody's selects the indicated capital from the 99.9th percentile its 60,000 simulations as the risk adjusted required capital. The MRAC ratio is computed as follows:

$$\text{MRAC Ratio} = \frac{\text{Book Surplus + Surplus Adjustment}}{\text{MRAC Charge}_{99.9\%} + \text{Surplus Adjustment}}$$

Where: Adjusted Book Capital = Book Surplus + Surplus Adjustment

The MRAC Ratio is then scaled upward based on the estimated duration of the company's liabilities. The MRAC model is a one-year projection model intended to put companies on an even playing field. However, Moody's recognizes that the likelihood of failure over a given time horizon will differ with different liability profiles. Longer duration liabilities afford greater leeway than do shorter duration liabilities in the event of capital difficulties. Moody's has derived the adjustment factors based on their idealized default table for single A-rated credits.

Moody's uses MRAC results to map to their insurance financial strength ratings in the following ways:

Ratio Mapping: Moody's analysis suggests that higher MRAC Ratios are associated with higher ratings (e. g., Aa, A, Baa). Further, Moody's has found that the ideal relationship involves a transformation of the MRAC Ratio into [1 + ln(MRAC Ratio)]. They have found that a transformed ratio of 100% corresponds to a rating between A3 and Baa1.

Expected Default Probability: By examining the distribution of model results, Moody's can identify the threshold at which ending surplus is negative, which they equate to economic insolvency, or default. The default percentage can then be mapped to Moody's historical default probability table (for a time horizon consistent with the computed liability duration), yielding an implied rating.

Expected Loss: By examining the distribution of model results, Moody's can compute the expected policyholder deficit (EPD) (equal to MRAC Charge minus Book Adjusted Capital divided by Policyholder Liability). This EPD can then be mapped to Moody's idealized expected loss table (using a time horizon consistent with the computed liability duration), yielding an implied rating.

Relative Contribution of Risk Categories

The various rating agency capital models aim to reflect the various sources of risk affecting a property/casualty company. While investment risk and credit risk can sometimes be significant contributors to this overall risk, underwriting risk typically represents the largest portion of the required capital charge for most property/casualty insurance companies. Per the NAIC [1], charges related to underwriting risk represent approximately 80% of the aggregate industry risk-based capital. A.M. Best compiled a similar analysis of the total industry gross required capital, using 2002 year-end industry aggregate figures. Using the BCAR model, capital charges related to premiums written and loss/LAE reserves comprised 59% of the total, while charges related to investments contributed 31% and credit risk charges contributed 10%.

3. LOSS RESERVE ADEQUACY

A significant source of risk for property/casualty insurers relates to reserve risk. Given that loss reserves recorded in the Annual Statement represent "management's best estimate" of the company's outstanding unpaid claim liability, it is unlikely that two companies will be at the same level of reserve adequacy. This reality creates an interesting dilemma for rating agencies, as they make adjustments to the companies' reported policyholders' surplus in order to make them comparable.

If the rating agencies did not make adjustments for perceived loss reserve redundancies or deficiencies, companies with more conservative loss reserves would be at a disadvantage for the following reasons when evaluating their capital adequacy:

- Higher loss and LAE reserves translate into a higher *required* capital amount.
- Higher loss and LAE reserves result in a lower *actual* capital amount.

Given that capital adequacy models generally summarize the result of their calculation as the ratio of actual capital to required capital, both the numerator and the denominator are impacted by the level of reserve adequacy. In order to address this potentially significant impact, rating agencies have made adjustments to their formulas.

RBC

The RBC formula does not adjust for potential reserve adequacy. However, it is important to realize that the RBC formula is only one of the tools available to regulators to maintain company solvency; a financial examination is another. As part of this process, regulators generally develop an alternative estimate of the outstanding unpaid claim liability of the company, which, if vastly different from the company's loss reserves, can be used to make an adjustment to the company's Annual Statement.

With its multiple levels of potential regulatory intervention, the RBC formula is designed to assist regulators in identifying companies that may have potential solvency issues. While a company could avoid falling below a certain level of the RBC formula by initially recording

lower loss reserves, it is unlikely that this approach could be repeated over an extended period of time with the same benefit. Given the formula's built-in adjustment factor for company reserve development, the RBC factors would be adjusted over time and result in a higher capital requirement eventually. The perceived initial benefit would be temporary and mitigated over time.

BCAR

Assessing reserve adequacy is a difficult process for a rating agency, given that they generally do not have access to important information used by actuaries in developing estimates of a company's unpaid claim liability. Nevertheless, A.M. Best has developed a methodology to determine the size of a company's reserve deficiency. Per A.M. Best [3], the "initial determination of reserve deficiency is based on a number of actuarial techniques used within A.M. Best's proprietary loss-reserve model, including paid and case-incurred development. In addition to the reserve model, a diagnostic analysis of Schedule P and a qualitative assessment of the company's operating environment and historical reserve development are used to arrive at A.M. Best's view of reserve deficiency."

Also, A.M. Best mentions that a number of issues can affect their view of a company's reserve position. These would include:

- Number of reserve adjustments
- Size of the adjustments
- Lines of business involved
- Accident years generating the adverse development
- Source of development (expected or unexpected)

In addition, A.M. Best performs a separate analysis of the company's A&E liabilities. "Any deficiency in mass-tort reserves is added to the core deficiency. For A&E reserves, A.M. Best uses a survival ratio method, a premium market share method and a paid-loss-share method to generate an initial assessment of these reserves. Discussions with company

management and a current, third-party, ground-up review then are used to supplement the initial analysis."

S&P

While the CAR model does not make a specific adjustment for reserve adequacy, the model can be adjusted for reserve redundancies or deficiencies.

MRAC

As described above, the reserve risk component of the MRAC model is based on a simulation. For each simulation, the model takes as input Moody's estimate of the unpaid claim liability and a calculated standard deviation, reflective of the company's claim volatility. The reserve charge is derived as the difference between the simulated amount for all lines of business and the company's reserves as recorded in the Annual Statement. In order to describe Moody's adjustment for reserve adequacy, it helps to first decompose the reserve charge into a reserve development charge and a reserve deficiency adjustment.

Reserve Charge = Simulated Loss Amount – Company Loss Reserve

= (Simulated Loss Amount – Moody's Estimate) + (Moody's Estimate – Company Loss Reserve)

= Reserve Development Charge + Reserve Deficiency Adjustment

The reserve development charge is similar in concept to a factor-based model. The key difference is that, since the risk capital factor is stochastic, the reserve charge will be different for each simulation.

The reserve deficiency adjustment is based on a credibility-weighted procedure between the company's own data and industry data. It is calculated through on the following steps:

- For accident years t-3 through t-9, Moody's use Schedule P loss triangles to project ultimate losses by accident year with chain-ladder method. The projections are

performed on both paid and case-incurred triangles, using all-year weighted averages of the report-to-report factors and tail factors specific to the line of business.

- For accident years t-1 and t-2, Moody's projects forward the two-year average projected loss ratio (obtained as the simple average of years t-3 and t-4) using estimated premium trend and loss trend by year. The industry trend factors are specific to the line of business and derived by Moody's. The resulting loss ratios are then multiplied by the earned premium to obtain accident year ultimate losses.
- Moody's then applies credibility rules to the projections. The company report-to-report factors are given a 75% weight if the line of business represents more than 10% of the company's ultimate losses or more than 0.5% of total industry losses. Otherwise, they receive a 25% weight, with the industry receiving the rest. The weights are applied to the report-to-report factors in order to derive the estimated ultimate losses. For accident years t-1 and t-2, the loss ratio trending approach is used on the prior years' loss ratios after the credibility-weighting procedure.
- The ultimate loss estimates are next discounted using discount factors specific to the line of business as derived by Moody's using aggregate payout data and judgment. Discount factors are applied only to the unpaid portion of the ultimate loss estimates.
- Finally, Moody's calculates the reserve deficiency adjustment as the difference between the aggregate discounted ultimate loss estimates using the methodology described above and the company's estimate of ultimate losses, as reported in their Annual Statement.

4. QUALITATIVE FACTORS

While each of the models is designed to be quantitative in nature, with the exception of the NAIC approach, qualitative factors also play a large role in determining the outcomes of the various models.

BCAR

There are several areas throughout the BCAR model where A.M. Best utilizes qualitative adjustments to supplement the quantitative information provided by the company. These adjustments stem from discussions with company management and information gathered through A.M. Best's Supplemental Rating Questionnaire. Some of these qualitative factors are discussed below.

From an overall standpoint, A.M. Best says that its model can be qualitatively adjusted to reflect various market issues such as the state of the underwriting cycle, changing reinsurance products, and the dependence on reinsurance.

Many of the qualitative adjustments center around the use of reinsurance.

With regard to the Credit Risk category, A.M. Best notes that the required capital, "might be modified after taking into account any collateral offsets for reinsurance balances, the quality of the reinsurers that participate in the company's domestic reinsurance program, and the company's dependence on its reinsurance program."

As was previously mentioned, the A.M. Best analyst can assign a risk charge for reinsurance recoverables for the company's domestic reinsurance program based on the A.M. Best's Rating of the reinsurers participating in the program; this risk charge can range from 2% for an A++ (Superior) reinsurer to charges in excess of 50% for "suspect" reinsurers.

Likewise, A.M. Best may also include an additional capital requirement for those companies that they feel have an over dependence on unaffiliated reinsurance, regardless of the financial strength of the reinsurers involved. A.M. Best uses two tests to determine the extent, if any, of over dependence. The first test compares the company's recoverable-to-surplus ratio to an industry benchmark. In the second test, a company's total ceded leverage is compared to

thresholds of five, seven, and 10 times surplus, resulting in risk charges from 15% to 25% of nonaffiliated recoverables.

Furthermore, A.M. Best may modify the underwriting risk charges to reflect the amount of risk transfer that is involved with various reinsurance products. For example, the use of prospective stop-loss contracts will impact many components of the company's statement values and A.M. Best will modify its factors to compensate for these impacts.

In addition to reinsurance, A.M. Best applies judgment in other areas throughout its BCAR model. For example, whereas the A.M. Best's baseline risk charge for balances of pools and associations is 10%, they may use their judgment to adjust the balances based on the creditworthiness of the pool and the state's regulatory environment.

Other Models

While the other rating agencies do not provide as detailed an explanation of the qualitative factors that impact their ratings process, it is generally understood that they follow a similar process before assigning a rating to a company (i.e. the capital model score is not the only determinant in the rating process).

5. ENTERPRISE RISK MANAGEMENT DEVELOPMENTS

Capital models, whether driven by application of factors to exposure bases or by complex stochastic engines, serve important purposes in the understanding and management of risks and rewards for an insurance enterprise. Economic capital models provide a framework for modeling the volatility of a risky transaction, as well as the associated capital needed to support adverse outcomes. Further, since the amount of capital required for a project is fundamentally related to the desired (absolute) return, the determination of capital need suggests a pricing requirement as well. Capital models are thus part of the process of analyzing and pricing risk/reward tradeoffs.

Economic capital models are, in turn, naturally related to the broader subject of Enterprise Risk Management (ERM). ERM is a shorthand reference to an entire range of processes and techniques (of which economic capital modeling is one) for understanding, quantifying and managing risk and reward at the enterprise level.

Like economic capital modeling, ERM serves the central purposes of an insurance enterprise: understanding and managing risk, determining and reflecting the capital investment in the insurance business(es), and suggesting appropriate risk-adjusted pricing. Rating agencies properly recognize that this developing area will affect both the theory and practice of efficient risk and capital management in the insurance arena.

To incorporate some of these recent developments, below we have included a brief discussion of the rating agencies' activities in the area of ERM:

S&P

With the publication of their ERM Evaluation Framework in October of 2005, S&P took a significant step toward the explicit incorporation of ERM into their rating analysis of a company. S&P views ERM as the guiding umbrella framework within which a company is able to:

- Identify and *regularly* monitor important risks (emphasis added)

- Set and enforce risk limits so that losses remain within explicitly determined and tolerable bounds
- Develop pricing approaches and capital allocations that reflect the risk to the enterprise and produce a return commensurate with that risk
- Learn from mistakes

The emphasis on the word "regularly" indicates the view that ERM should be an institutionalized process that a company builds into its daily operations and culture. In fact, from their stated vision, S&P suggests a useful theme for the process of Enterprise Risk Management:

> "The result of risk management is therefore a controlled risk-taking environment. A company with risk management is not one where managers believe that they do not take any risks. Rather, a company with risk management is one where managers knowingly take considered risks and understand that losses are probable. In effect, risk management should provide a company with reasonable grounds to believe that it will be able to manage any events and losses within predetermined bounds."

As the term suggests, S&P emphasizes the *enterprise-level* nature of ERM, such that risks are analyzed across all points of exposure. This broad focus ensures that losses from all sources are considered when determining and enforcing risk tolerances. It helps mitigate the chance that an organization would be "surprised" by its exposure to a given event or series of events.

S&P also recognizes and stresses the opportunity (or "reward") side of ERM. As their framework suggests, protecting against severe downside is only one manifestation of an intelligent and structured process for understanding and accepting risk/reward tradeoffs. Perhaps more openly than ever, S&P explicitly states that factor-based capital models (including their own) are simple and somewhat undesirable tools for managing a company. It is preferable for a company to use a robust economic capital model to understand the true range of opportunity and downside associated with a given activity. Although S&P does not have plans to develop their own economic capital model, their framework makes clear that

they will make judgments about a company's own internal models and the extent to which the company is effectively using those models to make "offensive" as well as "defensive" risk and capital management decisions.

6. REFERENCES

Research Papers

[1] Feldblum, Sholom, "NAIC Property/Casualty Insurance Company Risk-Based Capital Requirements", *Proceedings of the Casualty Actuarial Society, Volume LXXXIII* (p.297-435)

[2] American Academy of Actuaries, "Property/Casualty RBC Task Force – Report on Reserve and Underwriting Risk Factors" (1993)

Model Descriptions

[3] A.M. Best Company, Inc., "Understanding BCAR, A.M. Best's Capital Adequacy Ratio for P/C Insurers – And Its Implications for Ratings" (November 2003).

[4] Moody's Investors Service, "Moody's Risk Adjusted Capital Model for Property & Casualty Insurers" (September 2004).

[5] National Association of Insurance Commissioners, "2002 NAIC Property and Casualty Risk-Based Capital Report Including Overview and Instructions for Companies" (July 2002)

[6] Standard and Poor's, "Property and Casualty Insurance Criteria" (November 2004)

APPENDIX I – HISTORICAL AM BEST RATINGS

Rank	Company	2005	2004	2003	2002	2001
1	State Farm Group	A++	A++	A++	A++	A++
2	American International Group, Inc [1]	A++/A+	A++	A++	A++	A++
3	Allstate Insurance Group	A+	A+	A+	A+	A+
4	St Paul Cos	A	A	A	A	A+
5	Farmers Insurance Group [2]	A	A	A	A+/A	A+
6	Berkshire Hathaway Insurance Gr [3]	A++	A++	A++	A++	A++
7	Nationwide Group	A+	A+	A+	A+	A+
8	Progressive Ins Group [4]	A+	A+	A+	A+	A+
9	Liberty Mutual Ins Cos	A	A	A	A+	A+
10	Chubb Group of Ins Cos	A++	A++	A++	A++	A++
11	Hartford Ins Group [5]	A+	A+	A+	A+	A+
12	USAA Group	A++	A++	A++	A++	A++
13	State Comp Ins Fund of Calif	NR-4	NR-4	NR-4	B+/B-/NR-4	B+
14	CNA Ins Cos	A	A	A	A	A
15	Zurich Financial Svcs NA Group [6]	A	A	A	A+/A	A+
16	Amer Family Ins Group	A	A	A+/A	A+	A+
17	Safeco Ins Cos	A	A	A	A	A
18	Ace INA Group [7]	A	A	A	A	A
19	GE Global Ins Group [8]	B+	B+	A-	A-	A
20	Allianz of America Inc [9]	A	A	A+/A	A++	A++
21	Auto-Owners Ins Group	A++	A++	A++	A++	A++
22	W R Berkley Group [10]	A	A	A	A	A
23	Erie Ins Group	A++	A++	A++	A++	A++
24	White Mountains Ins Group [11]	A	A	A	A	A
25	Fairfax Financial (USA) Group [12]	B++	B+/B++	B+	B++	A-/B++
26	Cincinnati Ins Cos	A++	A++	A++	A++	A++
27	MetLife Auto & Home Group [13]	A	A	A	A	A
28	Everest Re U.S. Group	A+	A+	A+	A+	A+
29	GMAC Insurance Group	A-	A	A-/A	A+	A+
30	Mercury General Group [14]	A-	A-	A-	A-	A-

APPENDIX II – HISTORICAL BCAR SCORES

Rank	Company	2005	2004	2003	2002	2001
1	State Farm Group	229.1	229.1	229.4	266.9	290.8
2	American International Group, Inc[1]	171.1	171.1	140.4	174.9	167.4
3	Allstate Insurance Group	211.1	211.1	193.0	207.8	187.8
4	St Paul Cos	166.4	170.4	156.8	139.0	201.8
5	Farmers Insurance Group[2]	156.9	156.9	160.1	135.8	167.7
6	Berkshire Hathaway Insurance Gr[3]	234.0	184.9	183.8	181.2	208.2
7	Nationwide Group	175.8	187.7	169.5	191.5	160.9
8	Progressive Ins Group[4]	188.3	188.3	180.4	194.3	129.9
9	Liberty Mutual Ins Cos	184.1	184.1	155.4	152.8	150.5
10	Chubb Group of Ins Cos	217.9	204.0	181.5	177.9	199.5
11	Hartford Ins Group[5]	236.5	236.5	226.2	187.0	185.0
12	USAA Group	254.5	254.3	221.7	212.6	220.2
13	State Comp Ins Fund of Calif	n/a*	n/a*	n/a*	n/a*	n/a*
14	CNA Ins Cos	183.0	183.0	170.5	152.4	n/a*
15	Zurich Financial Svcs NA Group[6]	144.5	144.4	144.5	144.4	n/a*
16	Amer Family Ins Group	218.8	208.6	164.6	211.6	235.6
17	Safeco Ins Cos	232.5	177.8	208.1	158.0	217.5
18	Ace INA Group[7]	169.5	169.5	161.5	154.9	n/a**
19	GE Global Ins Group[8]	168.8	168.8	153.7	n/a*	n/a*
20	Allianz of America Inc[9]	161.0	142.8	144.0	115.9	n/a**
21	Auto-Owners Ins Group	313.4	312.9	302.6	343.8	n/a**
22	W R Berkley Group[10]	145.5	145.5	119.3	99.1	169.4
23	Erie Ins Group	239.5	239.5	214.6	316.8	394.2
24	White Mountains Ins Group[11]	197.0	197.0	152.2	153.8	159.5
25	Fairfax Financial (USA) Group[12]	n/a*	n/a*	n/a*	n/a*	n/a*
26	Cincinnati Ins Cos	207.8	261.2	183.2	203.2	235.5
27	MetLife Auto & Home Group[13]	234.4	276.3	288.4	198.4	242.3
28	Everest Re U.S. Group	139.6	145.1	157.7	169.9	n/a**
29	GMAC Insurance Group	227.0	216.5	213.0	240.2	285.7
30	Mercury General Group[14]	190.8	391.2	381.7	367.5	390.7

BCAR scores as of 06/16/2005, 07/22/04,07/22/03, 07/11/02, 07/20/01, 07/21/00

* BCAR not available

** Company cannot be found

APPENDIX III – HISTORICAL S&P RATINGS

Rank	Company	2005	2004	2003	2002	2001
1	State Farm Group[1]	AA	AA	AA	AAA	AAA
2	American International Group, Inc[2]	AA+	AAA	AAA	AAA	AAA
3	Allstate Insurance Group[3]	AA	AA	AA	AA	AA
4	St Paul Cos[4]	A+	A+	A+	AA-	AA
5	Farmers Insurance Group[2]	A	A	A	AA-	AA+
6	Berkshire Hathaway Insurance Gr[6]	AAA	AAA	AAA	AAA	AAA
7	Nationwide Group[7]	A+	A+	A+	A+	AA-
8	Progressive Ins Group[8]	NR	NR	AA	AA	AA
9	Liberty Mutual Ins Cos[9]	A	A	A+	A+	AA-
10	Chubb Group of Ins Cos[10]	AA	AA	AA+	AA+	AAA
11	Hartford Ins Group[11]	AA-	AA-	AA-	AA	AA
12	USAA Group[12]	AAA	AAA	AAA	AAA	AAA
13	State Comp Ins Fund of Calif	NR	NR	NR	NR	NR
14	CNA Ins Cos[13]	A-	A-	A-	A-	A
15	Zurich Financial Svcs NA Group[14]	A+	A+	A+	AA	AA+
16	Amer Family Ins Group[15]	A+	AA-	AA-	AA-	AA-
17	Safeco Ins Cos[16]	A+	A+	A+	A+	AA-
18	Ace INA Group[17]	A+	A+	A+	A+	A+
19	GE Global Ins Group[18]	A+/A	A+	A	A+	A+
20	Allianz of America Inc[19]	A	A+	A+	AA-	AA-
21	Auto-Owners Ins Group[20]	AAA	AAA	AAA	AAA	AAA
22	W R Berkley Group[21]	A+	A+	A+	A+	A+
23	Erie Ins Group[22]	A	A	AA	AA	AA
24	White Mountains Ins Group	NR	NR	NR	NR	NR
25	Fairfax Financial (USA) Group[23]	BBB	BBB	BBB	BBB	BBB+
26	Cincinnati Ins Cos[24]	AA-	AA-	AA-	AA-	AA+
27	MetLife Auto & Home Group	NR	NR	NR	NR	NR
28	Everest Re U.S. Group[25]	AA-	AA-	AA-	AA-	AA-
29	GMAC Insurance Group	NR	NR	NR	NR	NR
30	Mercury General Group[26]	AA	AA	AA	AA	A

APPENDIX IV – HISTORICAL MOODY'S RATINGS

Rank	Company	2005	2004	2003	2002	2001
1	State Farm Group[1]	Aa1	Aa1	Aaa/Aa1	Aaa	Aaa
2	American International Group, Inc[2]	Aaa/Aa1 /Aa2	Aaa	Aaa	Aaa	Aaa
3	Allstate Insurance Group[3]	Aa2	Aa2	Aa2	Aa2	Aa2
4	St Paul Cos[4]	A1	A1	Aa3/A1	Aa3	Aa2/Aa3
5	Farmers Insurance Group[2]	A3	A3	A3	A1/A3	Aa3/A1
6	Berkshire Hathaway Insurance Gr[6]	Aaa	Aaa	Aaa	Aaa	Aaa
7	Nationwide Group[7]	Aa3	Aa3	Aa3	Aa3	Aa3
8	Progressive Ins Group[8]	Aa2	Aa2	Aa3/Aa2	Aa3	Aa3
9	Liberty Mutual Ins Cos[9]	A2	A2	A2	A1/A2	Aa3/A1
10	Chubb Group of Ins Cos[10]	Aa2	Aa2	Aa2	Aa1/Aa2	Aa1
11	Hartford Ins Group[11]	Aa3	Aa3	Aa3	Aa3	Aa3
12	USAA Group[12]	Aaa	Aaa	Aaa	Aaa	Aaa
13	State Comp Ins Fund of Calif	NR	NR	NR	NR	NR
14	CNA Ins Cos[13]	A3	A3	A3	A3	A2/A3
15	Zurich Financial Svcs NA Group[14]	A2	A2	A1/A2	Aa2/A1	Aa2
16	Amer Family Ins Group[15]	Aa3	Aa3	Aa2/Aa3	Aa2	Aa2
17	Safeco Ins Cos[16]	A1	A1	A1	A1	A1
18	Ace INA Group[17]	A2	A2	A2	A2	A2
19	GE Global Ins Group[18]	NR	NR	NR	NR	NR
20	Allianz of America Inc[19]	A2	A2	A1/A2	A1	Aa1/Aa3 /A1
21	Auto-Owners Ins Group[20]	NR	NR	NR	NR	NR
22	W R Berkley Group[21]	A2	A2	A2	NR	NR
23	Erie Ins Group[22]	NR	NR	NR	NR	NR
24	White Mountains Ins Group[23]	A2	A2	A2	A2	NR
25	Fairfax Financial (USA) Group[24]	Baa3	Baa3	Baa3	Baa2/Ba a3	Baa2
26	Cincinnati Ins Cos[25]	Aa3	Aa3	Aa3	Aa3	Aa3
27	MetLife Auto & Home Group[26]	Aa3	Aa3	Aa3	Aa3	Aa3
28	Everest Re U.S. Group[27]	Aa3	Aa3	Aa3	Aa3	A1/Aa3
29	GMAC Insurance Group	NR	NR	NR	NR	NR
30	Mercury General Group[28]	Aa3	Aa3	Aa3	Aa3	Aa3