

Risk-Based Capital (RBC) Underwriting Risk Factor Safety Levels

Report 11 of the CAS Risk-Based Capital (RBC) Research Working Parties Issued
by the RBC Dependencies and Calibration Subcommittee

Abstract: The underwriting elements in the NAIC Property Casualty RBC Formula (RBC Formula) are not selected to achieve a particular total safety level. We examine the historical variability in underwriting experience and measure the achieved safety level in terms of a Value at Risk (VaR). As explained in this paper, we consider a Policyholder View for measuring safety level as opposed to a Company View. We demonstrate that the line of business (LOB) risk factors for premium and reserves, while calibrated to an 87.5th percentile safety margin with a Company View, produce a safety margin higher than 87.5% on a Policyholder View.

We show that the underwriting risk charge resulting from the combined effects of individual line of business premium and reserve risk charges, the diversification credits, and the dependency between premium and reserve risk in the 2010 RBC Formula produces a 91% safety level.

This analysis does not evaluate the effect on the safety level of other elements of the RBC Formula, i.e., the R0, R1, R2, R3 risks including R3-Reinsurance Credit Risk, the own company adjustment factors, loss sensitive contract discounts, the growth risk charge or the choice of 5% interest rate assumption in the investment income offset. The paper identifies potential biases in observed safety level due to the use of immature data in the analysis.

This is one of several papers being issued by the Risk-Based Capital (RBC) Dependencies and Calibration.

Keywords: Risk-Based Capital, Capital Requirements, Analyzing/Quantifying Risks, Assess/Prioritize Risks, Integrate Risks

1. Introduction and Findings

1.1 Background

The underwriting elements in the RBC Formula are not selected to achieve a particular total safety level. When the RRFs and PRFs, collectively underwriting (UW) risk factors, were updated by the NAIC in 2008, 2009 and 2010, those elements of the RBC Formula were selected to equal the 87.5th percentile of company-LOB data points in the ten accident years (AYs)/runoff years of data from the most recent Annual Statement, for all companies above a threshold size level, excluding anomalous data and subject to limits on fluctuations in risk factors from year to year.¹ These calibrations represent a VaR approach based on the frequency of company UW results above the VaR threshold levels used to establish the RBC Company Action Level.²

¹ American Academy of Actuaries, P/C Risk-Based Capital Working Group, “An Update to P/C Risk-Based Capital Underwriting Factors,” September 2007, page 6.

² The RBC Formula is used to produce several capital values such that if company capital falls below those levels company or regulatory action is triggered. The first trigger, corresponding the highest of those capital amounts, is called the Company Action Level. For more details, see the NAIC, “Risk-Based Capital Forecasting & Instructions,” Property Casualty, 2010. Our analysis of safety level is relative to Company Action Level of RBC.

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We assess the effect of that LOB-calibration on the broader RBC Formula considering other facets of the RBC Formula. In addition to the LOB risk factors we consider the premium concentration factor (PCF), the loss concentration factor (LCF) and the dependency between premium risk and reserve risk.

Moreover, in addition to considering the safety level based on the number of companies with underwriting variability below the Company Action Level RBC (Company View), we examine the safety level by summing the premiums plus reserves³ for companies with variability below that RBC level. This alternative approach gives more weight to large companies with more policyholders and claimants than does counting the number of companies. We refer to the premium + reserve basis as the Policyholder View of safety level.⁴ The distinction between number of policyholders/claimants and number of companies is important because, generally, larger LOBs have lower variability and achieve higher safety levels when risk charges do not vary by LOB-size.^{5,6}

We use 23 years of loss ratio experience, accident years 1988-2010, and 22 years of reserve runoffs from 1988-2009. We measure the achieved premium safety level as the percentage of Net Earned Premium or (NEP) for companies with loss and loss adjustment expense ratios (LRs) or AY underwriting results that are more favorable than the RBC UW factors. We measure the achieved reserve safety level as the percentage of reserves³ for companies with runoff results that are more favorable than the RBC UW factors.

1.2 Findings

1.2.1 Findings - Observed Safety Levels

We test how well the current UW risk factors stand up against the observed variability of company reserve development and accident year loss ratios observed in the prior 22 and 23 years respectively of experience within our data set at three levels of detail:

By LOBs,

All-lines reserve risk and premium risk separately, and

All-lines premium and reserve risks combined.

Table 1.1 below shows that for all-lines premium and reserve risk combined, the 2010 RBC Formula produces a safety level of 91.2%⁷. By this we mean that 91.2% of NEP plus reserves³ from

³ Reserves here include A&O

⁴ We recognize that premium and claim reserves reflect many variables in addition to the number of policyholders and claimants. Nonetheless, we believe the reference is a useful contrast to the alternative Company View.

⁵ DCWP Report 6 pages 21-25 and 60-64 and Report 7 pages 25-30 and 60-66, regarding premium risk and reserve risk by LOB-size, respectively.

⁶ This issue affects Solvency II calibrations as discussed in EIOPA, "Calibration of the Premium and reserve risk Factors in the Standard Formula of Solvency II, Report of the Joint Working Group on Non-Life and Health NSLT Calibration, pg. 31-33 and 57-58.

⁷ Before adjustment for maturity issues discussed below.

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company/year combinations that have an observed risk from NEP and reserves that is less than the risk determined from the RBC Formula for premiums and reserves³.

Looking at reserve risk alone for all lines combined, 91.1% of reserves³ are from company/year combinations that have an observed risk that is less than the reserve risk determined from the RBC Formula. Looking at premium risk alone, 90.5% of NEP is from company/year combinations that have an observed risk that is less than the premium risk from the RBC Formula.

**Table 1.1
Reserve and Premium Safety Levels**

Risk	Safety Levels ⁸	Basis
Reserve	91.1%	Percentage of reserve including A&O
Premium	90.5%	Percentage of NEP
Premium & Reserve Combined	91.2%	Percentage of NEP and reserve including A&O

1.2.2 Findings - Maturity Effect

DCWP Reports 6 and 7 show that the least mature data points indicate low PRF and RRF values that develop upward at later maturities, and, therefore that the use of the least mature data might understate the risk factors.⁹

We test the potential impact of that finding on the observed safety level. To do so we repeat the analysis excluding the least mature data points. We find that removing the four least mature years from the data history for premium and reserves reduces the safety level from 91.2% to 88.6%.¹⁰

**Table 1.2
Effect of Maturity Adjustment
Reserve and Premium Safety Levels Excluding Data with the Least 4 Mature Points¹¹**

Risk	Safety Level	Basis
Reserve	88.4%	Percentage of reserve including A&O
Premium	89.2%	Percentage of NEP
Premium & Reserve Combined	88.6%	Percentage of NEP and reserve including A&O

The decrease in safety level from Table 1.1 to Table 1.2 could be due, in part or in whole, to factors other than maturity. For example, our test excludes recent data that might be more favorable than the

⁸ Before adjustment for maturity issues discussed below.

⁹ DCWP Report 6 pages 25-30. DCWP Report 7 pages 30-34.

¹⁰ A portion of the decline relates to the difference in years included. A portion relates the maturity of the data points. It is beyond the scope of this paper to determine the portion related to maturity.

¹¹ For reserves this excludes data points with maturities of 24, 36, 48 and 60 months. For premiums this excludes data points with an AY maturity of 12, 24, 36 and 48 months.

long term history. Nonetheless, the observation supports the need for further research on the effect of maturity on risk factor calibration and back-testing.

1.2.4 Remainder of Report

In the remainder of this report:

- Section 2 provides more detail regarding our approach,
- Section 3 describes the safety level analyses by LOB,
- Section 4 describes the safety level analyses for all LOBs combined, separately for premium risk and reserve risk,
- Section 5 describes the safety level analysis for all LOBs combined, for combined premium and reserve risk,
- Section 6 presents further results on the impact of excluding the least mature years,
- Section 7 lists areas for further research, and
- Appendices A, B and C contain further information about our data and a number of sensitivity tests.

1.3 Terminology, Assumed Reader Background and Disclaimer

This paper assumes the reader is generally familiar with the property/casualty RBC Formula¹² and has a working knowledge of DCWP Reports 6 and 7.

In this paper, references to “we” and “our” refer to the principal authors of this paper. The “working party,” and “DCWP” refer to the RBC Dependencies and Calibration Working Party.

The analysis and opinions expressed in this report are solely those of the authors, and in particular are not those of the members’ employers, the Casualty Actuarial Society, or the American Academy of Actuaries.

DCWP makes no recommendations to the NAIC or any other body. DCWP material is for the information of CAS members, policy makers, actuaries and others who might make recommendations regarding the future of the P&C RBC Formula. In particular, we expect that the material will be used by the American Academy of Actuaries.

This paper is one of a series of articles prepared under the direction of the DCWP.

¹² For a detailed description of the formula and its basis, see Feldblum, Sholom, “NAIC Property/Casualty Insurance Company Risk-Based Capital Requirements,” *Proceedings of the Casualty Actuarial Society*, 1996 and NAIC, “Risk-Based Capital Forecasting & Instructions,” *Property Casualty*, 2010.

2. Approach

Our approach to measuring the implied safety level in the RBC Formula is as follows:

1. We obtain the observed Reserve Runoff Ratios (RRRs) and observed LR_s for each LOB/company/year from 1996-2010 Annual Statements as described in DCWP Reports 6 and 7.
2. We apply the RBC Formula to each LOB/company/year NEP and loss reserve and use the Company Action Level RBC as the predicted or modeled values of expected variability (or risk) for each LOB/company/year data point.
3. We interpret the observed RRRs and observed LR_s as reflecting the anticipated future distribution (or risk) of actual RRRs and LR_s.
4. We count the number of data points where the RRR or LR, respectively, do not exceed the modeled value. The proportion of data points with RRR or LR below the modeled value can be interpreted as a “per Company View” of the safety level for LOB risk factors.
5. We total the reserve or premium for the data points where the RRR or LR, respectively, do not exceed the modeled value. Summing the premiums plus reserves gives more weight to large companies with more policyholders and claimants than does counting the number of companies. We refer to the premium + reserve basis as the Policyholder View of safety level.¹³
6. We focus on the Policyholder View, rather than the Company View, in that this gives the security level on a “per policyholder basis” or “per claimant basis”.¹⁴ The “per policyholder/per claimant” safety level will tend to be higher than the per company safety level because larger LOBs tend to have less variation in experience than smaller LOBs, and larger LOBs have a high proportion of the policyholders/claimants.
7. We apply this approach for premium and reserve risk by LOB, for premium and reserve risks with all-lines combined, and for all-lines with premium and reserve risks combined.

2.1 Important Approximations/Simplifications

Several issues that are particularly important in interpreting the results of this paper are discussed below.

First, our analysis does not include all of the elements of the RBC Formula.

Within the premium and reserve risk calculations, we do not consider the effect on safety level from the following: (1) the own-company adjustment, (2) loss sensitive business discount, (3) the growth risk

¹³ We recognize that premium and claim reserves reflect many variables in addition to the number of policyholders and claimants. We believe the reference is a useful contrast to the alternative Company View.

¹⁴ The Solvency II “99.5%” safety level also considered both the company view and the policy view. Joint Working Group on Non-Life and Health NSLT Calibration, pg. 31-33 and 57-58.

charge (3) the choice of 5% interest rate assumption in the investment income offset, or (5) the portion of R3-Reinsurance Credit Risk associated with underwriting risk. We discuss the potential effect of these simplifications in Section 7, “Future Research”.

Second, the paper identifies potential size of biases in observed safety level due to the use of some immature data in the measurement of achieved safety level, but does not attempt to fully quantify that.

Third, we also do not test the R0, R1, R2 or R3 elements of the RBC Formula.

Fourth, the reliability of these estimates of safety levels depends on the extent to which there is enough data, both in number of data points and with respect to variability in economic and insurance market conditions. For example, the other liability LOB results for reserves are influenced by continuing adverse development of asbestos liabilities. To the extent that the severity and longevity of that source of claim development is not representative of the future, the data may understate the safety level for the other liability LOB. On the other hand, the adverse medical malpractice reinsurance experience of the 1970-1985 time period is not represented in the calibration data.

3. Safety Levels by LOB

The subsections below discuss modeled risk, observed risk and observed safety level, the key elements used in this analysis of the safety levels resulting from RRFs and PRFs by LOB.

3.1 Data

3.1.1 Data for Modeled Risk

The key elements in the modeled risk are the NEP and reserves³ used to calculate premium and reserve risk respectively. For each LOB/company/year that information is available in our risk data set.

We use the 2010 RBC PRF and RRF factors shown in Appendix A.

3.1.2 Data on Observed Risk

The observed RRRs and LRs are the LOB/Company/Year data points described in DCWP Reports 6 and 7.¹⁵

In brief, the RRR data consists of reserve runoff ratios for initial reserve dates 1988-2009. The ratios, net of reinsurance, are developed through the latest available maturity from Schedule P, Parts 2 and 3, in the 1997-2010 Annual Statements, by LOB and company for individual companies and DWCP-defined group pools, as indicated. Thus, each data point is the runoff ratio from a single reserve date and LOB for a single company or pool (LOB/company/year).

Similarly, the LR data consists of AYs 1988-2010 loss and loss adjustment expense ratios, net of

¹⁵ DCWP Report 6 pages 7-16. DCWP Report 7 pages 9-21.

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reinsurance, at the latest available maturity from Schedule P, Part 1, in the 1997-2010 Annual Statements, by LOB and by company for individual companies and DWCP-defined group pools, as indicated. Thus, each data point is a single AY and LOB for a single company or pool (LOB/company/year).

3.1.3 Selection of Data Points (Matching Year “Y-1” and Year “Y”)

To calculate observed and modeled premium and reserve risk, as we use those terms in this Report, we use Risk Data, as follows:

- Premium Risk:

For modeled premium risk, following the RBC Formula, we use NEP for year Y-1 as the base for premium risk as that is the base for premium risk arising from year Y.

For observed premium risk we use the LR¹⁶ and NEP for year Y as those represent the incurred loss that emerges in observed year Y.

For example, we use year 2000 NEP and PRF to predict observed 2001 NEP and LR.

- Reserve Risk:

For modeled reserve risk, following the RBC Formula, we use reserve for year Y-1 as that is base for reserve risk in the RBC Formula for year Y-1.

For observed reserve risk we use the RRR from year Y-1 and the initial reserve at year Y-1, as those represent the runoff in calendar year Y and subsequent on year Y-1 unpaid claims.

For example, we use year 2000 initial reserve and RRF to predict reserve runoff in 2001 and subsequent on claims unpaid at year end 2000.

- Combined Risk:

We use the data required for both premium risk and reserve.

Table 3-1 below summarizes the data requirements.

**Table 3-1
Data Required to Evaluate Modeled Risk vs. Observe Risk for Year Y¹⁷**

Premium Risk	Reserve Risk	Premium + Reserve Risk
NEP – Year Y-1	Initial reserve Year Y-1	NEP – Year Y-1
NEP – Year Y	RRR – Year Y-1	NEP – Year Y
LR – Year Y		LR – Year Y
		Initial reserve Year Y-1
		RRR – Year Y-1

¹⁶ The observed incurred losses and LAE for each LOB/Year/Company data point are at the most mature evaluation date available. For example, from the 2010 Annual Statement the 2002 AY would be evaluated at 9 years maturity, 2003 AY at 8 years of maturity and so on until 2010 at 1 year of maturity.

¹⁷ As explained below, for premium risk and combined premium and reserve risk we also use Company Expense Ratios (CERs) for Year Y-1 and Y.

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In some cases we have data required for premium, but we do not have data required for reserves, or conversely. In those cases we could do either the premium analysis or the reserve analysis, but we cannot do the combined premium + reserve analysis. However, while it is more stringent than necessary, we chose to do all the analyses using only the data points for which we have the data required for the premium + reserve analysis.¹⁸¹⁹

In the LOB analysis in this section we simplify the comparison. We use year Y data for both modeled and observed risk. With this simplification we remove the effect of year-to-year changes in premium levels and we thereby specifically test the model LR distribution against the actual LR distribution. This simplified approach corresponds to the way the PRFs are calibrated.

3.1.4 Approximations

In applying the portion of the RBC Formula that we analyze, we make two approximations:

1. For premium risk, the RBC Formula uses net written premium (NWP). We use NEP, which is more readily available. The effect of using NEP rather than NWP would tend to reduce the measure of actual risk, as NWP can vary more from year to year than is the case for NEP.
2. For reserve risk, the RBC Formula uses unpaid loss plus Defense and Cost Containment Expenses (DCC) plus Adjusting and Other expenses (A&O). Our observed data only includes loss plus DCC. We thus use loss + DCC reserves and apply a factor to approximate and include the A&O value. In Appendix B we discuss how we determined the A&O factors and its impact on the results.

3.2 Modeled Risk

The modeled risk in this analysis is the premium or reserve risk charge produced by the RBC Formula. We call these the Modeled Premium Risk (MPR_{LOB}) and Modeled Reserve Risk (MRR_{LOB}), respectively. These values are the 2010 PRF or RRF factors multiplied by the reserve or NEP for the LOB/company/year data points.

Specifically, the modeled risk values are calculated as follows:

$$MRR_{LOB,YEAR,COMPANY} = Reserve_{LOB,YEAR,COMPANY} * (1 + A\&O\%_{LOB,YEAR,COMPANY}) * RRF_{LOB}$$

$$MPR_{LOB,YEAR,COMPANY} = NEP_{LOB,YEAR,COMPANY} * PRF_{LOB}$$

¹⁸ Excluding the company/year combinations without a full match increases the premium safety level by 0.3% and the reserve safety level by less than 0.001%.

¹⁹ Note that in the section 3 LOB analysis we used premium or reserve data points regardless of whether there were corresponding reserve or premium data points, respectively, and regardless of whether we had data points for both the current and subsequent years.

3.3 Observed Risk

The observed risk is the distribution of reserve runoff and incurred losses by LOB/company/year. We call these the Observed Reserve Risk ($ORR_{LOB,YEAR,COMPANY}$) and the Observed Premium Risk ($OPR_{LOB,YEAR,COMPANY}$).²⁰

These calculations are as follows:

$$ORR_{LOB,YEAR,COMPANY} = RRR_{LOB,YEAR,COMPANY} * Reserve_{LOB,YEAR,COMPANY} * (1+A\&O\%_{LOB,YEAR,COMPANY})$$

$$OPR_{LOB,YEAR,COMPANY} = LR_{LOB,YEAR,COMPANY} * NEP_{LOB,YEAR,COMPANY}$$

3.4 Observed Safety Level

The observed safety level is the percentage of reserve³ (as opposed to data point counts) for which the $ORR_{LOB,YEAR,COMPANY}$ is less than the $MRR_{LOB,YEAR,COMPANY}$ or percentage of NEP for which the $OPR_{LOB,YEAR,COMPANY}$ is less than the $MPR_{LOB,YEAR,COMPANY}$ charge for that line of business.

For each LOB,

LOB Reserve Safety Level = (Sum of all reserves including A&O in data points for which $ORR_{LOB,YEAR,COMPANY} \leq MRR_{LOB,YEAR,COMPANY}$) divided by (Sum of all reserves including A&O)

LOB Premium Safety Level = (Sum of all NEP in data points for which

$OPR_{LOB,YEAR,COMPANY} \leq MPR_{LOB,YEAR,COMPANY}$) divided by (Sum of all NEP)

The results are shown in Table 3.2 below.

²⁰ The LRs are evaluated at the most recent evaluation within the data set for each LOB/Year/Company data point. For example, from the 2010 Annual Statement the 2002 AY would be evaluated at 9 years maturity, 2003 AY at 8 years of maturity and so on until 2010 at 1 year of maturity. Likewise the RRRs are evaluated at the most recent evaluation of incurred development for that LOB/Year/Company data point. For example, from the 2010 Annual Statement the 2002 AY evaluated at 9 years of maturity and so on until 2009 AY at 2 years of maturity.

Table 3.2
Summary of Observed Safety Levels by LOB

Line of Business	Reserve	Premium
Homeowners/Farmowners	94.9%	86.2%
Priv. Passenger auto Liability	97.0%	94.3%
Commercial Auto Liability	90.7%	90.4%
Workers Comp	91.6%	86.2%
Commercial Multi-Peril	93.8%	91.2%
Medical Mal – Occurrence	96.2%	95.0%
Medical Mal - Claims Made	94.2%	77.5%
Special Liability	86.1%	90.6%
Other Liability	81.5%	90.2%
Special Property	79.7%	92.3%
Auto Physical Damage	94.4%	91.6%
Fidelity & Surety	83.5%	91.9%
Other	83.2%	79.1%
International	77.4%	89.9%
Reinsurance A&C	89.3%	92.4%
Reinsurance B	89.5%	93.2%
Products Liability	72.4%	90.1%
Financial Guarantee	95.2%	90.6%
Warranty	84.7%	91.9%
All Lines*	91.1%	90.5%

*Note: The “All lines” value is calculated in Section 4.

In Table 3.2, we observe that even though the risk charges are intended to be calibrated to the 87.5th percentile safety level by LOB, for most lines, the calculated safety level is higher than 87.5%. This arises largely because the 87.5th percentile LR or RRR varies significantly by LOB-size.²¹

Tables 3.2A and 3.2B below show how the 87.5th percentile RRRs vary by LOB-size²² and how they compare to the overall 87.5th percentile for the Private Passenger Auto Liability (PPA) and Other Liability²³ (OL) LOBs. Each of the 11 horizontal bars represents a group of companies with LOB reserve-size within a size band. The height of the bar represents the 87.5th percentile RRR for LOBs within that LOB-reserve size band. The horizontal line represents the 87.5th percentile RRR for all

²¹ The differences between 87.5% and the observed safety levels by LOB might also arise if the PRFs and RRFs used in the RBC Formula were not consistent with the 87.5th percentile for the data used in this back-testing. To test for that possibility we calculate the PRFs and RRFs by LOB that would be indicated based on the data used in this back-testing. In Appendix D, Table D.1, we show that, even if using those indicated PRFs and RRFs, the patterns in observed safety levels by LOB are similar to the patterns in Table 3.1.

²² LOB sizes are expressed in bands: band 1= 0-15% smallest, band 2= 15%-25%, band 3 = 25-35%, ... band 9 = 85-95%, band 10 = 95%-100% less the 100 largest data points, band 11 is for the 100 largest data points, approximately 5 companies. The band percentiles are by number of companies and are not by reserve/premium size. The highest numbered band sizes contain the bulk of total reserve amounts and the bulk of total premium amounts. Size band 1 includes PPA reserves size of \$0 to \$0.8m. Size band 5, the median size band, covers PPA reserves sizes of \$7.4m to \$12.5m. Size bands 9 and 10, the largest 95% of reserve sizes covers reserves sizes of \$105m to \$17 billion. The band sizes are based on reserve for loss and DCC only. DCWP Report 7 page 60 and 62.

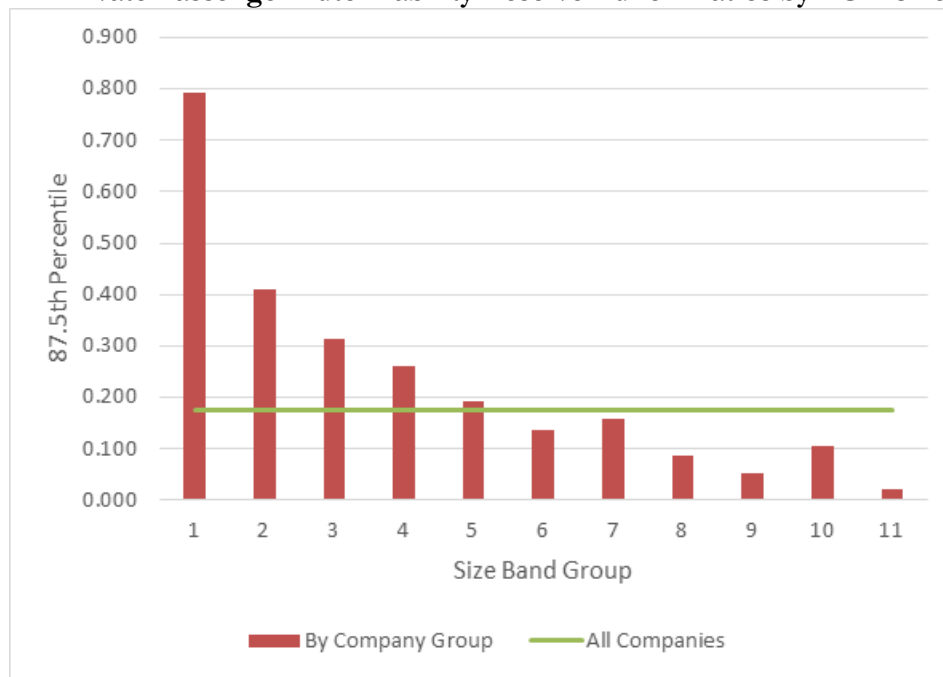
²³ Other Liability is a combination of data from the Other Liability Occurrence and Other Liability Claims Made lines

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companies except those below a selected minimum size threshold.²⁴

In table 3.2A we see that the 87.5th percentile RRFs for the largest LOB-sizes are the lowest, and, in particular, are lower than the combined all-size 87.5th percentile RRF. As the largest LOB-sizes contribute disproportionately to the total industry reserve dollars, the observed reserve safety level we calculated for this line is higher than the 87.5th percentile. The PPA pattern is directionally typical of many LOBs, although the magnitude of the decrease is more significant for PPA than for other LOBs.

Table 3.2A
Private Passenger Auto Liability Reserve Runoff Ratios by LOB-Size

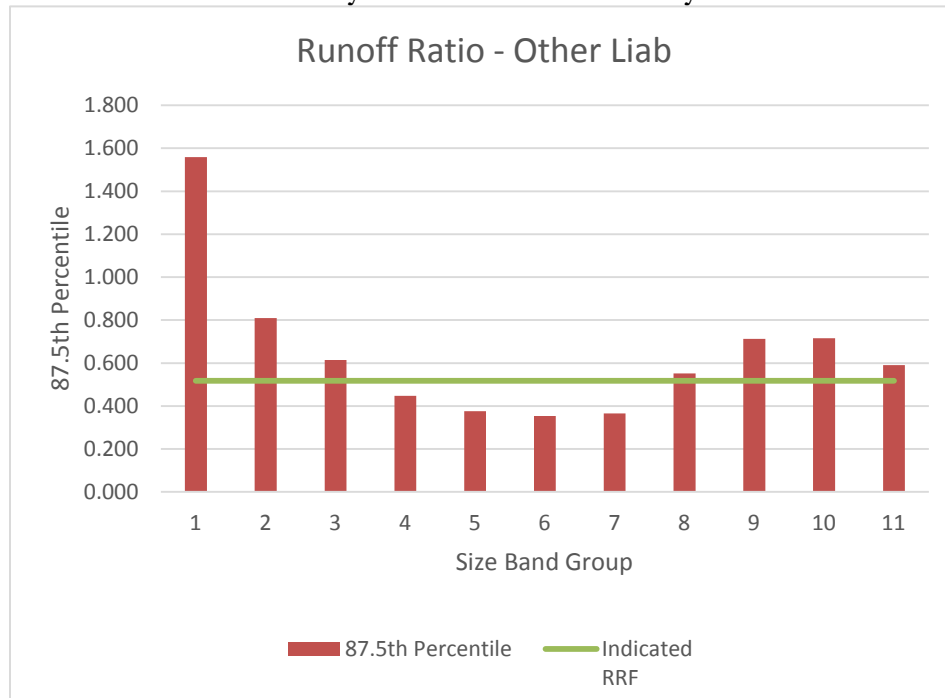


In table 3.2B we see a different pattern that applies to some lines, including the Other Liability LOB. For Other Liability the largest LOB-sizes have RRFs that are larger than the combined all-size indicated RRF. As the largest companies contribute disproportionately to overall reserve dollars, the observed reserve safety level we calculated for this line is lower than the 87.5th percentile. DCWP Reports 6 and 7 provide further detail on variation in indicated 87.5th percentile safety levels by LOB-size for all each of the LOBs.²⁵

²⁴ \$350k for PPA and \$1,250 for OL. Less than 25% of LOB data points are smaller than that.

²⁵ DCWP Report 6 pages 21-25 and 60-64 and Report 7 pages 25-30 and 60-66, regarding premium risk and reserve risk, respectively.

**Table 3.2B
Other Liability Reserve Runoff Ratios by LOB- Size**



4. Reserve and Premium Safety Levels for All Lines Combined

The subsections below discuss modeled risk, observed risk and observed safety level, the key elements used in our analysis of the all-lines combined reserve and all-lines combined premium risk safety levels.

4.1 Data

The required data for this analysis includes the LOB NEP and reserve³ amounts, and the LOB LRs and RRRs used in the previous sections.

In addition, we use investment income offsets (IIO's) by LOB, company expenses (all-lines, by company and year), and we calculate premium and reserve concentration factors (PCFs and LCFs) for each company/year combination.

4.1.1 IIO's

Although U.S. Statutory Accounting is based on loss reserves that are not discounted, the premium and reserve risk charges in the RBC Formula are reduced to the extent that future investment income on assets corresponding to unpaid claims and unearned premium is available to offset adverse outcomes. Specifically, the factor called the Investment Income Offset (IIO) in the RBC Formula serves to calculate the available investment income, and it is applied to produce a risk charge that is reduced accordingly. The IIO uses a 5% interest rate²⁶. IIOs vary by line of business based on the LOB payment patterns. We represent the Premium and Reserve IIOs by LOB as IIO_P_{LOB} and IIO_R_{LOB}, respectively.

In examining individual LOBs, in Section 3, we do not reflect the IIOs, as modeled and actual risk levels have the same IIOs. In combining LOBs, as we do in this section, we use IIO's by LOB to recognize that \$1 of adverse reserve development or underwriting loss in a short tail line has more impact on the financial condition of the company than \$1 of adverse development or underwriting loss in a long tail line. We use the 2010 IIO_P_{LOB}'s and 2010 IIO_R_{LOB}'s that are based on a 5% interest rate regardless of the AY or initial reserve date.

4.1.2 Company Expense Ratios (CER%s)

For all lines combined, we convert PRFs to Premium Risk Charges (PRCs) using all-lines company expenses to calculate the underwriting loss that would apply if the loss ratio were at the PRF level. The PRC equals the PRF plus CER% minus 100%. This is the underwriting loss produced by a loss ratio equal to the PRF.

Appendix B provides details on how we estimate the company expenses by company/year.

4.1.3 Concentration/Diversifications Factors

In the RBC Formula the reserve and premium LOB risk charges after discounting are combined using concentration factors. The degree of concentration for each company/year combination is measured by taking the largest LOB²⁷ NEP or reserve³, for premium risk and reserve risk, respectively, divided by the total NEP or reserve³. This ratio is 100% for mono-line companies. The ratio might be close to zero for highly diversified companies.²⁸ We refer to this method of measuring of concentration as the "Max Line%" approach.

The RBC Formula uses Max Line% and a maximum diversification credit of 30% to calculate PCFs and LCFs as follows:

²⁶ We do not test the effect that interest rates changing over time on the safety margin.

²⁷ In measuring premium and loss (reserve) concentration, the RBC Formula combines data for Other Liability Occurrence and Other Liability Claims Made and does the same for Product Liability.

²⁸ 0% concentration is not achievable, but premium or reserves equally spread among 17 LOBs would produce a concentration value of 1/19 or 5.9%.

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$$PCF_{YEAR,COMPANY} = 0.7 + 0.3 * \text{Max Line \% (NEP)}_{YEAR,COMPANY}$$

$$LCF_{YEAR,COMPANY} = 0.7 + 0.3 * \text{Max Line \% (reserves)}_{YEAR,COMPANY}$$

4.2 Modeled Risk

We calculate the modeled risk using the PRF and RRF values, PCF and LCF values, IIO_P and IIO_R values as discussed below.

4.2.1 Modeled Reserve Risk

For each LOB we calculate the model reserve risk ($MRR_{LOB,YEAR,COMPANY}$) using the LOB reserve, the $A\&O\%_{LOB,YEAR,COMPANY}$ RRF_{LOB} , and IIO_R_{LOB} . We combine these using the $LCF_{YEAR,COMPANY}$ as follows:

First we calculate the following for each LOB/company/year combination:

$$MRR_{LOB,YEAR,COMPANY} = ((RRF_{LOB} + 1) * IIO_R_{LOB} - 1.0) * \text{Reserve}_{LOB,YEAR,COMPANY} * (1 + A\&O\%_{LOB,YEAR,COMPANY})$$

Subject to the following condition:

$$\text{If } ((RRF_{LOB} + 1) * IIO_R_{LOB} - 1.0) < 0, \text{ then Reserve Risk}_{LOB,YEAR,COMPANY} = 0.0^{29}$$

Then, for each company/year combination, we calculate the $MRR^{All-Lines}_{YEAR,COMPANY}$ as follows:

$$MRR^{All-lines}_{YEAR,COMPANY} = \left[\sum (\text{over all LOBs}) \text{ of } MRR_{LOB,YEAR,COMPANY} \right] * LCF_{YEAR,COMPANY}$$

4.2.2 Modeled Premium Risk

For each LOB we calculate the model premium risk ($MPR_{LOB,YEAR,COMPANY}$) using the PRF_{LOB} , $NEP_{LOB,YEAR,COMPANY}$, IIO_P_{LOB} , and $CER\%_{YEAR,COMPANY}$.³⁰ We combine these using $PCF_{YEAR,COMPANY}$.

First, we calculate the following for each LOB/company/year combination:

$$MPR_{LOB,YEAR,COMPANY} = (PRF_{LOB} * IIO_P_{LOB} + CER\%_{YEAR,COMPANY} - 1.0) * NEP_{LOB,YEAR,COMPANY}$$

Subject to the following conditions:

$$\text{If } (PRF_{LOB} * IIO_P_{LOB} + CER\%_{YEAR,COMPANY} - 1.0) < 0, \text{ then (Premium risk)}_{LOB,YEAR,COMPANY}$$

$$= 0,$$

and

²⁹ This condition is always satisfied in our analysis. If the own-company or loss sensitive business discount were applied, the condition might affect the result for companies with favorable adjustments.

³⁰ Consistent with the RBC Formula, the all-lines company operating expense ratio is applied to each LOB. Therefore we have $CER\%$ rather than $CER\%_{LOB}$.

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If $CER\%_{YEAR,COMPANY} > 400\%$ then $CER\%_{YEAR,COMPANY} = 400\%$ ³¹

Then, for each company/year combination we calculate $MPR^{All-Lines}_{YEAR,COMPANY}$ as follows:

$$MPR^{All-lines}_{YEAR,COMPANY} = \sum (\text{over all LOBs}) \text{ of Modeled Premium Risk}_{LOB,YEAR,COMPANY}] * PCF_{YEAR,COMPANY}$$

4.3 Observed Risk

The observed risk is the distribution of all-lines reserve runoff and AY UW losses by company/year after reserve and premium adjustments for investment income.

4.3.1 Observed Reserve Risk

We calculate the actual all lines reserve risk charge $ORR^{All-Lines}_{YEAR,COMPANY}$ for each company/year combination as follows:

$$ORR^{All-lines}_{YEAR,COMPANY} = \sum (\text{over all LOBs}) \text{ of } [(1 + RRR_{LOB,YEAR,COMPANY}) * IIO_R_{LOB} - 1] * Reserve_{LOB,YEAR,COMPANY} * (1 + A\&O\%_{LOB,YEAR,COMPANY})]$$

4.3.2 Observed Premium Risk

We calculate the actual premium risk charge $OPR^{All-Lines}_{YEAR,COMPANY}$ for each company/year combination as follows:

$$OPR^{All-lines}_{YEAR,COMPANY} = \sum (\text{over all LOBs}) \text{ of } [LR_{LOB,YEAR,COMPANY} * IIO_P_{LOB} + CER\%_{YEAR,COMPANY} - 1.0] * NEP_{LOB,YEAR,COMPANY}]$$

Unlike the modeled premium risk, the CER% is not capped at 400% for the observed premium risk.

4.4 Observed Safety Level

We determine the observed safety level for reserve risk and premium risk as described below.

4.4.1 Reserve Safety Level

For each company/year combination, we compare the $ORR^{All-Lines}_{YEAR,COMPANY}$ to the $MRR^{All-Lines}_{YEAR,COMPANY}$. We calculate the industry reserve safety level as:

Reserve Safety Level = (Sum of all reserves including A&O in data points for which

³¹ The 400% limit is in the RBC Formula.

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$ORR^{All-lines}_{YEAR,COMPANY} \leq MRR^{All-lines}_{YEAR,COMPANY}$ divided by (Sum of all reserves including A&O)

4.4.2 Premium Safety Level

For each company/year combination, we compare the $OPR^{All-lines}_{YEAR,COMPANY}$ to the $MPR^{All-lines}_{YEAR-1,COMPANY}$. We calculate the industry premium safety level as:

Premium Safety Level = (Sum of all NEP in data points for which

$OPR^{All-lines}_{YEAR,COMPANY} \leq MPR^{All-lines}_{YEAR-1,COMPANY}$) divided by (Sum of all NEP)

4.4.3 Results

The results are shown in Table 4.1

Table 4.1
Safety Level for all-lines Premium and Reserve Risk

Risk	Safety Level	Basis
Reserve	91.1%	Percentage of reserve including A&O
Premium	90.5%	Percentage of NEP

5. Combined Premium + Reserve Safety Level

The subsections below discuss modeled risk, observed risk and observed safety level, the key elements used in the analysis of the combined premium + reserve (“Underwriting” or “UW”) safety level.

5.1 Modeled Risk

We described the separate all-lines premium and all-lines reserve modeled risk charges ($MRR^{All-lines}_{YEAR-1,COMPANY}$ and $MPR^{All-lines}_{YEAR-1,COMPANY}$) in section 4 above. The charges are combined with a square root rule to give the combined modeled UW risk:

$$MUWR^{All-lines}_{YEAR,COMPANY} = \text{Square Root } (MRR^{All-lines}_{YEAR-1,COMPANY}^2 + MPR^{All-lines}_{YEAR-1,COMPANY}^2)$$

Note that we use year Y-1 data to model the underwriting risk in year Y.

The square root rule reflects the RBC Formula assumption that premium risk and reserve risk are not correlated.

5.2 Observed Risk

The observed risk is the distribution of discounted all-lines reserve runoff plus the discounted all-lines accident year underwriting results by company/year, expressed as a dollar amount.

The accident year LR and RRRs in this analysis are constructed as discussed in Section 4. They are combined as follows:

$$\text{OUWR}^{\text{All-lines}}_{\text{YEAR,COMPANY}} = \text{ORR}^{\text{All-lines}}_{\text{YEAR-1,COMPANY}} + \text{OPR}^{\text{All-lines}}_{\text{YEAR,COMPANY}}$$

In the OUWR, the reserve runoff affecting year Y is the reserve runoff from year Y-1, hence the mixture of “Y” and “Y-1” in the OUWR formula above.

5.3 Observed Safety Level

The safety level for the combined is measured as the amount of NEP and reserves³ from the company/year combinations that have an $\text{OUWR}^{\text{All-lines}}_{\text{YEAR,COMPANY}} \leq \text{MUWR}^{\text{All-lines}}_{\text{YEAR,COMPANY}}$.

Table 5.1 shows the results for premium and reserve combined, comparing those to the separate premium and reserve results from Table 4.3.

Table 5.1
Summary of Reserve and Premium Safety Levels

Risk	Safety Level	Basis
Reserve	91.1%	Percentage of reserve including A&O
Premium	90.5%	Percentage of NEP
Premium & Reserve Combined	91.2%	Percentage of NEP and reserve including A&O

6. Impact of Maturity

DCWP Reports 6 and 7 show that the least mature data points indicate low PRF and RRF values that develop upward at later maturities, and therefore the use of the least mature data might understate the risk factors.

We test the potential impact of that observation on the achieved safety level. To do so we repeat the analysis, excluding the least mature LOB/company/year data points. As the less mature years are excluded the combined level safety decreases, as we show in Table 6.1.

Table 6.1
Impact on Safety Level of Excluding Least Mature Years

Maturities Excluded	Combined Risk as % NEP & Reserves including A&O	Premium Risk as % NEP	Reserve Risk as % Reserves Including A&O
None	91.2%	90.5%	91.1%
Least Mature Year	90.6%	90.6%	90.6%
Least Two Mature Years	90.0%	90.2%	89.9%
Least Three Mature Years	89.4%	89.9%	89.3%
Least Four Mature Years	88.6%	89.2%	88.4%

The decrease in safety level shown in Table 6.1 could be due, in part or in whole, to factors other than maturity. For example, our test excludes recent data that might be more favorable than the long term history. Nonetheless, the observed decreases in indicated safety level support the need for further research on the effect of maturity on risk factor calibration and back-testing.

7. Further Research

The observed safety level measured in our analysis would be affected if we had considered additional elements of the RBC Formula. Those areas are outlined below.

7.1 IIO

We did not test the 5% interest rate assumption used in the Investment Income Offset. As interest rates have declined over the course of the 24 year period, the safety level at current interest rates is likely lower than shown, if all else were constant. Evaluating the investment income impact is a matter for further research.

7.2 R3-Reinsurance Credit Risk

The RBC Formula includes a 10% charge on reinsurance balances receivable³² on reinsurance ceded to non-Affiliates less any applicable reinsurance penalty. This charge is referred to as R3-Reinsurance Credit Risk. In most cases,³³ half of the 10% charge is included with R4, reserve risk and half is included in R3, credit risk.

³² Reinsurance balances receivable includes any amounts due on paid and unpaid, plus unearned premiums. The 10% charge does not apply to reinsurance with U.S affiliates, State Mandated Involuntary Pools and associations or to Federal insurance programs.

³³ If R4-reserve risk (loss portion only) is less than the sum of half of the R3-Reinsurance credit risk and other Credit Risk, then R3-Reinsurance Credit Risk is included fully in the credit risk category. If it's more than, then half the R3-Reinsurance Credit Risk is included in the R4 reserve risk.

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The R3-Reinsurance Credit Risk includes an (unspecified) element for the expectation that overall underwriting risk is higher for companies that use higher amounts of reinsurance.³⁴ That portion of R3-Reinsurance Credit Risk is realized in the observed reserve and premium risks, ORR and OPR.

Since the observed risk is part of the data, it would be reasonable to include the related portion of the modeled R3-Reinsurance Credit Risk in the analysis. If we had done so, modeled risk value, MUWR, would have been higher and the safety level would be higher than shown, if all else were constant.

We did not include the R3 consideration at this point, but should be considered in further research.

7.3 Other Elements of RBC Formula

Other elements of the RBC Formula that are not reflected in our analysis of observed safety level are:

- Own-company adjustment - This is the ratio of Company Development to Industry Development for reserves and Company Loss and Expense ratio to Industry Loss Ratios for premium, shown on Line 3 of RBC forms PR016 and PR017 for reserves and premium respectively. Directionally, the effect of including the own-company adjustment factors is uncertain. On one hand, we would expect that including the own-company adjustment factors might increase the apparent safety level, as the worse performing companies would have higher risk charges than assumed in our tests. On the other hand, larger companies, with lower indicated risk, might have favorable own-company adjustments that would lower the apparent safety level.
- Loss sensitive contract discount - The RBC Formula allows a 30% discount in risk charge for loss sensitive business written directly and a 15% discount in risk charge is allowed for business assumed. No allowance has been made for loss sensitive business in our calculation.
- Growth risk charge - The RBC Formula includes an increase in premium and risk charges for companies with three year average growth rates in excess of 10%. The magnitude of the increase in risk charges depends on the difference between the growth rate and the 10% threshold level. Directionally, including the effects of the growth rate would increase the modeled risk with no change in the observed risk. Therefore, the observed safety level would be higher than shown, if all else were constant.
- NEP and NWP - We use NEP rather than NWP in both the modeled risk calculation and the observed risk calculation because historical NEP by schedule P is available in our Risk Data and NWP is not. This simplification is applied in both modeled risk and observed risk. The simplification affects the results to the extent that the year-to-year change in NEP is different

³⁴ American Academy of Actuaries, P&C Risk Based Capital Committee, "Report on Reinsurance Credit Risk charge in the NAIC Property/Casualty Risk-Based Capital," March 29, 2013.

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from the year-to-year change in NWP and to the extent that the reserves-to-NEP differs from reserves to NWP.

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9. GLOSSARY

Term	Interpretation
A&O	Adjusting and Other Expense; a part of LAE
A&O%	Adjusting and Other Expense % that is applied to Loss and DCC reserves
AY	Accident year
CER%	Company underwriting expense ratio as specified by company within the RBC Formula
DCC or DCCE	Defense and cost containment expenses; a part of LAE
DCWP	Dependency and Calibration Working Party
IIO	Generic for IIO_P or IIO_R
IIO_P	Premium investment income offset from 2010 RBC Formula
IIO_R	Reserve investment income offset from 2010 RBC Formula
LAE	Loss adjustment expenses
LCF	Reserve Concentration Factor as calculated in 2010 RBC Formula
LOB	Schedule P Lines of Business
LOB-size	Line of business size based on NEP or Initial Reserve, as appropriate.
LR	AY Loss and LAE ratios
MPR	Modeled Premium Risk – See sections 3 & 4 for definitions.
MRR	Modeled Reserve Risk – See sections 3 & 4 for definitions.
MUWR	Modeled Underwriting Risk – See section 5.1
NEP	Net Earned Premium
NWP	Net Written Premium
OPR	Observed Premium Risk – See sections 3 and 4 for definitions
ORR	Observed Reserve Risk – See sections 3 and 4 for definitions
OUWR	Observed Underwriting Risk – See section 5.2
PCF	Premium Concentration Factor as calculated in 2010 RBC Formula
PPA	Private Passenger Auto Liability
PRF	Premium Risk Factor from 2010 RBC Formula
R ₀	Asset Risk – Insurance affiliate investment and (non-derivative) off-balance sheet risk.
R ₁	Asset Risk – Fixed Income Investments
R ₂	Asset Risk – Equity
R3-Reinsurance Credit Risk	The portion of R3-Credit Risk applicable to ceded reinsurance balances
RBC Formula	The 2010 NAIC RBC Formula
Initial Reserve Date or Reserve Date	Each year-end in our data set, December 31, 1987 through December 31, 2010
Reserves or Loss Reserves	Case, bulk and IBNR loss and defense and cost containment expense (DCCE) ³⁵ reserves net of reinsurance, as shown in Schedule P – Part 2 and 3 for current AY and all prior AYs; Reserves include or exclude A&O as indicated.
RRF	Reserve Risk Factor from the 2010 RBC Formula

³⁵ “Defense and Cost Containment Expenses” are called “Allocated Loss Adjustment Expenses” (ALAE) in older Annual Statements. In our analysis we treat DCCE and ALAE as equivalent.

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Term	Interpretation
RRR	Runoff ratio or Reserve Runoff Ratio The ratio of: (a) the incurred movement from the initial reserve date to the latest available evaluation date, for all constituent AYs combined to b) the Initial Reserve
TVaR	Tail Value at Risk
UW	Underwriting, the combination of AY results and development on prior year reserves
VaR	Value At Risk

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Appendix A

A.1 Risk and IIO Factors

LOB	2010 RBC Factors				DCWP Indicated ³⁶	
	Reserves		Premium		Reserves	Premiums
	RRF	IIO_R	PRF	IIO_P	RRF	PRF
Homeowners/Farmowners	0.201	0.938	0.937	0.954	0.201	0.958
Priv. Passenger Auto Liability	0.192	0.928	0.969	0.925	0.156	0.984
Commercial Auto Liability	0.230	0.911	0.988	0.890	0.320	1.001
Workers' Comp	0.324	0.830	1.033	0.839	0.336	1.053
Commercial Multi-Peril	0.465	0.876	0.921	0.896	0.462	0.897
Medical Mal – Occurrence	0.431	0.865	1.822	0.767	0.314	1.512
Medical Mal – Claims Made	0.306	0.883	1.092	0.827	0.106	1.203
Special Liability	0.257	0.890	0.904	0.898	0.449	0.963
Other Liability	0.511	0.852	1.042	0.816	0.518	1.038
Special Property	0.191	0.966	0.941	0.949	0.311	0.830
Auto Physical Damage	0.112	0.976	0.843	0.971	0.165	0.855
Fidelity & Surety	0.325	0.940	0.883	0.904	0.612	0.674
Other	0.172	0.967	0.893	0.947	0.271	0.941
International	0.327	0.874	1.169	0.905	0.490	0.832
Reinsurance Prop and Financial	0.286	0.901	1.349	0.893	0.422	1.290
Reinsurance B	0.769	0.838	1.507	0.777	0.657	1.328
Products Liability	0.643	0.841	1.214	0.774	0.894	1.196
Financial Guarantee	0.200	0.926	1.482	0.884	0.000 ³⁷	1.553
Warranty	0.325	0.940	0.883	0.904	0.032 ³⁷	1.238

³⁶ 87.5th percentile LR or RRR, as appropriate, for all data points in the risk data excluding the smallest data points. The smallest data points are defined as those having premium or reserve amounts below a threshold level that varies from \$1m to \$100k by LOB (threshold values listed in Reports 6 and 7).

³⁷ The indicated values for Financial Guarantee and Warranty are lower than would be used in practice. If higher RRFs were used in practice, the observed safety level would be higher than indicated using these values.

Appendix B

Operating Expense / Adjusting and Other Expenses

B.1 Company Expense Ratios – Premium Risk

To calculate the MPR and OPR we need all-lines company/year expense ratios. We obtain this information from industry databases for the years 1996 – 2010. The data is on an individual company basis and we combine companies into DCWP-defined pools when necessary³⁸. For years 1995 and prior, we used the NWP weighted average of the calendar years 1998-1996. For company/year combinations for which no expense ratio information was available we used the industry premium weighted average for that year. In accordance with the RBC Formula, where the company CER% was greater than 400%, the MPR is based on 400%. The OPR is based on actual expenses, without limit.

B.2 Adjusting and Other Expenses (A&O) – Reserve Risk

The RBC Formula applies RRF to losses including A&O. Our data, however, is from, Schedule P Parts 2 and 3, which do not include A&O. That feature of the data would not affect our analysis if A&O were a constant percentage of loss plus DCC for all companies, all LOBs and at all stages of maturity. As that is not the case, for our back testing we include A&O to the extent possible. We consider three issues:

1. A&O% can vary as losses develop.
2. A&O% can be higher on data points with RRRs that are higher than average and lower on data points with RRRs that are lower than average.
3. A&O% varies by LOB.

The implication of these issues is discussed below.

B.2.1 - A&O% can develop

The A&O% used to calculate the MRR is not necessarily the same as the A&O% used to calculate the ORR. The A&O% used in the MRR should be the A&O% at the initial reserve date. The A&O% used in the ORR should be the A&O% for the developed reserves. To the extent that A&O develops differently than loss plus DCC, the A&O% for developed reserves will not be the same as the A&O% in the initial reserve.

As the developed A&O is not available in Schedule P, Parts 2 and 3, we assume the ratio for the developed data is the same as the ratio at the initial reserve date, i.e., A&O development is proportional to loss and DCC development and the A&O% for the initial reserve is the same as the A&O% for the ultimate reserve.³⁹ However, we cannot test this assumption without comparing multiple annual

³⁸ Pooling Adjustment - We pool participants as described in Appendix G of DWP paper 6. The NWP for the pooled entity is the sum of the premium for all pool members. The expense ratio for the pooled entity is the weighted average of the expense ratios for the individual pool members, weighted by NWP.

³⁹ RRFs are calibrated on the assumption that A&O develops at the same rate as loss plus DCC.

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statements, and we did not do that for this study.

B.2.2 - A&O% can be higher on ‘unfavorable’ data points than on ‘favorable’ data points

Assuming that the A&O% does not develop, then for the calculation of safety levels by LOB, the A&O% equally affects the modeled and actual results by LOB and would not impact whether the actual result exceeded the modeled result and therefore would not affect the company view of safety level.

However, if A&O% is higher for companies with unfavorable RRRs than is the case for companies with more favorable RRRs, then the portion of reserve including A&O from companies above the safety level would be higher than would appear to be the case for reserves excluding A&O. We address that by calculating an A&O% for each company.

Table B.1 below shows that there is only a small effect from using the A&O adjustment in the calculations of individual LOB safety levels. Column 2 shows the safety levels by LOB from Table 3.1. Column 3 shows the safety levels that would have been produced if we had not made the A&O adjustment.

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**Table B1
Reserve LOB Safety Levels**

(1)	(2)	(3)
Line of Business	Base Analysis	No A&O Adj
Homeowners/Farmowners	94.9%	94.9%
Priv. Passenger Auto Liability	97.0%	96.9%
Commercial Auto Liability	90.7%	90.7%
Workers' Comp	91.6%	91.6%
Commercial Multi-Peril	93.8%	93.7%
Medical Mal – Occurrence	96.2%	96.2%
Medical Mal – Claims Made	94.2%	94.1%
Special Liability	86.1%	86.1%
Other Liability	81.5%	81.4%
Special Property	79.7%	79.7%
Auto Physical Damage	94.4%	93.5%
Fidelity & Surety	83.5%	83.6%
Other	83.2%	83.1%
International	77.4%	77.5%
Reinsurance A&C	89.3%	89.3%
Reinsurance B	89.5%	89.5%
Products Liability	72.4%	72.2%
Financial Guarantee	95.2%	95.2%
Warranty	84.7%	84.7%
All Lines	90.1%	90.0%

Column (2) From Table 3.2 except for All Lines.

All lines row is the weighted average or safety level from all-lines data points

B.2.3 - A&O varies by LOB

Third, for the calculation of safety levels for all lines combined, the A&O% affects the observed safety level to the extent that A&O% varies by LOB.

We apply the A&O adjustment by LOB.

B.2.4 - LR Data Points

We make no A&O adjustment to the LR points as the LRs we obtain from Schedule P Part 1 include A&O.

Safety levels of PRFs and RRFs In NAIC Formula (Report 11)

B.2.5 - Calculating the A&O%

To determine an A&O% for LOB/company/year combination we extract the following data by calendar year from industry databases for calendar years 1997-2010:

1. A&O
2. Direct and Assumed Loss and all LAE
3. Ceded Loss and all LAE

We calculate:

4. $A\&O\% = (1) / [(2)-(3)-(1)]$

The data is on an individual company basis and we combine it as necessary for DCWP-defined pools⁴⁰. We select A&O% for years prior to 1997⁴¹ and company/year combinations where no expense ratio was available as follows:

- For years 1996 and prior we use the reserve weighted average of the years 1997-1999.
- For LOB/company/year combinations where no data was available we use the industry average for that Year/LOB combination.

For all years we apply the following filters:

- If $A\&O \leq 0$, we set A&O to be \$0
- If $A\&O \% > 2 * \text{Industry } A\&O\%$, we set $A\&O \% = \text{Industry } A\&O \%$ for that LOB.

⁴⁰ The A&O percentage for the pooled entity is the weighted average of the A&O percentage for the individual pool members, weighted by reserve.

⁴¹ Data was available back to 1996, but we extracted data beginning with 1997.

Appendix C

Sensitivity Testing

In this section we discuss certain aspects of the Risk Data and the effect on the safety level calculations.

C.1 LOB Risk Data – All Data vis-à-vis Calibration Data

In all cases we begin with the LOB Risk Data:

- The premium file contains 157,622 LOB/company/year data records.
- The reserve file contains 128,439 LOB/company/year data records.

These are all data points other than those with anomalous values and after consolidating pools into a single data point.

In Reports 6 and 7 we discuss calibration of LOB risk factors using a subset of the data that excludes (a) new-LOBs (with NEP for less than 5 years) and (b) minor lines (LOB containing less than 5% of the company total business). That data set consists of the following:

- The premium file contains 86,861 LOB/company/year data records.
- The reserve file contains 71,352 LOB/company/year data records.

Table 3.1 showed the LOB safety levels based on the larger data set. Table C.1 below shows the LOB safety levels based on the Report 6 and 7 calibration data. Columns (3) and (5), compared to columns (2) and (4) show that the safety levels are in general higher using the calibration data than all the data. This would be expected as the filters were designed to remove the volatile points.

Safety levels of PRFs and RRFs In NAIC Formula (Report 11)

Table C.1
LOB Safety Levels – All Data vs. Calibration Data

(1)	Reserve Risk		Premium Risk	
	(2)	(3)	(4)	(5)
Line of Business	All Data	Calibration Data	All Data	Calibration Data
Homeowners/Farmowners	94.9%	95.5%	86.2%	86.2%
Priv. Passenger Auto Liability	96.9%	97.4%	94.3%	94.4%
Commercial Auto Liability	90.7%	92.6%	90.4%	90.6%
Workers' Comp	91.6%	91.7%	86.2%	86.0%
Commercial Multi-Peril	93.7%	94.2%	91.2%	92.1%
Medical Mal – Occurrence	96.2%	98.0%	95.0%	96.5%
Medical Mal – Claims Made	94.1%	97.1%	77.5%	79.2%
Special Liability	86.1%	87.5%	90.6%	91.0%
Other Liability	81.4%	81.4%	90.2%	90.1%
Special Property	79.7%	79.5%	92.3%	92.7%
Auto Physical Damage	93.5%	95.4%	91.6%	91.6%
Fidelity & Surety	83.6%	89.3%	91.9%	97.7%
Other	83.1%	78.3%	79.1%	80.8%
International	77.5%	92.1%	89.9%	93.7%
Reinsurance A&C	89.3%	91.5%	92.4%	93.9%
Reinsurance B	89.5%	91.1%	93.2%	94.4%
Products Liability	72.2%	90.2%	90.1%	92.5%
Financial Guarantee	95.2%	97.5%	90.6%	85.7%
Warranty	84.7%	100.0%	91.9%	93.9%
All Lines	90.0%	91.2%	90.3%	90.6%

All lines row is the weighted average or safety level from all-lines data points. The values in Table 4.1 differ from the total row in the above Table. The total values in Table C.1 above represent the weighted average of the LOB safety levels. The Table 4.1 values represent the safety level when all lines are combined into a single modeled or observed risk data point for company/year combinations.

The values in columns (2) and (3) are calculated excluding the A&O adjustment. Column (2) is from Table B1 column (3)

C.2 All Lines Risk Data:

We use the larger data set to construct all-lines risk data points for each company/year combination. Each all-lines data point is the weighted average of LOB data points.

- For reserve risk, there are 31,949 all-lines company/year combinations for calculating the all-lines company/year Actual Reserve Runoff.
- For premium risk, there are 35,750 all-lines company/year combinations for calculating the all-lines company/year Loss Ratios.
- For premium and reserve risk combined there are a total of 39,544 unique all-lines company/year combinations. This count is greater than either the number of premium all-lines data points or the number of reserve all-lines data points because some combinations have premium data points only and some combination have reserve risk data points only.

Our all-lines premium, reserve and combined premium+reserve safety level analysis uses four key elements MRR_{year-1} , MPR_{year-1} , OPR_{year} and ORR_{year-1} . We use only those where all the components exist. Of the 39,544 unique company/year combinations there are 30,292 company/year combinations where all four data points exist. The other combinations are:

- 2,644 company/year combinations where OPR_{year} exists but MRR_{year-1} , MPR_{year-1} , and ORR_{year-1} do not exist (i.e. year exists in the premium data file but the year y-1 is not in the reserve or premium data files).
- 4,961 company/year combinations where MPR_{year-1} exists but the MRR_{year-1} and ORR_{year-1} do not exist (i.e. year y-1 exists in the premium data file but the year y-1 is not in the reserve data file).
- 1,160 company/year combinations where MRR_{year-1} and ORR_{year-1} exist but the MPR_{year-1} does not exist (i.e. year y-1 exists in the reserve data file but the year y-1 is not in the premium data file).
- 497 company/year combinations where MRR_{year-1} and ORR_{year-1} exist but the OPR_{year} does not exist (i.e. year y-1 exists in the reserve data file but the year is not in the premium data file).

Table C.2 shows the differences in calculated safety level between using the 30,292 data set and the 39,544 data set and a number of intermediate sized data sets. It shows that the combined safety level is slightly higher, 91.17%, using company/years with all data points, compared to 91.01% when we include all unique company/year combinations available regardless of if all data points exist. Thus, the impact of excluding data from the combined safety level is minor, less than 0.2%.

Safety levels of PRFs and RRFs In NAIC Formula (Report 11)

For the premium risk alone, the difference in safety level is slightly higher, 0.34% (90.47% compared to 90.12%).

For the reserve risk alone, the difference in safety level is minor, less than 0.0001% difference.

Table C.2
Comparison of Analyses Using Different Company/Year Combinations

	Number CO/YRs	Combined Safety Level	Premiums Safety Level	Reserves Safety Level	Reserve \$millions	NEP \$millions
(A)	30,292	91.17%	90.47%	91.15%	9,194,901	7,044,283
(A) - (B)		0.163%	0.344%	0.000%	-30,182	-265,131
(B)	39,554	91.01%	90.12%	91.15%	9,225,084	7,309,414
(C)	36,910	91.12%	90.35%	91.15%	9,225,084	7,096,628
(C) - (B)	2,644	0.108%	0.222%	0.000%	0	-212,786
(D)	31,949	91.17%	90.46%	91.15%	9,225,084	7,046,155
(D) - (C)	4,961	0.053%	0.117%	0.000%	0	-50,473
(E)	30,789	91.18%	90.47%	91.15%	9,206,799	7,044,283
(E) - (D)	1,160	0.004%	0.004%	0.003%	-18,284	-1,872
(F)	30,292	91.17%	90.47%	91.15%	9,194,901	7,044,283
(F) - (E)	497	0.00%	0.000%	-0.003%	-11,898	0

Notes to Table C.2

(A)	Only used company/year combinations where we have a full set of data - i.e. company/year (x) combination (ORR, MRR, MPR) exists in both the reserve and premium file and the company/year (x+1) exists in the premium file (OPR)
(B)	Use all company/year combinations that exist.
(C)	Exclude 2,644 company/year combinations where year x+1 in premium (OPR) but year x not in reserve (ORR, MRR) or premium file (MPR)
(D)	Exclude 4,961 company/year combinations where year x in premium (MPR) but not in reserve (ORR, MRR)
E	Exclude 1,160 company/year combinations where year x in reserve (ORR, MRR) but not in premium (MPR)
F	Exclude 497 company/year combinations remaining where no year x+1 in premium (OPR)

C.3 Measuring Safety Level Based on Premium

We measure premium safety level based on NEP, reserves safety level based on reserves including A&O, and combined premium + reserves safety level based on combined NEP and reserves including A&O.

We considered evaluating safety level based on NEP in all cases. That would require matching each reserve data point to a corresponding premium data point, e.g., AY 1990 premium and 1990 reserves.

However, we found a premium match for only 89% of reserve entries. The unmatched entries are due to factors including:

- Some reserve data points (e.g., runoff companies) have no corresponding premium, and
- Some data was eliminated by our filtering of exceptional values.

Rather than removing about 10% of our data due to unmatched entries we decided to measure the safety levels of the reserves using reserve data.

Table C.3 below summarizes the match by line of business.

Table C.3
Matching Premium and Reserve Records

LOB	NEP (Premium File) \$000	Number Premium Entries	Reserves \$000	Number Reserve Entries	Matched NEP from Premium file to Reserve File \$000	Number Unmatched Reserve Entries	% of Reserve Entries Unmatched
Homeowners/Farmowners	837,779,469	14,388	283,743,839	12,890	752,237,134	849	7%
Priv. Passenger Auto Liability	1,665,757,585	12,648	1,484,867,521	11,825	1,557,250,433	1,059	9%
Commercial Auto Liability	339,751,660	12,563	475,364,115	11,725	318,861,103	1,059	9%
Workers' Compensation	850,602,677	10,752	2,285,323,369	10,767	799,713,126	1,642	15%
Commercial Multi-Peril	514,883,064	12,988	606,805,258	12,011	479,399,100	1,179	10%
Medical Mal - Occurrence	45,844,899	3,463	251,165,745	3,922	40,187,542	1,191	30%
Medical Mal - Claims made	113,039,619	4,224	279,537,964	3,695	101,607,051	334	9%
Special Liability	100,242,320	5,045	93,242,192	4,559	92,159,493	804	18%
Other Liability	605,485,345	20,790	1,607,856,355	17,557	552,581,070	1,462	8%
Special Property	433,757,648	17,081	114,752,709	10,970	326,843,828	494	5%
Auto Physical Damage	1,165,687,705	15,040	63,696,563	6,759	540,233,500	311	5%
Fidelity & Surety	90,811,841	7,517	31,768,591	3,505	62,741,739	234	7%
Other	200,447,319	5,294	46,788,712	3,758	126,916,957	870	23%
International	7,409,062	659	11,818,154	785	5,883,989	316	40%
Reinsurance A&C	98,929,534	4,179	124,874,904	3,659	87,561,671	627	17%
Reinsurance B	178,061,703	4,046	713,338,940	4,537	159,822,581	1,383	30%
Products Liability	53,086,437	6,195	255,964,385	5,235	49,081,648	732	14%
Financial Guarantee	1,972,460	540	847,662	211	554,636	38	18%
Warranty	5,863,372	210	318,810	69	1,090,852	25	36%
All Lines	7,309,413,719	157,622	8,732,075,788	128,439	6,054,727,453	14,609	11%

APPENDIX D

Sensitivity Tests

D.1 Safety Level with 2010 Risk Factors vs. Safety Level with Indicated Risk Factors

In Table 3.2, we observed that differences between the observed safety levels by LOB and 87.5% might arise if the PRFs and RRFs used in the 2010 RBC Formula were not consistent with the 87.5th percentile for the data used in this back-testing. To test for that possibility we calculate the PRFs and RRFs by LOB that would be indicated based on the data used in this back-testing. Table D.1 shows that, even if using those indicated PRFs and RRFs, the patterns in observed safety levels by LOB are similar to the patterns in Table 3.2.

The indicated factors for this purpose are the 87.5th percentile LR and RRR by company count based on the current data using the work completed in DCWP Reports 6 and 7.⁴²

Table D.1 Column (2) repeats the results from Table 3.2 and Column (4) from Table C1 Column (4) (which is Table 3.2 re-calculated with no A&O adjustment)... Columns (3) and (5), compared to columns (2) and (4), show that the safety levels are only slightly higher overall, with no consistent pattern across LOBs.

⁴² Indicated risk factors are shown in Appendix A. These are the 87.5th percentile LR or RRR, as appropriate, for all data points in the risk data excluding the smallest data points. The smallest data points are defined as those having premium or reserve amounts below a threshold level that varies from \$1m to \$100k by LOB (threshold values listed in Reports 6 and 7).

Safety levels of PRFs and RRFs In NAIC Formula (Report 11)

Table D.1
Premium Equivalent Safety level of 2010 and Indicated Risk Factors⁴³

(1)	Safety Level in Premium Risk Factors		Safety Level in Reserve Risk Factors	
	(2)	(3)	(4)	(5)
	2010 Factors	Indicated Factors	2010 Factors	Indicated Factors
Homeowners/Farmowners	86.2%	89.0%	94.9%	92.4%
Priv. Passenger Auto Liability	94.3%	97.1%	96.9%	96.3%
Commercial Auto Liability	90.4%	91.6%	90.7%	94.6%
Workers' Comp	86.2%	87.0%	91.6%	92.7%
Commercial Multi-Peril	91.2%	89.0%	93.7%	94.3%
Medical Mal – Occurrence	95.0%	87.9%	96.2%	95.0%
Medical Mal – Claims Made	77.5%	84.0%	94.1%	87.8%
Special Liability	90.6%	92.9%	86.1%	93.0%
Other Liability	90.2%	89.2%	81.4%	82.8%
Special Property	92.3%	86.1%	79.7%	83.2%
Auto Physical Damage	91.6%	93.9%	93.5%	93.9%
Fidelity & Surety	91.9%	85.8%	83.6%	90.8%
Other	79.1%	90.1%	83.1%	89.0%
International	89.9%	72.1%	77.5%	80.1%
Reinsurance A&C	92.4%	90.6%	89.3%	92.5%
Reinsurance B	93.2%	90.7%	89.5%	87.8%
Products Liability	90.1%	89.9%	72.2%	81.2%
Financial Guarantee	90.6%	91.5%	95.2%	67.7%
Warranty	91.9%	99.5%	84.7%	76.6%
All Lines	90.3%	91.4%	90.0%	90.7%

Column (2) from Table 3.2, Column (4) from Table C1.

All lines row is weighted average or safety level from all-lines data points

⁴³ Calculated with no A&O adjustment.