# *Does the NAIC Risk-Based Capital Suffice?*
# *And*
# *Are Property & Casualty Insurance Company Asset Allocations Rational?*

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*This paper examines the asset allocation for a typical property & casualty insurer, and the effect of asset allocation changes on the NAIC Risk-Based Capital (RBC) requirements. The effect on performance measures such as Return on Equity (ROE), growth in capital and surplus, and the ratio of capital and surplus to RBC are studied in parallel to determine if RBC properly rewards good risk decision-making. This paper further examines the extent to which the RBC requirements favor asset or insurance risk and whether or not this is a desirable quality of RBC.*

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## Introduction

Traditionally, property & casualty insurers have invested very conservatively. Generally, these companies favor treasuries and investment grade corporate bonds. During the last decade a few exceptions have emerged, but for the most part property & casualty insurers have opted to accept little or no asset risk. Is this a desirable and a rational decision?

## DFA Model

The analysis in this paper was performed using DFA Capital Management Inc.'s Dynamic Financial Analysis (DFA) software. This software is an enterprise-wide model built specifically for insurance companies. The model calculates transaction level detail on both sides of the balance sheet, and produces all the major accounting and tax schedules and forms at each node of the simulation. In addition, the model calculates the regulatory requirements (NAIC Risk-Based Capital (RBC) and Insurance Regulatory Information System (IRIS) ratios) at each node[1].

Simulating at this level of detail is necessary to address the questions that this paper poses, namely:

- Does RBC suffice?
- Are property & casualty insurance company asset allocations rational?

## Does RBC Suffice?

The NAIC Risk-Based Capital (RBC) measure consists of six components, referred to as R0 through R5. R0 is based on off balance sheet investments and investments in insurance company affiliates. R1 is based on the company's fixed income portfolio and R2 is based on the company's equity portfolio. R3 is a charge based on credit risk, which can arise from either side of the balance sheet. R4 is a charge based on the

[1] A DFA simulation simulates thousands of paths (sometimes called iterations) across time. A node is any one point in time along any one path.

loss and the loss adjustment expense reserves. R5 is a charge based on premium written. Overall, RBC is determined as shown in Equation 1.

**Equation 1**

$$RBC = R0 + \sqrt{R1^2 + R2^2 + R3^2 + R4^2 + R5^2}$$

For all of these components, R0 through R5, percentage charges are tallied based upon certain criteria. For example, R2, the equity component, is simply 15% of the market value of common stock, if the company holds only common stock (as opposed to preferred stock, for example).

If the company's capital and surplus falls below the RBC amount, the company has to submit a plan of corrective action to the regulators. If the company's capital and surplus falls below half of the RBC amount, then the regulators will intervene. It should be clear that it is essential for an insurance company to monitor its RBC amount since it represents a minimum threshold to regulators. In fact, most insurers will maintain a healthy margin between their capital and surplus and their RBC amount.

The charges for some of the main asset components of a property & casualty insurer are shown in Table 1. Each percentage is applied to the market value of the category. For fixed income assets, classes 1 and 2 are considered investment grade. Classes 3 and higher are considered high yield.

**Table 1**

| Security | Rating | RBC Category | Charge |
|---|---|---|---|
| Fixed Income | US Treasury | US Treasury | 0.0% |
| Fixed Income | AAA, AA, A | Class 1 | 0.3% |
| Fixed Income | BBB | Class 2 | 1.0% |
| Fixed Income | BB | Class 3 | 2.0% |
| Fixed Income | B | Class 4 | 4.5% |
| Fixed Income | CCC, CC, C | Class 5 | 10.0% |
| Fixed Income | CI, D (Default) | Class 6 | 30.0% |
| Common Stock | | Common Stock | 15.0% |
| Real Estate | | Real Estate | 10.0% |

Table 1 shows the NAIC risk-based capital charges for each asset class as a percentage of market value.

In reviewing these charges, we can see that investing in US Treasury bonds carries no capital charge. For fixed income securities, the charge relates to default risk as opposed to price fluctuation. Since there is little or no default risk associated with US Treasury debt, there is no charge for holding it. This is the case despite the fact that prices can fluctuate quite significantly for longer maturity bonds. Investment grade corporate bonds carry with them a small capital charge of 0.3% to 1.0%, whereas equities carry a charge that is fifteen times as large (before the independence assumption adjustment) as the charge for the lowest rated investment grade corporate bonds. It would appear that the deck is stacked against equities here.

For a little background, take a look at the following over-simplified and generalized example: a property & casualty insurance company is completely invested in US treasuries and has no reinsurance or other credit risk. Thus, the company has only R4 (reserves) and R5 (premium written) charges. Also say that the insurer has a ratio of R4 to assets of 10% and a ratio of R5 to assets of 4%. Then we can write the following:

**Equation 2**

$$\frac{RBC}{Assets} = \frac{R0}{Assets} + \sqrt{\left(\frac{R1}{Assets}\right)^2 + \left(\frac{R2}{Assets}\right)^2 + \left(\frac{R3}{Assets}\right)^2 + \left(\frac{R4}{Assets}\right)^2 + \left(\frac{R5}{Assets}\right)^2}$$

$$\Updownarrow$$

$$\frac{RBC}{Assets} = 0.00 + \sqrt{(0.00 \cdot 1.00)^2 + (0.15 \cdot 0.00)^2 + (0.00)^2 + (0.10)^2 + (0.04)^2}$$

$$\Updownarrow$$

$$\frac{Assets}{RBC} = 9.28$$

Let us say that we shift some funds that were in treasuries (with no RBC charge) to equities (with 15% RBC charge). Specifically, say we shift 10% of assets from US Treasury bonds to common stocks. The amount of total assets will not change, but RBC will.

**Equation 3**

$$\frac{RBC_{post}}{Assets} = \frac{R0}{Assets} + \sqrt{\left(\frac{R1_{post}}{Assets}\right)^2 + \left(\frac{R2_{post}}{Assets}\right)^2 + \left(\frac{R3}{Assets}\right)^2 + \left(\frac{R4}{Assets}\right)^2 + \left(\frac{R5}{Assets}\right)^2}$$

$$\Updownarrow$$

$$\frac{RBC_{post}}{Assets} = 0.00 + \sqrt{\left(\frac{0.00 \cdot FixedIncome}{Assets}\right)^2 + \left(\frac{0.15 \cdot Equities}{Assets}\right)^2 + (0.00)^2 + (0.10)^2 + (0.04)^2}$$

$$\Updownarrow$$

$$\frac{RBC_{post}}{Assets} = \sqrt{(0.00 \cdot 0.90)^2 + (0.15 \cdot 0.10)^2 + (0.10)^2 + (0.04)^2}$$

$$\Updownarrow$$

$$\frac{Assets}{RBC_{post}} = 9.20$$

We see that the asset-to-RBC ratio has changed from 9.28 to 9.20. In terms of the capital and surplus to RBC ratio, if the company previously had capital and surplus equal to one third of assets, then the company has just reduced its ratio from 3.095 to 3.065 – a reduction of roughly 1% due to an increase in the allocation to equities. While this difference may seem trivial at first, it is not. In order to return the ratio to its prior level, equities (assuming no equities prior to the change) need to return approximately 10%[2].

But it is actually worse than that. To truly bring the ratio back to its prior level one year in the future, equities will need to outperform treasuries by 10%. If treasuries return 5% for the next year, equities will need to return 15% to be equivalent to the all-treasuries scenario. This is greater than the long-term equity performance, which depending on time horizon has been about 8-10% per annum. In short, it seems virtually impossible to justify an equity allocation in terms of RBC.

Another implication of RBC is that the lower the R4 and R5 to asset ratios are, the higher the hurdle rate for equities in the example above. While we

[2] Equities make up 10% of assets. A 10% return from equities is a 1% return on assets.

will not pursue this particular aspect any further here, it is suggested as an area for further research. It suggests that the higher the capital-to-asset ratio of an insurer is, the higher the assumed equity return needs to be in order to justify it in terms of RBC. On the other end of the scale, this also suggests there is an incentive for low capital-to-asset ratio companies to increase their equity exposure. This is the exact opposite of the behavior that regulators should encourage.

It is interesting to note that A.M. Best in its Best's Capital Adequacy Ratio (BCAR) calculation charges relatively more for underwriting risk than the NAIC model does[3]. This is another way of leveling the field between the asset and underwriting risk.

There are other measures of risk that better balance performance such as the distribution of return on equity (ROE), growth in capital and surplus, down-side risk of capital and surplus and so on. We will examine some of these, along with RBC, in a stochastic environment in the paragraphs that follow.

## Reviewing the Simulations

Three simulations were run. All simulations were based on a typical property & casualty insurer. The insurer had ten product lines and twelve treaties covering losses from those products. Measured in terms of expected net losses, 70% of the product lines covered automobile losses with a slightly greater exposure to liability as opposed to physical damage. The greater part of the remaining 30% (of expected net losses) was from commercial property. At the start of the simulation, the insurer had about $200 million in total assets and about $70 million in capital and surplus. Twenty quarters were simulated.

Every simulation started with the same asset allocation. Only the investment strategy was changed for each of the three simulations. Transaction costs were incorporated and the shift in asset allocation was gradual over time just as it would be in reality. The different strategies are summarized below:

[3] Mosher, M., "Understanding BCAR", A.M. Best, August, 2001.

- Base Case: This investment strategy matches duration and convexity of the fixed income portfolio to the company's liabilities. This means that the company is investing mostly in short-term (five years or less, average duration is less than two years) fixed income securities. Treasury bonds must make up at least 25% of the total bond portfolio and common stock must make up roughly 20% of the entire portfolio. Corporate bonds cannot exceed 80% of the bond portfolio. All bonds must be investment grade.

- Alternative 1: Common stocks must make up 20-30% of portfolio. Corporate bonds must make up 30-50% of the entire portfolio. All bonds must be investment grade. Treasury bonds cannot make up more than 30% of the entire portfolio. The duration of the company's fixed income securities must be maintained around five years.

- Alternative 2: Mid-term Treasury bonds must make up 70% of the entire portfolio. 10% of the portfolio must be in common stocks and 20% must be in corporate bonds.

In the table below, the starting portfolio and the average[4] portfolio after five years are summarized.

**Table 2**

| | Asset Allocations | | |
|---|---|---|---|
| | **Base Case** | **Alternative 1** | **Alternative 2** |
| **At Beginning of Simulation** | 10% Equity<br>45% Corporate<br>32% Treasury<br>13% Municipal | 10% Equity<br>45% Corporate<br>32% Treasury<br>13% Municipal | 10% Equity<br>45% Corporate<br>32% Treasury<br>13% Municipal |
| **After Five Years (20 Quarters)** | 20% Equity<br>20% Corporate<br>47% Treasury<br>13% Municipal | 30% Equity<br>30% Corporate<br>30% Treasury<br>10% Municipal | 10% Equity<br>20% Corporate<br>70% Treasury<br>0% Municipal |

[4] Since the investment strategy is modeled, each path can have a different asset allocation depending on the company's circumstances on that particular path.

Table 2 shows the beginning asset allocation and the expected asset allocation after five years. Note, that the beginning portfolio is the same for all three scenarios. The only difference is the strategy applied over the five years. All transaction costs and tax consequences were considered in applying these strategies.

Transaction costs and all tax consequences were considered in adjusting the portfolio over time. In Tables 3 and 4 we look at the expected value of the capital and surplus to RBC ratio to get a sense of the expected impact of the change in investment strategy. Later, we will look at the entire distribution of the ratio.

**Table 3**

| Expected Ratio of Capital and Surplus to RBC | | | |
|---|---|---|---|
| | **Base Case** | **Alternative 1** | **Alternative 2** |
| **After 4 Quarters** | 3.31 | 3.15 | 3.57 |
| **After 20 Quarters** | 3.75 | 3.59 | 3.67 |

Table 3 shows the expected value of the ratio (averaged over all simulated paths) of capital and surplus to RBC at different points in time for the three different asset strategies. After 4 quarters, Alternative 2 has the highest ratio due to the immediate drop in RBC charges. After 20 quarters, the Base Case has the highest expected ratio.

Not surprisingly, the company gets penalized in the first year for holding equities. The ratio of capital and surplus to RBC drops to 3.15 from 3.31. But over the next four years, the company is able to grow its surplus relative to RBC and the relative difference between the Base Case and Alternative 1 decreases.

Alternative 2 looks good in the first year relative to RBC, but over the next four years, the portfolio barely grows relative to RBC and the company pays the price for being too conservatively invested.

**Table 4**

| Expected Percentage Change in Capital and Surplus to RBC Ratio | | | |
|---|---|---|---|
| | **Base Case** | **Alternative 1** | **Alternative 2** |
| **20 Quarters Divided by 4 Quarters** | 13% | 14% | 3% |

Table 4 shows the expected change in the ratio of capital and surplus to RBC. Alternative 1 shows the greatest improvement in this ratio over 5 years, though the Base Case shows roughly the same improvement.

In short, it appears that the Base Case is the best strategy of the three when viewed in the context of the capital and surplus to RBC ratio. Alternative 1 does appear to offer a decent alternative, but even over five years, it does not quite match the Base Case, while short-term there is definitely a price to pay.

*But is capital and surplus to RBC really a measure that property & casualty insurers should care about? Of course, but only because it is imposed by regulators. In and of itself it is not that meaningful and may even encourage sub-optimal decision making by property & casualty decision-makers.*

Since the ratio of capital and surplus to RBC is reviewed once a year, it is implied that the time frame inherent in RBC is one year. Below, we review the actual level of capital and surplus after one year.

**Figure 1: One Year Horizon, Cumulative Distribution Function of Statutory Capital and Surplus**

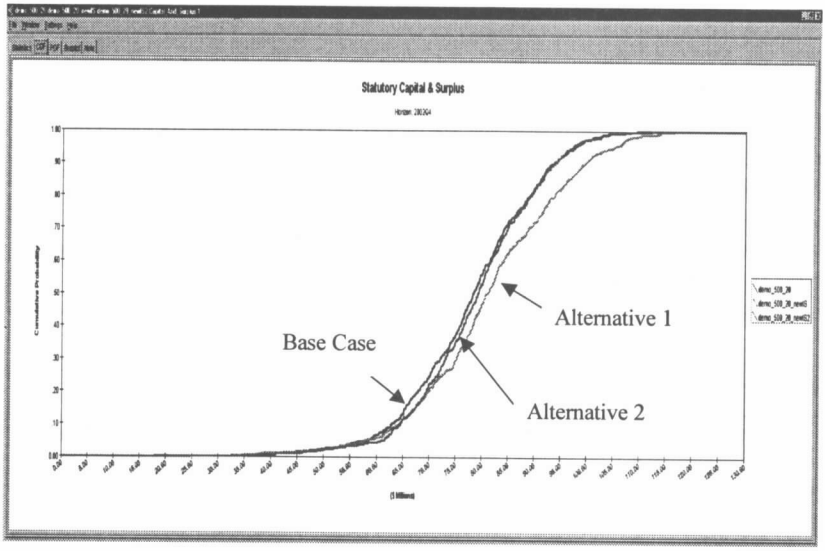


Figure 1 shows the cumulative distribution function of capital and surplus after one year for each of the three strategies: "demo_500_20" is the Base Case (blue), "demo_500_20_newIS" is Alternative 1 (green), and "demo_500_20_newIS2" is Alternative 2 (red). Alternative 1 is almost completely to the right of the Base Case and Alternative 2 suggesting that in terms of surplus growth and even down-side risk, Alternative 1 is the superior strategy.

The start of the simulation is 1/1/2002, so the above chart (Figure 1) is at the end of the first year. It should be easy to see that Alternative 1 (labeled demo_500_20_newIS) almost completely dominates the Base Case. *At virtually all levels of probability, Alternative 1 produces a higher capital and surplus position after one year. Clearly, this should be a desirable outcome. Yet, as we saw earlier, RBC penalizes the move from US Treasuries to investment grade corporate bonds and equities enough such that the ratio of capital and surplus to RBC drops.*

Below (Figure 2) is an enlarged image of the down-side tail. Again, it is clear that Alternative 1 (green) almost completely dominates the Base Case (blue). Alternative 2 (red), being very conservative, has less down-side to capital and surplus after one year as illustrated by its tail region (see Figure 2).

**Figure 2: One Year Horizon, Down-side Tail of Cumulative Distribution Function of Statutory Capital and Surplus**

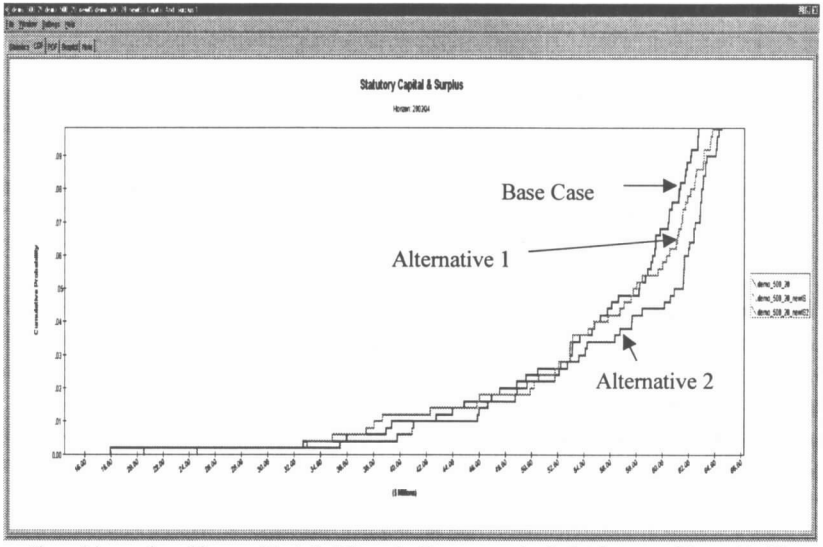


Figure 2 is an enlarged image of the tail of Figure 1. Here we see clearly that in terms of down-side risk, Alternative 2 (red) is slightly superior. Mostly, however, the three strategies have similar tails.

What does the picture look like after five years? Here (Figure 3), Alternative 1 is the clear-cut best choice. The worst scenario is the one which is mostly invested in treasuries (Alternative 2).

**Figure 3: Five Year Horizon, Cumulative Distribution Function of Statutory Capital and Surplus**

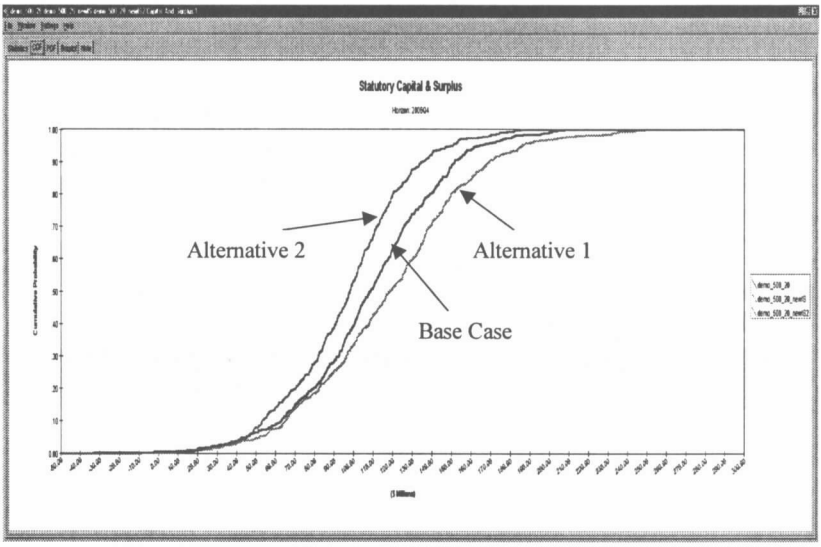


Figure 3 is similar to Figure 1 except that the time horizon is five years rather than one. At this time frame, Alternative 1 completely dominates the other strategies for all levels of probability, suggesting that Alternative 1 is the preferable strategy.

*In terms of absolute dollars, capital and surplus is expected to be $10 million higher under Alternative 1 relative to the Base Case after five years (see Table 5). Even Alternative 1's worst case, as represented by the lowest observation, is more desirable than the Base Case. Yet, RBC penalizes this strategy due to its greater concentration of corporate bonds and equities. Certainly, equities and corporate bonds are more risky than treasuries, but it seems RBC charges unfairly for this risk.*

**Table 5**

**Capital and Surplus at 5 Year Horizon**

| | Base Case | Alternative 1 | Alternative 2 |
|---|---|---|---|
| **Average** | 108,154,635 | 118,268,283 | 96,333,953 |
| **St. Dev.** | 36,276,521 | 42,473,574 | 32,129,526 |
| **Minimum** | -33,111,610 | -9,906,571 | -8,962,279 |
| **Maximum** | 212,220,244 | 250,642,713 | 188,112,618 |
| **1st Percentile** | 19,689,593 | 22,372,340 | 22,057,790 |
| **99th Percentile** | 199,905,756 | 234,605,286 | 174,620,491 |

Table 5 shows the various levels of capital and surplus associated with Figure 3. As can be seen, even the worst case (minimum) outcome is $23 million better under Alternative 1 when compared to the Base Case. It is worth noting that the volatility is higher under Alternative 1, but it is up-side volatility, which is attractive.

If we look at return on equity (ROE) to obtain some insight into the return for shareholders, we see a picture that is similar to what we just saw. Over a five year time horizon, Alternative 1 dominates (see Table 7). Even over a one year time frame (Table 6), Alternative 1 looks the most attractive, though the first percentile (-13.9%) is slightly less than the Base Case (-10.1%).

**Table 6**

**Economic ROE at 1 Year Horizon**

| | Base Case | Alternative 1 | Alternative 2 |
|---|---|---|---|
| **Average** | 9.5% | 12.9% | 10.4% |
| **St. Dev.** | 7.8% | 10.5% | 6.6% |
| **Minimum** | -26.5% | -26.0% | -23.0% |
| **Maximum** | 33.6% | 42.5% | 26.6% |
| **1st Percentile** | -10.1% | -13.9% | -6.4% |
| **99th Percentile** | 26.1% | 36.2% | 23.4% |

Table 6 shows economic return on equity after one year. The result here is consistent with Table 5 in that Alternative 1 looks the most attractive.

**Table 7**

**Economic ROE at 5 Year Horizon**

| | Base Case | Alternative 1 | Alternative 2 |
|---|---|---|---|
| **Average** | 9.2% | 10.9% | 7.1% |
| **St. Dev.** | 6.2% | 6.6% | 5.3% |
| **Minimum** | -32.5% | -17.9% | -21.9% |
| **Maximum** | 23.2% | 27.0% | 19.2% |
| **1st Percentile** | -10.9% | -6.9% | -7.0% |
| **99th Percentile** | 20.6% | 24.0% | 17.1% |

Table 7 shows economic return on equity after five years. The result here is also consistent with Table 5 in that Alternative 1 looks the most attractive.

It seems that focusing on the capital and surplus to RBC ratio can lead to sub-optimal company performance. Below, we take a closer look at RBC under the Base Case and Alternative 1, the two strategies that appear most attractive.

**Table 8**

**RBC at the End of First Simulated Quarter**[5]

| | Base Case | Alternative 1 |
|---|---|---|
| R0: RBC not subject to co-variance | 0 | 0 |
| R1: Fixed Income RBC | 985,063 | 579,558 |
| R2: Equity RBC | 8,633,360 | 12,925,410 |
| R3: Credit & Reinsurance RBC | 946,806 | 937,272 |
| R4: Loss and LAE Reserve RBC | 14,672,659 | 14,672,659 |
| R5: Premium Written RBC | 6,401,369 | 6,401,369 |
| RBC | 18,250,214 | 20,618,702 |

Table 8 breaks down RBC for the Base Case and Alternative 1. As can be seen, increasing the equity exposure from 20% to 30% is very costly in terms of RBC. The fixed income charge actually drops in the first quarter (longer duration does not impact RBC).

A few observations from this table can be highlighted:

[5] Each entry in this table is the expected value across all paths of the simulations. This means that the RBC listed at the bottom cannot be calculated directly from the table entries as the distribution of RBC and its components is skewed.

- Changing the asset allocation strategy from the Base Case to Alternative 1 causes RBC to increase by almost $2.4 million or over 13% over the first year.
- In the Base Case strategy at the end of the first year, the charge for asset risk (R1, R2 and some of R3) is roughly half that of the charge for insurance risk (R4, R5 and some of R3).

Even though the capital and surplus in Alternative 1 almost completely dominates (i.e., higher for each level of probability meaning the entire distribution has shifted right) the Base Case over both the one- and five-year horizons, the increase that this change brings is not enough to offset the increase in RBC. Thus, the ratio of capital and surplus to RBC deteriorates suggesting that monitoring this ratio beyond what is absolutely essential is counter-productive.

In Figures 4 and 5 below, we break down the Statutory Income Statement into underwriting income/(loss) on the vertical axis and investment income/(loss) on the horizontal axis. Figure 4 shows underwriting income plotted against investment income after one year - the implied timeframe of RBC. A best-fit regression line has also been added. As can be seen, there does not appear to be any relationship between the two, which suggests that the independence assumption that RBC makes among the various components of RBC is valid. Though this is a model result, the model is based on a parameterization of real life tying underwriting cash flows to the appropriate economic measures, and while not definitive proof, it does seem to support the RBC independence assumption.

**Figure 4: One Year Horizon, Statutory Underwriting Income Versus Statutory Investment Income**

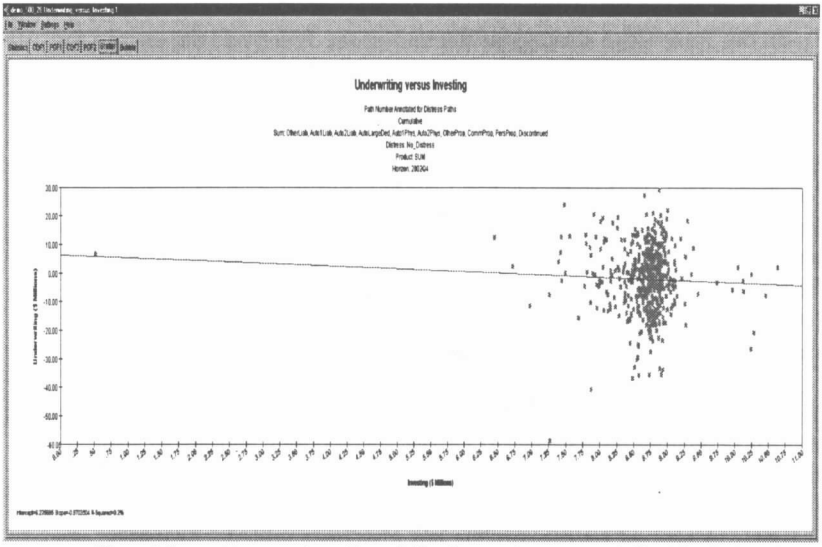


Figure 4 shows statutory underwriting gain/(loss) versus investment gain/(loss) for the Base Case strategy. By simple inspection, the volatility of the underwriting gain/(loss) is much greater than the volatility of the investment gain/(loss). Yet, in Table 8, we saw that RBC ranks investment risk as half of underwriting risk.

However, if we look at the ranges in Figure 4, we see that – with one exception – investment income is in the range of $6 million to $11 million while underwriting income is in the range of $-40 million to $30 million. Thus, the range of investment results is $5 million, whereas the range of insurance results is $70 million. That is a relative risk of 1 to 14. Yet, the capital charge for investments is half of that of insurance or 1 to 2.

**Figure 5: Five Year Horizon, Statutory Underwriting Income Versus Statutory Investment Income**

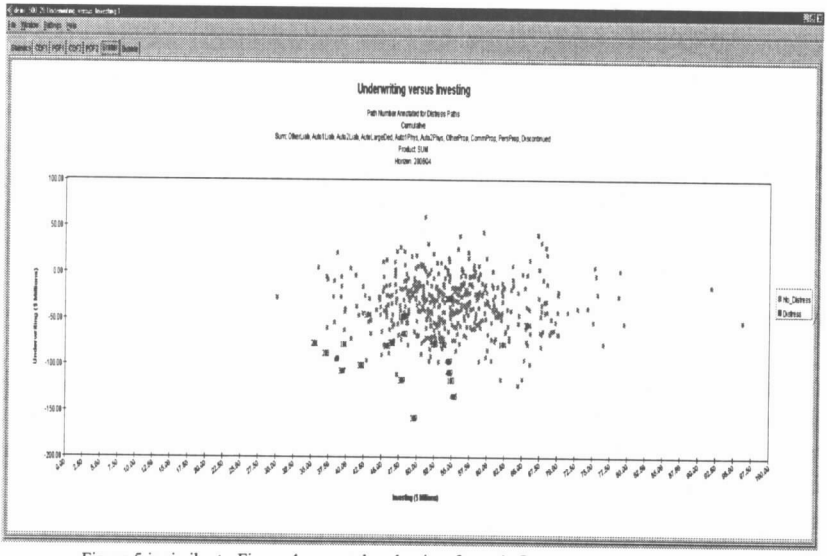


Figure 5 is similar to Figure 4 except that the time frame is five years. In this case, points where capital and surplus fell below RBC have been colored red and path numbers have been annotated. Notice that in general, paths where capital and surplus fall below RBC are located in the lower left quartile of the scatter plot (low investment income and low underwriting gain).

Over five years, the story is similar. The cumulative ranges are now roughly $35 million to $80 million for investments and $-150 million to $50 million for insurance. In this case, the ranges are $45 million versus $200 million, or 1 to 4.4. Relatively speaking, the asset risk has increased, but this is not the timeframe that RBC is concerned with. Even if it were, it is difficult to see how the RBC charge is reasonable. It would seem that an RBC asset charge of about 50% or less of what is currently indicated would be more reasonable.

## The "Real World"

Most property & casualty insurers are very conservatively invested. The author has often wondered why that is. Why do companies that are so willing to take enormous risks on the liability side of the balance sheet shy away from asset risk? The answer often is that they choose to do one

thing and do it to the best of their ability is too convenient in a market place with many players. The fact is that it appears that regulators, through the RBC standard, provide a disincentive for property & casualty insurers to take asset risk. Since asset risk and traditional insurance risk are mostly unrelated, regulators are in fact providing a disincentive for companies to diversify risk and maximize shareholder value.

Thus, it appears based on the analysis offered in these pages, that the choice of most property & casualty insurers to invest conservatively is in fact a rational choice if they are focused on satisfying regulators.

## Conclusion

In a regulated insurance world, the obstacles that insurers have to navigate through are complex. Not only need insurers be concerned with regulators, they also need to concern themselves with shareholders. As we have shown, these issues are often at odds with one another. In fact, an insurer specifically focused on satisfying traditional regulator measures, such as the ratio of capital and surplus to the NAIC Risk-Based Capital, may be sacrificing shareholder value and even the overall long-term health of the company.

As technology has improved and as the banking and insurance lines have become blurred, it would seem to make sense for regulators to adopt new standards for charging for asset risk that would encourage maximization of shareholder value thereby aligning shareholder and regulator objectives more closely.

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