Decomposing Risk to Enhance ALM and Business Decision Making for Insurance Companies

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Abstract
Managing risk within an insurance company is a complex process that must consider the dynamics and interactions of asset, liability, and capital market ("A-L-C") factors. Assessing the characteristics, relationships and variability of these A-L-C factors is critical to successful asset-liability management and allows for sound business and investment decision making. This paper describes an approach for using "decomposition of risk" as part of a comprehensive ALM analysis for an insurance company. The objective is to identify and quantify the major A-L-C factors that contribute to a company’s total corporate risk. Isolating each component of risk allows a company to understand better its total risk and thus develop strategies to improve its risk-return profile. As a result, management can assimilate the relative and combined risk of assets, liabilities, and capital markets into a set of stochastic financial statements, thereby providing the information necessary to improve strategic investment, operating and capital allocation decisions.

This paper includes a case study in which we decompose the economic surplus volatility of a hypothetical property/casualty insurance company into its major risk factors. This case study illustrates the benefits of using variance analysis techniques to isolate and quantify the contribution of individual risk components to the total risk of a company. The case study concentrates on one possible application - asset allocation, of the use of decomposition of risk within a total integrated risk management framework. Other applications are mentioned but will not be explored in this paper. However, it should be clear to the reader that the potential benefits once a company establishes a total integrated risk management framework are innumerable.

Keywords
Asset/liability-management, variance analysis, asset allocation.

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Managing risk within an insurance company is a complex process that must consider the dynamics and interactions of asset, liability, and capital market ("A-L-C") factors. Assessing the characteristics, relationships and variability of these A-L-C factors is critical to successful asset-liability management and allows for sound business and investment decision making. This paper describes an approach for using "decomposition of risk" as part of a comprehensive ALM analysis for an insurance company. The objective is to identify and quantify the major A-L-C factors that contribute to a company's total corporate risk. Isolating each component of risk allows a company to understand better its total risk and thus develop strategies to improve its risk-return profile. As a result, management can assimilate the relative and combined risk of assets, liabilities, and capital markets into a set of stochastic financial statements, thereby providing the information necessary to improve strategic investment, operating and capital allocation decisions.

This process is the next step in Falcon Asset Management's evolution of insurance asset/liability management. It enables a company to shift from discretely managing each major business function (e.g. underwriting, investment, reinsurance) to managing the functions in unison in order to maximize shareholder value. At Falcon Asset Management, we call this process Total Integrated Risk Management (TIRM).

Falcon Asset Management's TIRM process is outlined below in Exhibit 1 and is an extension of earlier work presented by Correnti and Sweeney at the 4th and 5th AFIR Colloquiums.
This paper will focus on the decomposition of risk step of the TIRM process, and how Falcon Asset Management uses variance analysis techniques to assist with strategic business decisions and risk evaluation.

*Total Integrated Risk Management (TIRM)*

Before we begin our discussion on how to decompose total corporate risk into its major components, we first review the entire TIRM process.
**Step 1: Evaluation of Economy and Capital Markets**

The goal of this initial step is to simulate a wide range of realistic economic conditions which represent possible future states of the economy. Economic and capital market factors include interest rates, inflation, and returns for various asset classes, such as bonds and stocks. It is important to distinguish between a simulation model and a forecasting model. A forecasting model will attempt to "predict" future economic conditions, whereas a simulation model creates a set of scenarios (we utilize up to 500 different scenarios) intended to represent a reasonable sample of possible future economic conditions. Simulation models are not concerned with predicting the future. The goal of the simulation is to produce a broad range of economic conditions that span the entire universe of possible outcomes.

We employ a stochastic economic simulation model that has a cascade, or top-down structure (see Appendix I for a diagram of the cascade structure), and which uses a combination of diffusion, econometric, and conditional lognormal models in each of its phases. The first phase of the model generates future interest rates using a variant of the two factor Brennan-Schwartz model. This model, which is expressed as stochastic differential equations, controls short and long interest rates in an interconnected process. In other words, the simulated short and long spot rates are correlated to each other as well as their prior values. The interest rate model also includes mean reversion parameters, so that interest rates, while following a random walk, will trend toward a long term level.

Once the future yield curves are determined, the cascade structure of the economic simulation model produces inflation, stock dividend yields and growth rates, and asset class returns that are consistent within each interest rate scenario. Calibrating, or validating, the model's parameters is as much an art
as a science, and each parameter is adjusted so that the simulated economic conditions produced are consistent with historical experience.

Typically, the core asset classes modeled include fixed income, equity, and cash. Fixed income categories are defined as a function of their anticipated yield (spread to relevant Treasury), duration, convexity, and default or volatility risk. Additional asset classes, such as intermediate bonds, mortgage-backed securities, and high yield bonds are then modeled based on the derived results for the core asset classes. These classes serve as a proxy for the assets currently held and/or expected to be held by the company. The economic simulation model ensures that the resulting asset class returns are consistent with each of the economic conditions simulated.

**Step 2: Evaluation of Financial Statements**

Since the TIRM process is dependent on an insurance company's liabilities, modeling the liability cash flows accurately is critical to obtain meaningful results. Falcon's proprietary liability simulation model can be broken down into two distinct steps: 1) modeling the existing reserves, and 2) modeling the company's new business plan. Both existing reserves and new business liabilities are modeled by line of business (up to 20 lines) so that the unique characteristics of each line can be captured. Historical experience and expected future trends need to be reflected in the assumptions to capture how the insurance company's liability structure will develop in the future.

Projections of the existing loss reserves are generated stochastically by assuming an underlying distribution (normal or lognormal) for the loss reserves and inputting an expected calendar year payout pattern. Since the distribution of existing loss reserves is often skewed, the model allows for losses to follow a lognormal distribution with an absolute lower bound. This recognizes that the
magnitude of adverse loss experience is potentially greater the the magnitude of beneficial loss experience.

Modeling the existing liabilities alone would imply that the company is in a liquidation mode. Since most companies consider themselves a going concern, it is imperative to model the company's new business plan in order to accurately reflect the company's liability structure in the future. The model allows for up to ten years of new business to be layered on top of the existing reserve cashflows. Modeling the new business plan one year at a time allows us to reconcile the results back to the company's deterministic (best estimate) mid-range budget or business plan.

In order to project the new business liability cash flows, assumptions regarding the premium cash flows, loss ratios, expected payout patterns and expenses are needed. The model assumes that the new business loss ratios follow a stochastic mean reverting process. The prior year loss ratio is used as the initial rate; and expected future loss ratios are generated using a mean reverting random walk. An additional adverse loss component to reflect random loss ratio shocks is generated stochastically and can be added to the expected loss ratio calculated above. Once the projected loss ratios are determined, the total liability cash flows are calculated by multiplying the generated loss ratio by the forecasted earned premium and accident year payout pattern. Again, it is important to recognize that since each line of business has its own characteristics, all of the above projections are performed on a line-by-line basis before being aggregated to a total company level. Comparing the company's forecast to the model's distribution of results allows us to measure the degree of conservatism or aggressiveness explicitly used in the business plan.

To reconcile the model results to forecasted profit and loss statements, assumptions regarding taxes, premium collection patterns, and various other
liability items (including non-cash flow items) are required. With this information, income statements and balance sheets can be produced on a statutory, GAAP or economic basis.

**Steps 3 through 7: Consolidation and Analysis**

The liability and asset cash flows generated above are projected over the economic scenarios in Step 3. Adjustments are made to the cash flows as necessary to account for the correlation between the assets, liabilities, and capital markets.

In Step 4, the cash flows are fed into Falcon's proprietary insurance optimizer to solve for an efficient frontier (a set of portfolios that provide the highest return for a given level of risk). We typically use the mean ending surplus (statutory surplus, shareholders' equity, or economic value) as the reward measure, and the standard deviation of ending surplus as the measure of risk.
Alternatively, we can look at various downside risk measures or customized objective functions. Figure 1 shows an example of an efficient frontier using ending economic surplus as the reward measure, and the standard deviation of ending economic surplus as the risk measure. It is important to note that although the mean results are shown on the efficient frontier graph, it is important to analyze the entire surplus distribution. Figure 2 shows the distribution of results for three selected portfolios from the efficient frontier.
Once efficient portfolios are identified, the “analysis of results” phase of the TIRM process (Step 5) can commence. Two of the more common types of analyses performed are the decomposition of risk (which is the focus of the remainder of the paper) and downside risk analysis. These types of analyses identify the factors that have the greatest impact on the company’s overall risk, and as a result require additional sensitivity testing (Step 6).

The end results of the TIRM process go far beyond the objectives and goals of traditional ALM. Like traditional ALM, a primary use of TIRM is to determine an appropriate investment strategy. However, by being able to analyze the company in the aggregate and in a fully integrated framework (integrating liabilities, assets, and capital markets), the company has an invaluable tool which can help evaluate a wide range of business decisions and quantify various risk management strategies.
Decomposition of Risk

Variance analysis techniques are used to investigate the effects of two or more factors that influence an outcome. The method used at Falcon and described below allows us to decompose the total risk facing an insurance company into its key components. In Falcon’s TIRM framework, the total variance represents the volatility of ending surplus resulting from a particular asset portfolio chosen from the efficient frontier. To analyze this volatility further, one can break down the total risk into key drivers such as asset risk and liability risk. Identifying and comprehending the factors that contribute to the total risk for the company allows management to develop strategies to mitigate its risk exposure or to exploit market conditions. In either case, the company will have a better understanding of its risk profile and will be able to take proactive steps to improve that position in the future.

In general, recall that:

$$VAR(x + y) = VAR(x) + VAR(y) + 2COV(x, y)$$

$$= VAR(x) + VAR(y) + 2\text{CORREL}(x, y) \times STDDEV(x) \times STDDEV(y)$$

where

$$VAR(x) = \mathbb{E}[(x - \mu_x)^2] = \sum(x - \mu_x)^2 \Pr(x),$$

$$COV(x, y) = \mathbb{E}[(x - \mu_x)(y - \mu_y)] = \sum(x - \mu_x)(y - \mu_y)\Pr(x, y),$$

$$STDDEV(x) = \sqrt{VAR(x)};\ STDDEV(y) = \sqrt{VAR(y)};$$

$$STDDEV(x + y) = \sqrt{VAR(x + y)}$$

(1)
\[ \text{CORREL}(x,y) = \text{COV}(x,y) + \left(\text{STDDEV}(x) \times \text{STDDEV}(y)\right) \]

It is important to observe that if two variables are perfectly correlated (i.e. \( \text{CORREL}(x,y) = 1 \)), then equation (2) reduces to:

\[ \text{STDDEV}(x + y) = \text{STDDEV}(x) + \text{STDDEV}(y). \]

For correlations less than 1, the standard deviation of the sum of two variables will be less than the sum of the two standard deviations. In other words, if \( \text{CORREL}(x,y) < 1 \), then

\[ \text{STDDEV}(x + y) < \text{STDDEV}(x) + \text{STDDEV}(y). \quad (3) \]

The covariance (or correlation) component of the total variance will reduce the overall standard deviation of a distribution unless the underlying variables are perfectly correlated. This fact is crucial to our risk management process. Additional factors (such as new asset classes or new lines of business) that in isolation appear to be risky, may improve the overall company risk profile when viewed in aggregate provided that the new factor is not perfectly correlated with all of the existing factors. This observation will be explored in further detail in the case study below.

For three variables, the formula for variance expands to:

\[ \text{VAR}(x + y + z) = \text{VAR}(x) + \text{VAR}(y) + \text{VAR}(z) + 2\text{COV}(x,y) + 2\text{COV}(x,z) + 2\text{COV}(y,z) \quad (4) \]

and,

\[ \text{VAR}(x + y + z) = \text{VAR}(x) + \text{VAR}(y) + \text{VAR}(z) + 2\text{COV}(x,y) + 2\text{COV}(x,z) + 2\text{COV}(y,z) \]
As above, unless the factors are perfectly correlated, the resulting standard deviation of the sum of the variables will be less than the sum of the standard deviations, i.e.

\[ \text{STDDEV}(x + y + z) < \sqrt{\text{VAR}(x + y + z)} \]

We are now ready to discuss the actual methodology of isolating individual risk factors.

Methodology

There are two main components that contribute to the total risk of an insurance company. They are the risk arising from the uncertainty in the economy and capital markets (asset risk) and the risk arising from the uncertainty in the ultimate loss payouts (liability risk). Further, the asset risk can be separated into the uncertainty surrounding the appropriate economic discount rate (discount rate risk) and the uncertainty in the asset class total returns (capital market risk). These risk breakdown components are outlined in Exhibit II.
The TIRM process can be used to isolate each of these risk components by holding two of the factors deterministic (constant), while allowing the third factor to be stochastic (variable). For example, to isolate the contribution to total risk from liability uncertainty, the TIRM model is run holding asset returns and interest rates constant while allowing liability cash flows to be stochastic. By running the model with liability cash flows and interest rates deterministic and asset returns stochastic, the capital market risk component can be identified. Finally, by making the liabilities and asset returns deterministic while allowing interest rates to be stochastic the TIRM model will identify the discount rate component of total risk. Table 1 outlines the eight runs necessary to complete a decomposition of risk analysis (S = Stochastic, D = Deterministic).
Run A, which assumes liabilities, asset returns and interest rates are all stochastic, represents the total risk to the company. By “turning off” discount rate and capital market volatility, we can determine the contribution to total risk arising from the liabilities (Run D). Similarly, making the liabilities deterministic allows us to quantify the impact of volatile capital market returns and discount rates (Run E). The other runs are necessary in order to calculate the covariance components of risk. Note that Run H, which assumes that all factors are deterministic, will have zero volatility and will represent the company’s forecast as described earlier in this paper. The results of these runs will allow for the identification of each of the variance and covariance terms identified in equation 4.

The following case study illustrates the steps involved in decomposing the volatility of a property/casualty insurance company into its key risk components, namely liability risk, discount rate risk, and capital market risk.
Case Study

As described above, decomposition of risk is an effective means for isolating and quantifying the key components of a company’s total risk exposure. By identifying the major contributors of risk, management is better positioned to evaluate the consequences of strategic decisions that involve these components. Further, by identifying the covariance components between these risk factors, the company will be better able to evaluate the potential benefits of diversification and/or hedging activities.

The following case study shows how decomposition of risk can be used to help a property/casualty insurance company more effectively evaluate its investment strategy. Property/Casualty Insurance Company (PCIC) is a hypothetical insurance company whose existing reserves are heavily influenced by its large worker’s compensation line of business. PCIC is currently writing new business in an equal amount of worker’s compensation, personal lines, and commercial lines. PCIC’s management felt that the portfolio duration for its current investment strategy was too short (3.5 years) when viewed in light of its current liabilities (with an ongoing duration of 4.9 years) and was interested in identifying alternative asset allocation strategies that would improve the economic value of the company over its three year business planning horizon. The analysis concentrated on PCIC’s worker’s compensation, personal and commercial lines of business that were modeled based on a thorough analysis of industry and PCIC historical loss ratio data and payout patterns. The historical information was combined with PCIC management’s business plan to generate 500 simulations of future premiums, loss payments and expenses using the Falcon Asset Management Total Integrated Risk Management process described above.
PCIC wanted to evaluate the maturity structure of its fixed income portfolio, as well as the possibility of adding equity investments. The analysis was performed using the following five asset categories:

- Cash Equivalents
- 5-year Bonds
- 10-year Bonds
- 20-year Bonds
- Large Capitalization Stocks

Five hundred simulations of total returns for each of these five asset classes were generated and merged with the previously generated liability scenarios. The analysis was simplified by assuming no correlation between the liabilities and capital market simulations, although a similar analysis could be performed with appropriate correlations built into the generation process. PCIC's current portfolio, represented by a 20% allocation to cash, 75% allocation to 5-year bonds and 5% to 10-year bonds, was decomposed into its asset and liability components.

Because PCIC was interested in evaluating its risk profile on an economic basis, the liability cash flows, that would be discounted at statutory valuation rates (worker's comp) or not discounted at all (personal and commercial lines) for reserving purposes, were discounted at market rates of interest. In addition, PCIC's evaluation was with respect to its three-year business plan. The analysis, therefore, factored in the implications of treating the company as a going concern. By allowing both the assets and liabilities of PCIC to be stochastic, the company was able to calculate its total economic risk as measured by the standard deviation of economic value at the end the three-year horizon. Based on the simulations used for this analysis, PCIC's total economic risk was equal to $707.3 thousand.
While this information was valuable to PCIC management, it did not give them the insights required to evaluate the contribution to total risk specifically attributable to their current asset allocation strategy. By holding the loss, expense and premium cash flows constant and letting the capital market returns and discount rates be stochastic, PCIC was able to identify the component of total risk that was the result of its current asset strategy. Further, by holding the capital market returns and discount rates constant while using stochastic liability cash flows, PCIC was able to identify the component of total economic risk attributable to their liabilities (underwriting operations).

Table 2, below, shows the asset and liability components of economic risk, as well as the corresponding covariance between the assets and the liabilities.

Table 2

<table>
<thead>
<tr>
<th>Decomposition of Total Risk - Current Portfolio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Run</td>
</tr>
<tr>
<td>-----</td>
</tr>
<tr>
<td>A</td>
</tr>
<tr>
<td>D</td>
</tr>
<tr>
<td>E</td>
</tr>
</tbody>
</table>

COV (Liab, Cap Mkt + Disc Rates)

- A: VAR (Liab + Cap Mkt + Disc Rate) 500,273.3
- D: VAR (Liab) 352,479.7
- E: VAR (Cap Mkt + Disc Rate) 129,816.1

Correlation (Liab, Cap Mkt + Disc Rate)

COV (Liab, Cap Mkt + Disc Rate) - (A - D - E) * 0.042

VAR (Liab + Cap Mkt + Disc Rates)

- D: VAR (Liab) 352,479.7 70.5%
- E: VAR (Cap Mkt + Disc Rates) 129,816.1 25.9%

STDDEV (Liab + Cap Mkt + Disc Rates) 707.3

Figure 3 plots the 95th, 75th, 50th, 25th and 5th percentile economic values at the end of PCIC's three year planning horizon on a total risk basis, together with the corresponding asset and liability risk components.
By decomposing risk into its asset and liability component parts, it could be seen that 70% of PCIC’s total economic risk, as measured by variance, was due solely to the uncertainty surrounding the liability loss cash flows. PCIC’s asset strategy contributed just 26% to its total corporate risk profile. The covariance component of risk was negligible (4%), since we assumed no correlation between the assets and liabilities.

After PCIC had identified the risk components of their current asset strategy, the next step was to identify the asset allocation that would minimize their total economic risk. In order to identify such a strategy, Falcon’s proprietary insurance optimizer was employed. Figure 4 shows PCIC’s fixed income efficient frontier along with the risk/reward point corresponding to PCIC’s current portfolio.
The minimum risk asset allocation strategy from the fixed income efficient frontier was composed of 20.1% Cash, 63.4% 5-year bonds, 5.7% 10-year bonds and 10.9% 20-year bonds.

The minimum risk asset allocation portfolio was decomposed in a manner similar to that performed on the current portfolio.
Table 3

<table>
<thead>
<tr>
<th>Run</th>
<th>Liabilities</th>
<th>Capital Market Rates</th>
<th>Std Dev</th>
<th>Var</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>S</td>
<td>S</td>
<td>653.7</td>
<td>427,323.7</td>
</tr>
<tr>
<td>D</td>
<td>S</td>
<td>D</td>
<td>594.2</td>
<td>353,073.6</td>
</tr>
<tr>
<td>E</td>
<td>D</td>
<td>S</td>
<td>251.3</td>
<td>63,151.7</td>
</tr>
</tbody>
</table>

\[
\text{COV (Liab,Cap Mkt + Disc Rates)} = (A - D - E) * .5
\]
\[
\text{CORREL (Liab,Cap Mkt + Disc Rate)} = 0.037
\]

<table>
<thead>
<tr>
<th>Run</th>
<th>VAR (Liab+Cap Mkt + Disc Rate)</th>
<th>% Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>353,073.6</td>
<td>83.7%</td>
</tr>
<tr>
<td>E</td>
<td>63,151.7</td>
<td>15.0%</td>
</tr>
</tbody>
</table>

\[
\text{VAR (Liab + Cap Mkt + Disc Rates)} = 427,323.7
\]
\[
\text{STDDEV (Liab + Cap Mkt + Disc Rates)} = 653.7
\]
Figure 5 and Table 3 show the results of this decomposition. As expected, the liability risk component is virtually the same as under the current portfolio since only the asset allocation strategy changed. The asset component, though, decreased so that the minimum risk fixed income portfolio contributes only 15% to PCIC’s total corporate risk profile.

Why has the asset component of total risk decreased even though the portfolio duration increased? To answer this, we further decomposed the asset risk into its two major components: 1) the risk due to uncertain capital market returns, and 2) the risk due to varying economic discount rates. By decomposing the asset risk of both the current and minimum risk portfolios it can be shown, as expected, that the discount rate component of risk is the same for both strategies. This is because the discount rate is unaffected by asset allocation strategy. The capital market risk component is larger under the low risk asset allocation strategy than under the current strategy as a result of the low risk asset allocation’s higher duration. However, the total asset risk component is actually smaller under the low risk asset allocation strategy. This is the result of
the greater covariance offset as a result of a better asset/liability match. The low risk asset allocation strategy forms a better natural hedge against the fluctuating market value of liabilities generating a covariance offset that more than compensates for the greater capital market risk. The details of the asset risk decomposition are outlined in Table 4 and Figure 6, as seen below.

Table 4

<table>
<thead>
<tr>
<th>Run</th>
<th>Liabilities</th>
<th>Capital Market</th>
<th>Discount Rates</th>
<th>Std Dev</th>
<th>Var</th>
<th>Std Dev</th>
<th>Var</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
<td>D</td>
<td>S</td>
<td>S</td>
<td>360.3</td>
<td>129,816.1</td>
<td>251.3</td>
<td>63,151.7</td>
</tr>
<tr>
<td>F</td>
<td>D</td>
<td>S</td>
<td>D</td>
<td>856.5</td>
<td>733,592.3</td>
<td>1,093.4</td>
<td>1,195,523.6</td>
</tr>
<tr>
<td>G</td>
<td>D</td>
<td>D</td>
<td>S</td>
<td>1,039.9</td>
<td>1,001,392.0</td>
<td>1,039.9</td>
<td>1,001,392.0</td>
</tr>
</tbody>
</table>

COV (Cap Mkt, Disc Rates)
E VAR (Cap Mkt + Disc Rate) 129,816.1 63,151.7
F VAR (Cap Mkt) 733,592.3 1,195,523.6
G VAR (Disc Rate) 1,081,392.0 1,081,392.0
COV (Cap Mkt, Disc Rate) = (E - F - G) * .5 (842,584.1) (1,106,881.9)
CORREL (Cap Mkt, Disc Rate) (0.946) (0.973)

VAR (Cap Mkt + Disc Rates)
F VAR (Cap Mkt) 733,592.3 1,195,523.6
G VAR (Disc Rates) 1,081,392.0 1,081,392.0
COV (Cap Mkt, Disc Rates) * 2 (1,685,168.2) (2,213,763.6)
VAR (Liab + Cap Mkt + Disc Rates) 129,816.1 63,151.7
STDDEV (Liab + Cap Mkt + Disc Rates) 360.3 251.3
After identifying the minimum risk fixed income asset allocation strategy, PCIC management concluded that its risk tolerance allowed them to take on a level of economic risk commensurate to that of its current asset allocation strategy. Additionally, PCIC was also interested in adding equities in the form of large capitalization stocks to its investment holdings. A second efficient frontier was therefore generated that included equities, and the asset allocation strategy with the same economic risk as the current asset allocation strategy was identified. Figure 7, below, shows the new efficient frontier together with the current and same risk asset allocation portfolios.
The same risk economic portfolio is composed of 1.7% cash, 4.1% equities, 92.2% 5-year bonds and 2.0% 20-year bonds. Figure 8 highlights the potential improvement that could be achieved by moving to a portfolio of equities and fixed income with the same economic risk as the current portfolio.
Again, a decomposition of risk was performed on the same risk equity asset allocation strategy with the results shown in Table 5 and Figure 9.
Table 5

Decomposition of Total Risk - Same Risk Equity Portfolio

<table>
<thead>
<tr>
<th>Run</th>
<th>Liabilities</th>
<th>Capital Mkt</th>
<th>Discount Rates</th>
<th>Std Dev</th>
<th>Var</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>707.3</td>
<td>500,273.3</td>
</tr>
<tr>
<td>D</td>
<td>S</td>
<td>D</td>
<td>D</td>
<td>596.4</td>
<td>355,693.0</td>
</tr>
<tr>
<td>E</td>
<td>D</td>
<td>S</td>
<td>S</td>
<td>347.3</td>
<td>120,617.3</td>
</tr>
</tbody>
</table>

COV (Liab, Cap Mkt + Disc Rates)

\[
\text{COV (Liab, Cap Mkt + Disc Rates)} = (A-D-E) \cdot \frac{1}{2}
\]

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</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>VAR (Liab+Cap Mkt + Disc Rate)</td>
<td>500,273.3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>VAR (Liab)</td>
<td>355,693.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>VAR (Cap Mkt + Disc Rate)</td>
<td>120,617.3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CORREL (Liab, Cap Mkt + Disc Rate) = 0.058

VAR (Liab + Cap Mkt + Disc Rates)

\[
\text{VAR (Liab + Cap Mkt + Disc Rates)} = (D + E) \cdot \frac{1}{2}
\]

<p>| | | | | | |</p>
<table>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>VAR (Liab)</td>
<td>355,693.0</td>
<td></td>
<td>71.1%</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>VAR (Cap Mkt + Disc Rates)</td>
<td>120,617.3</td>
<td></td>
<td>24.1%</td>
<td></td>
</tr>
</tbody>
</table>

COV (Liab, Cap Mkt + Disc Rates) * 2 = 23,963.0

VAR (Liab + Cap Mkt + Disc Rates) = 500,273.3

STDDEV (Liab + Cap Mkt + Disc Rates) = 707.3

Figure 9

<table>
<thead>
<tr>
<th>Percentiles</th>
<th>Total Risk</th>
<th>Liability Risk</th>
<th>Asset Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>90th</td>
<td>11,104</td>
<td>11,755</td>
<td>11,104</td>
</tr>
<tr>
<td>75th</td>
<td>10,782</td>
<td>10,476</td>
<td>10,694</td>
</tr>
<tr>
<td>50th</td>
<td>10,267</td>
<td>10,267</td>
<td>10,323</td>
</tr>
<tr>
<td>25th</td>
<td>9,959</td>
<td>9,959</td>
<td>10,694</td>
</tr>
<tr>
<td>5th</td>
<td>9,736</td>
<td>9,414</td>
<td>9,959</td>
</tr>
<tr>
<td>Mean</td>
<td>10,801</td>
<td>10,414</td>
<td>10,564</td>
</tr>
<tr>
<td>Std Deviation</td>
<td>347</td>
<td>347</td>
<td>347</td>
</tr>
<tr>
<td>Variance</td>
<td>500,273</td>
<td>355,693</td>
<td>120,617</td>
</tr>
<tr>
<td>% Total Variance</td>
<td>71.1%</td>
<td>71.1%</td>
<td>71.1%</td>
</tr>
</tbody>
</table>
This analysis shows that the comparable risk equity portfolio has the same asset and liability risk components as the current portfolio, but the distribution of economic values are significantly improved under the new strategy.

Conclusion

By undertaking this analysis, PCIC identified their asset and liability risk exposures. Armed with this information, they moved confidently into a revised asset allocation that contained a significant equity exposure. As a result, the company increased its expected economic value at the end of its three-year horizon as well as the economic value at each of the five specified percentiles across the distribution.

It must be made clear, however, that this analysis was based on a property/casualty insurance company with a large worker's compensation line of business. Because Falcon's TIRM process is dependent on a company's general ALM characteristics (i.e. liability structure, surplus level) different companies may experience different results.

This paper presents only one possible application of decomposition of risk analysis within a total integrated risk management framework. PCIC could have performed a similar analysis on its business mix strategy to determine the optimal mix of premium to allocate to its personal and commercial lines of business. It could have also evaluated possible acquisitions and divestitures in light of the impact these decisions would have on the total economic risk profile of the company. Alternatively, PCIC could use this technique to evaluate the appropriate level of reinsurance from a total company viewpoint, and to determine the value/cost tradeoffs of various reinsurance strategies. Finally, decomposition of risk could help PCIC better control volatility of shareholder's equity or statutory surplus over shorter time horizons.
The diverse characteristics of numerous risk elements at play within a large insurance company compound the difficulties of making appropriate decisions based on the overall benefit, or value, to the corporation. Management is often forced to make strategic and business decisions within the confines of each individual business or risk component. Moreover, even when individual decisions are correct, companies can still experience suboptimal financial results with respect to managing the overall risk/reward value of the total company. By using total integrated risk management and decomposition of risk to evaluate decisions within each subcomponent, management will be better positioned to make decisions that will benefit the company within a holistic decision making framework.
APPENDIX I

Stochastic Simulation Model

CAP:LINK
(Cascade Structure)

Treasury Yield Curve

Stock Dividend Yields

Price Inflation

Stock Dividend Growth Rate

Wage Inflation

Cash & Treasury Bonds Returns

Stock Returns

Primary Asset Class Returns
References


