Applying A DFA Model To Improve Strategic Business Decisions

by Salvatore Correnti, CFA,
Stephen M. Sonlin, CFA,
and Daniel B. Isaac, FCAS, MAAA

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Salvatore Correnti, CFA
Executive Vice President, Falcon Asset Management, Inc.,
Vice President-Asset/Liability Management, USF&G Corporation;
Stephen M. Sonlin, CFA
Vice President, Falcon Asset Management, Inc.
Daniel B. Isaac, FCAS
Vice President, Falcon Asset Management, Inc.;

6225 Smith Avenue
Baltimore, Maryland 21209

Telephone: 410/205-6400
FAX: 410/205-6406
e-mail: ssonlin@falconasset.com

ABSTRACT

Until recently, insurance companies were forced to evaluate business decisions at the functional level. With the advancement in computing power and understanding of advanced financial mathematics, company's are now able to integrate all of the various operational functions into a total company model, and evaluate the impact of various business decisions on the total company's risk/reward profile. 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 factors that contribute to a company's total risk. Isolating each component of risk allows a company to better understand its total risk and thus develop strategies to improve its risk/reward 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.

Applying a DFA Model to Improve Strategic Business Decisions

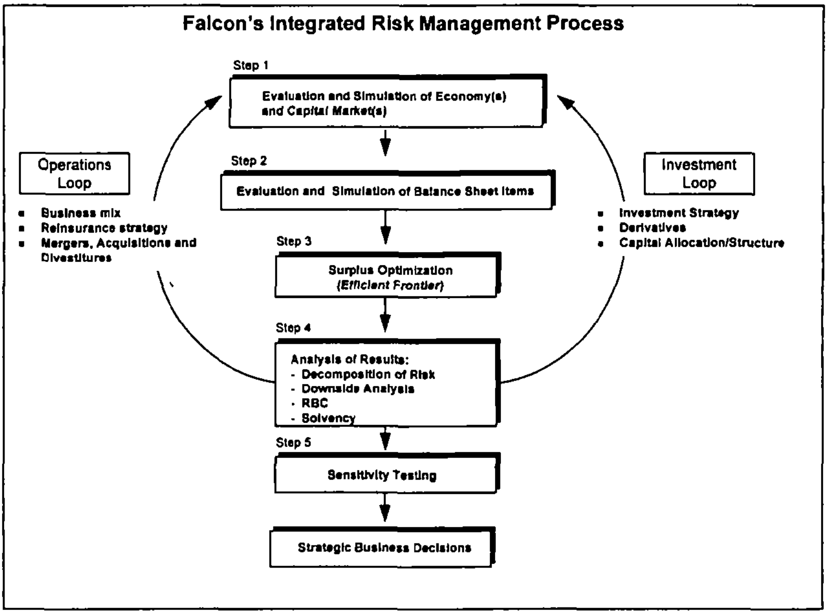
Until recently, insurance companies were forced to evaluate business decisions at the functional level. For example, Actuarial and Underwriting departments focused on the liability side of the operations, Investment departments concentrated on the risk and rewards of alternative asset strategies and asset classes, Treasury evaluated capital allocation decisions, and the Reinsurance unit explored the impact of various reinsurance treaties. With the advancement in computing power and understanding of advanced financial mathematics, company's are now able to integrate all of the various operational functions into a total company model, and evaluate the impact of various business decisions on the total company's risk/reward profile.

The risk management process developed at Falcon Asset Management, called Falcon Integrated Risk Management (FIRM™), is an example of a total company model that uses sophisticated techniques and gives management the ability to analyze problems at the total company level in a completely integrated framework (i.e., combining liabilities, assets and economic factors). As a result, management can analyze their key profit/cost centers, such as investment management, corporate finance/capital management, underwriting and reinsurance functions, on a consistent basis. An integrated risk management model uses simulation analysis of the aforementioned business functions and their key drivers to develop a comprehensive risk/reward profile for the company.

Many articles and papers have been written showing the benefits of including an insurance company's liabilities into its asset allocation decisions, including Sweeney and Correnti [1994] and Carino, et al. [1994]. Figure 1 expands on these concepts and gives a schematic view of an integrated risk management process. Total integrated risk management builds on traditional asset/liability analysis in that it explicitly considers strategic decisions impacting both operations and investment activities within a holistic framework . Once the key factors contributing to the overall risk of the company are identified and quantified, management has the ability to "loop" through the process by selecting either the investment loop (e.g., asset allocation, derivatives and capital allocation) or through the operations loop (e.g., business mix, reinsurance strategy and merger & acquisition analysis).

Traditional asset/liability analysis has been used to explore asset issues relating to asset allocation and derivative strategies only. An integrated risk management approach combines a more complete set of asset, liability, economic and capital market factors at the total company level giving management the ability to investigate the risk/reward tradeoffs of a wide range of alternative strategic business decisions. In addition the company is able to evaluate the joint impact of multiple strategic decisions through their interrelationships on the total company risk/reward profile.

Figure 1



For example, management can now evaluate various reinsurance strategies and quantify their impact on the company's financial objectives. The cost for the reinsurance protection can be compared to the reduction in risk provided by the reinsurance program and decisions concerning the appropriate level of reinsurance can be made. In addition, the integrated risk management approach provides management with a consistent framework to access the myriad of problems that they face. Whether deciding on an appropriate asset allocation strategy, reinsurance programs or corporate finance issues, management can use the integrated risk management process to perform the necessary analysis under a consistent risk/reward framework.

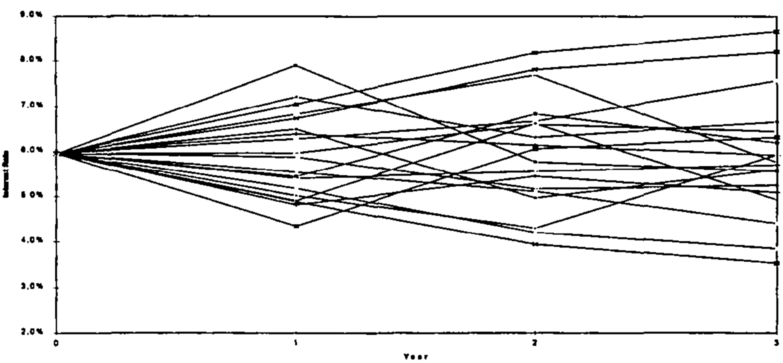
This paper will focus on the decomposition of risk step and how this information to assist a company with their strategic business decisions.

Economic and Capital Market Modeling

The first step in evaluating the asset allocation strategy for an insurance company is to evaluate the economy and the capital markets. This is Step 1 in the integrated risk management framework presented in Figure 1. For asset-only analysis over a single time period mean/variance models can be used effectively (see Markowitz [1987]). These models require inputs concerning the mean, standard deviation and correlations related to a particular set of asset categories being considered in the analysis. While effective for single period, asset-only analysis, these models are not adequate for more advanced asset/liability analysis or for use within a total integrated risk management framework. This is due to the fact that there is no explicit modeling of the underlying economic environment such as interest rates and inflation. The implicit economic environment that underlies a mean variance model can lead to interest rates that both explode to unreasonably high levels and even more undesirable, become negative.

Asset/liability management relies on the consistent relationship of both asset and liability movements to the underlying economic environment. Thus it is critical to model the economic variables explicitly to ensure reasonable future economic projections. The best models available for this purpose are models that utilize stochastic differential equations to describe the dynamics of the interest rate and inflation rate movements. For a more complete discussion of stochastic diffusion models see Mulvey and Thorlacius [1997]. Figure 2 shows twenty simulations corresponding to a three year projection of short-term interest rates that were generated from a stochastic diffusion model. This picture shows the year to year movements of the short-term interest rates together with the range of potential interest rate levels.

Figure 2



The economic and capital market diffusion model used employs a cascade, or top-down structure as described in Wilkie [1987]. The top of the cascade model involves generating price inflation rates. Future interest rates are modeled consistent with the previously generated inflation rates using a variant of the Heath-Jarrow-Morton interest rate model (see Heath, Jarrow and Morton [1988]). Once the future yield curves are determined, the cascade structure of the model produces asset class returns (both total returns and income returns) that behave consistently with the underlying economic scenario.

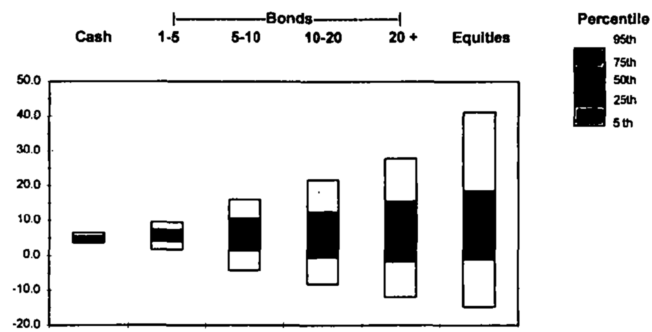
Asset classes are defined as homogeneous groups of individual investments such as fixed income of various maturities, equity, and cash. Fixed income categories are defined as a function of their anticipated yield, duration, convexity, and default or volatility risk. Equity returns are modeled as a function of their earnings yield and earnings growth. Asset classes, such as mortgage-backed securities, high yield bonds and property returns can be added to the analysis through the use of return generation tools available in the model. The modeled classes serve as a proxy for the assets currently held and/or expected to be held by the company.

The resulting returns can be summarized using the same mean, standard deviation and correlation statistics that are typically used as inputs to a mean/variance model. In addition, the same economic variables that are used to generate the capital market returns can be used to project the premium, loss and expense cash flows that will be required for the asset/liability analysis. This is the type of asset modeling system that we use in the integrated risk management system presented in Figure 1.

Figure 3 shows the 5th through the 95th percentile results corresponding to the average annual returns for each of six asset categories. As expected, over an annual holding period, cash returns show the smallest annual average return range while equities show the largest return range.

Figure 3

Average Annual Returns



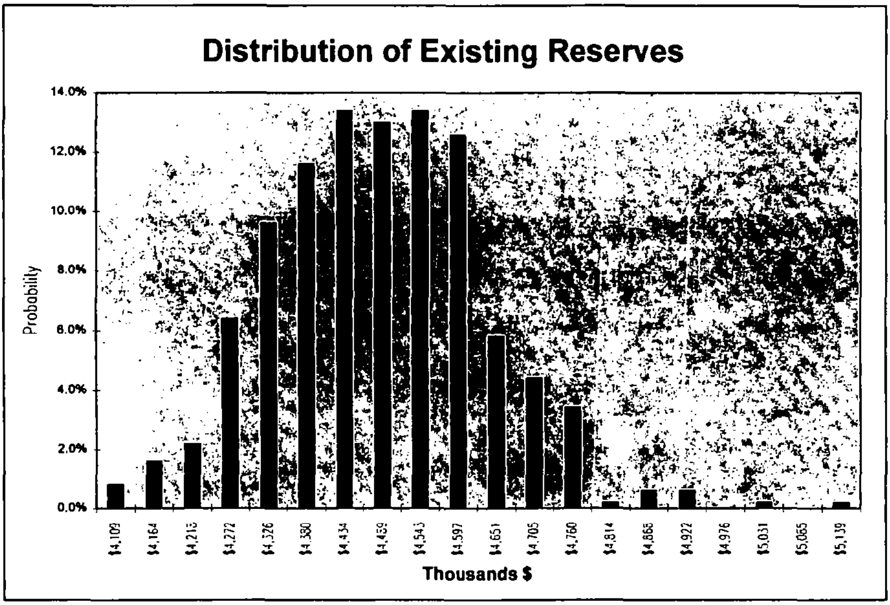
	Cash	1-5	5-10	10-20	20 +	Equities
Mean	4.86	5.65	5.88	6.29	7.10	9.87
Standard Dev	0.94	2.40	6.35	9.41	12.40	17.18
95th percentile	6.46	9.45	16.10	21.68	27.70	41.14
75th percentile	5.60	7.38	10.45	12.59	16.50	18.56
50th percentile	4.76	5.71	5.84	6.19	6.59	8.13
25th percentile	4.09	3.97	1.43	-0.51	-1.76	-1.15
5th percentile	3.56	1.64	-4.20	-8.24	-11.96	-14.81

The use of a stochastic economic and capital market simulation model of the type discussed above ensures that the asset class returns are consistent with the economic conditions that are being simulated. This is of critical importance to any application that is attempting to model assets and liabilities simultaneously.

Evaluation of Financial Statements

Since an integrated risk management process is dependent on an insurance company's liabilities, modeling the liability cash flows is critical for obtaining meaningful results. Liability simulation should consider both the existing reserves, and the company's business plan. Like asset categories, existing reserves and new business liabilities can be broken down into homogeneous lines of business to ensure that the unique characteristics of each line are 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.

Figure 4



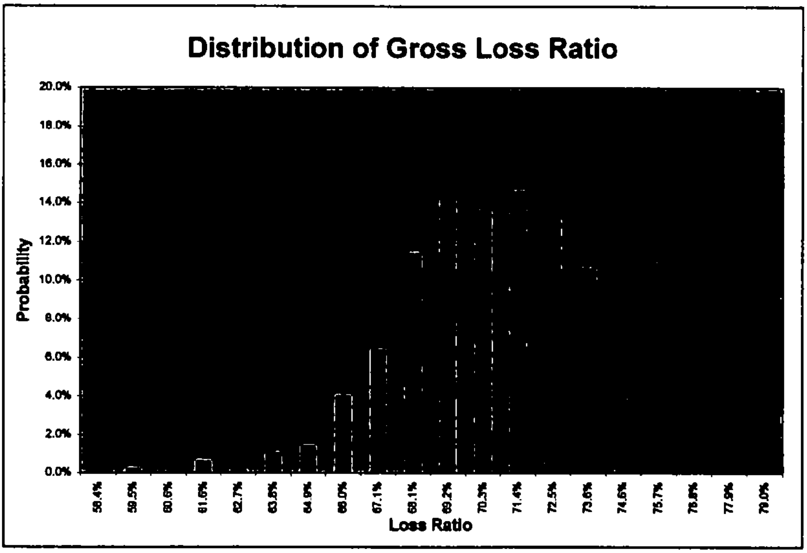
Projections of the existing loss reserves are generated stochastically by assuming an underlying distribution for the loss reserves and inputting an expected reserve runoff pattern. The loss reserve simulations should recognize that the magnitude of adverse loss development is potentially greater than the magnitude of beneficial loss development. Figure 4 illustrates the simulated distribution of the company's existing reserves.

Modeling the existing liabilities alone would imply that the company is in a liquidation, or runoff 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 complete liability structure in the future. Typically companies budget three to five years of new business which can be layered on top of the existing reserve cash flows.

In order to project the new business liability cash flows, assumptions regarding written and earned premium, loss ratios, expected accident year payout patterns, IBNR factors and expenses are needed. Loss ratios should be modeled so as to reflect relationships with the underlying economic environment and should be general enough to allow the user to incorporate cycles and reversions.

The low frequency/high severity nature of catastrophes requires more precise modeling techniques to simulate catastrophic events and the resulting cash flows. There are several cat models available in the marketplace today (e.g. AIR, EQE, RMS, etc.). Loss ratios and cash flows attributed to catastrophes can be generated using one of these simulation models and merged with the non-cat losses described above to produce the company's overall loss ratio distribution. Figure 5 shows the distribution of simulated year 1 loss ratios for a hypothetical property/casualty company.

Figure 5



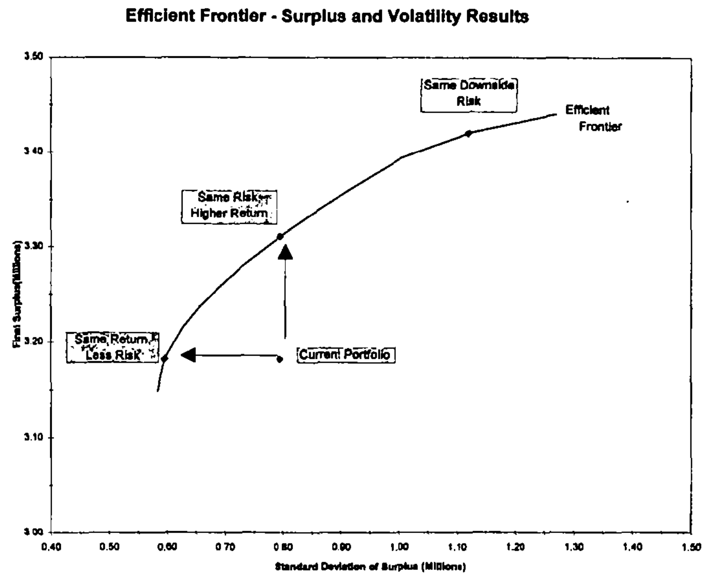
Once the projected loss ratios are determined, the total liability cash flows are calculated by multiplying the generated loss ratio by the forecasted earned premium and accident year payout pattern. The carried reserves can then be calculated as a function of the ultimate loss reserve, the expected loss reserve and the appropriate IBNR factor. It is important to recognize that since each line of business has its own characteristics, all of the above projections need to be performed on a line-by-line basis before being aggregated to a total company level.

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, stochastic income statements and balance sheets can be produced on a statutory, GAAP and economic basis. Further information concerning asset and liability model requirements for property/casualty insurance companies can be found in Almagro and Sonlin [1996].

Consolidation and Analysis

In Step 3, from the integrated risk management flowchart, the liability and asset simulations are fed into an insurance optimization model to solve for an efficient frontier (a set of portfolios that provide the highest reward for a given level of risk). There are an unlimited number of objective functions that can be used for optimization. Some simple objective functions can be defined as mean ending surplus (statutory surplus, shareholders' equity, or economic value) for the reward measure, and the standard deviation of ending surplus for the measure of risk. Alternatively, we can look at various downside risk measures or company specific risk/reward functions.

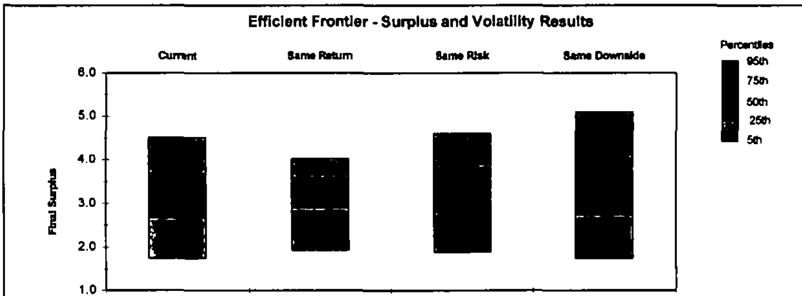
Figure 6



	Current	Same Return	Same Risk	Same Downside
Reward:	3.2	3.2	3.3	3.4
Risk:	0.8	0.6	0.8	1.0

Figure 6 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 the efficient frontier plots expected results only. One must analyze the entire distribution of results to determine the optimal choice based on the company's risk tolerance. Figure 7 shows the distribution of results for three selected portfolios from the efficient frontier.

Figure 7



Distribution of Results:	Current	Same Return	Same Risk	Same Downside
95th percentile	4.5	4.0	4.6	5.1
75th percentile	3.7	3.6	3.8	4.0
50th percentile	3.2	3.3	3.3	3.3
25th percentile	2.7	2.9	2.8	2.7
5th percentile	1.7	1.9	1.9	1.7
Mean:	3.2	3.2	3.3	3.4
Std Deviation:	0.8	0.6	0.6	1.0

Once efficient portfolios are identified, the "analysis of results" phase of the integrated risk management process (Step 4) can commence. Two of the more common types of analyses performed are decomposition of risk 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 5) or the identification of appropriate risk mitigating strategies. See Correnti and Sweeney [1994/1995], and Correnti, Nealon and Sonlin [1996/1997] for additional details on the process.

The end results of an integrated risk management process goes far beyond the objectives and goals of traditional ALM. Like traditional ALM, a primary use of integrated risk management is to determine an appropriate investment strategy. However, by being able to analyze a 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. For example, an integrated risk management process can be used to analyze a company's business mix and determine the optimal mix of premium to allocate to each of its lines of business. It could be used to evaluate possible acquisitions and divestitures in light of the impact these decisions would have on the total economic risk profile of the company. Alternatively, such a model could assist in determining the appropriate level of reinsurance from a total company viewpoint, and to determine the value/cost tradeoffs of various reinsurance strategies.

Decomposition of Risk

Variance analysis techniques are used to investigate the effects of two or more factors that influence an outcome. The method described below allows us to decompose the total risk facing an insurance company into its key components. In this 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:

$$VAR(x+y) = VAR(x) + VAR(y) + 2COV(x,y) \tag{1}$$

$$= VAR(x) + VAR(y) + 2CORREL(x,y) \times$$

$$STDDEV(x) \times STDDEV(y)$$

where

$$VAR(x) = \mathrm{E}\left[(x-\mu_x)^2\right] = \Sigma(x-\mu_x)^2 \mathrm{Pr}(x),$$

$$COV(x,y) = \mathrm{E}\left[(x-\mu_x)(y-\mu_y)\right] = \Sigma\Sigma(x-\mu_x)(y-\mu_y)\mathrm{Pr}(x,y),$$

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

$$STDDEV(x+y) = \sqrt{VAR(x+y)} \tag{2}$$

and

$$CORREL(x,y) = COV(x,y) + \{STDDEV(x) \times STDDEV(y)\}$$

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

$$STDDEV(x+y) = STDDEV(x) + STDDEV(y).$$

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 $CORREL(x,y) < 1$, then

$$STDDEV(x+y) < STDDEV(x) + STDDEV(y). \tag{3}$$

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:

$$VAR(x+y+z) = VAR(x) + VAR(y) + VAR(z) + 2COV(x,y) + 2COV(x,z) + 2COV(y,z) \tag{4}$$

and,

$$STDDEV(x+y+z) = \sqrt{VAR(x+y+z)} \tag{5}$$

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.,

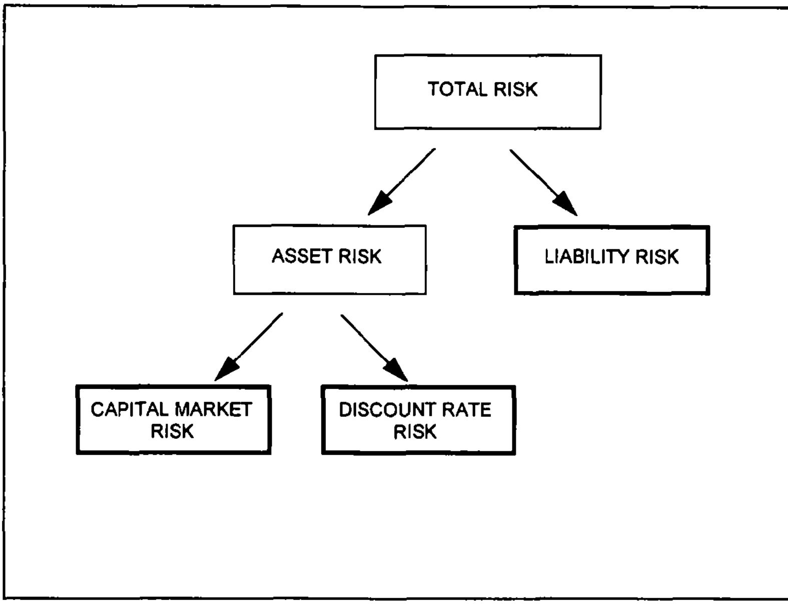
$$STDDEV(x+y+z) < STDDEV(x) + STDDEV(y) + STDDEV(z).$$

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.

Figure 8 **DECOMPOSITION OF RISK COMPONENTS**



This 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 model is run holding asset returns and interest rates constant while allowing liability cash flows to be stochastic. By running the model with deterministic liability cash flows and interest rates and stochastic asset returns, 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 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).

Table 1

Decomposition of Risk Runs

Run	Liabilities	Capital Market	Discount Rates
A	S	S	S
B	S	S	D
C	S	D	S
D	S	D	D
E	D	S	S
F	D	S	D
G	D	D	S
H	D	D	D

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 and how this information can be used to make more informed decisions.

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 make business decisions. Property/Casualty Insurance Company (PCIC) is a hypothetical insurance company with rapid growth plans. PCIC writes primarily short-tailed property lines. As a result, PCIC has amassed a substantial amount of CAT exposure. In response to the large potential variability of their liabilities, PCIC has traditionally invested its assets very conservatively: their current investment strategy is 20% cash and 80% bonds. Even with their conservative investment strategy, PCIC's senior management team was concerned that a large CAT might force them to seek a capital infusion in order to avoid regulatory action. This analysis focuses on two basic questions. First, what is the probability that

PCIC will need a capital infusion during the next three years given its current business plan. Second, if necessary, what is the best way to combine reinsurance and/or a revised asset allocation to reduce this capital risk while minimizing the reduction in economic value at the end of the three-year time horizon.

PCIC's liabilities 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 and results from a commercially available CAT model to generate 500 simulations of future premiums, loss payments and expenses using the process described above. PCIC's investment options were broken down into the following five asset categories:

- Cash Equivalents
- Short Term Bonds - 1 to 5 Years
- Medium Term Bonds - 5 to 10 Years
- Long Term Bonds - 10 to 30 Years
- Large Capitalization Stocks

Five hundred simulations of income and total returns for each of these five asset classes were generated and merged with the previously generated liability scenarios. PCIC's current asset allocation is 20% to cash, 25% to short term bonds, 50% to medium term bonds and 5% to long term bonds.

In order to set the baseline values for the analysis, PCIC's three-year business plan and current asset allocation strategy were run through the system. The system calculated the economic value and the progression of statutory surplus for each of the 500 scenarios modeled. The major differences between PCIC's economic value, as defined in the system, and its projected statutory surplus are: 1. economic value reflects the market (not book) value of all assets, 2. economic value discounts the future liability cash flows at the projected market rates of interest and 3. economic value includes a component related to future business, even business renewed beyond the end of the time horizon. Based on these 500 simulations, PCIC's average economic value at the end of the three-year horizon was $919.9 thousand with a standard deviation of $186.8 thousand. Based on the assumption that PCIC would need a capital infusion in any simulation in which the premium to surplus ratio exceeded 3.0 at any time during the three-year time horizon, these same simulations indicated that there was roughly a 5% chance that PCIC would need to raise capital during that time frame.

PCIC's management was comfortable with both the average economic value and economic risk associated with their current asset allocation. What concerned them was having such high a probably of needing to raise capital, especially given the large uncertainties associated with the CAT model's loss predictions. In order to better understand the drivers of this risk, both the economic value and statutory surplus risk were decomposed into an underwriting and an asset component. Specifically, by holding the loss, expense and premium cash flows constant and letting the capital market returns and economic 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 economic discount rates constant while using stochastic liability cash flows, PCIC was able to identify the component of total economic risk attributable to their underwriting operations.

Tables 2 and 3, below, show the asset and liability components of risk, as well as the corresponding covariance between the assets and the liabilities.

Table 2

Decomposition of Total Economic Value Risk - Current Portfolio

Run	Liabilities	Capital Market	Discount Rates	Std Dev (in $000s)	Variance (in $000s)
A	S	S	S	186.6	34,814.3
D	S	D	D	183.5	33,674.8
E	D	S	S	44.6	1,992.3

COV (Liab, Cap Mkt + Disc Rates)			
A	VAR (Liab+Cap Mkt+Disc Rate)	34,814.3	
D	VAR (Liab)	33,674.8	
E	VAR (Cap Mkt+Disc Rate)	1,992.3	
	COV (Liab,Cap Mkt+Disc Rate) = (A - D - E) * .5	(426.4)	
	CORREL (Liab,Cap Mkt+Disc Rate)	(0.052)	
VAR (Liab + Cap Mkt + Disc Rates)			% Total
D	VAR (Liab)	33,674.8	96.7%
E	VAR (Cap Mkt+Disc Rate)	1,992.3	5.7%
	COV (Liab,Cap Mkt+Disc Rate)* 2	(852.8)	
	VAR (Liab+Cap Mkt+Disc Rate)	34,814.3	
	STDDEV (Liab+Cap Mkt+Disc Rate)	186.6	

Table 3

Decomposition of Total Statutory Surplus Risk - Current Portfolio

Run	Liabilities	Capital Market	Discount Rates	Std Dev (in $000s)	Variance (in $000s)
A	S	S	S	179.0	32,028.8
D	S	D	D	178.9	32,004.1
E	D	S	S	22.8	520.2

COV (Liab, Cap Mkt + Disc Rates)			
A	VAR (Liab+Cap Mkt+Disc Rate)	32,028.8	
D	VAR (Liab)	32,004.1	
E	VAR (Cap Mkt+Disc Rate)	520.2	
	COV (Liab,Cap Mkt+Disc Rate) = (A - D - E) * .5	(247.8)	
	CORREL (Liab,Cap Mkt+Disc Rate)	(0.061)	
VAR (Liab + Cap Mkt + Disc Rates)			% Total
D	VAR (Liab)	32,004.1	99.9%
E	VAR (Cap Mkt+Disc Rate)	520.2	1.6%
	COV (Liab,Cap Mkt+Disc Rate)* 2	(495.5)	
	VAR (Liab+Cap Mkt+Disc Rate)	32,028.8	
	STDDEV (Liab+Cap Mkt+Disc Rate)	179.0	

By decomposing risk into its asset and liability component parts, it could be seen that over 95% of PCIC's total economic and statutory risk, as measured by variance, was due solely to the uncertainty surrounding the liability loss cash flows. Both PCIC's asset strategy and the covariance component of risk were negligible. As a result, the next step was for PCIC to develop an alternative reinsurance plan. After this plan, which included a substantial quota share treaty on one of the more CAT-prone lines, had been developed, the liability and financial runs were updated with the revised information.

As expected, the probability of needing to raise capital was reduced to a more acceptable level (i.e., less than 1% over the three-year time horizon) as a result of the revised reinsurance. In addition, the overall economic risk was reduced from \$186.8 thousand to \$111.6 thousand. Unfortunately, the overall economic value was also reduced from \$919.9 thousand to \$823.0 thousand.

PCIC's management was uncomfortable giving away nearly 10% of their company's economic value even given the dramatic reduction in risk. Given the small amount of risk generated by the asset portfolio, which was confirmed by decomposing the risk of the revised reinsurance position in Tables 4 and 5, we were confident that PCIC's asset allocation strategy could be changed to improve the economic value without sacrificing the risk reduction achieved. In order to identify such a strategy, our proprietary insurance optimizer was employed. Figure 9 shows PCIC's asset allocation efficient frontier along with the risk/reward point corresponding to PCIC's current portfolio with and without the reinsurance.

Table 4

Decomposition of Total Economic Value Risk - Revised Reinsurance

Run	Liabilities	Capital Market	Discount Rates	Std Dev (in $000s)	Variance (in $000s)
A	S	S	S	111.5	12,429.6
D	S	D	D	104.5	10,924.0
E	D	S	S	39.9	1,594.4

COV (Liab, Cap Mkt + Disc Rates)			
A	VAR (Liab+Cap Mkt+Disc Rate)	12,429.6	
D	VAR (Liab)	10,924.0	
E	VAR (Cap Mkt+Disc Rate)	1,594.4	
	COV (Liab,Cap Mkt+Disc Rate) = (A - D - E) * .5	(44.4)	
	CORREL (Liab,Cap Mkt+Disc Rate)	(0.011)	
VAR (Liab + Cap Mkt + Disc Rates)			% Total
D	VAR (Liab)	10,924.0	87.9%
E	VAR (Cap Mkt+Disc Rate)	1,594.4	12.8%
	COV (Liab,Cap Mkt+Disc Rate)* 2	(88.8)	
	VAR (Liab+Cap Mkt+Disc Rate)	12,429.6	
	STDDEV (Liab+Cap Mkt+Disc Rate)	111.5	

Table 5

Decomposition of Total Statutory Surplus Risk - Revised Reinsurance

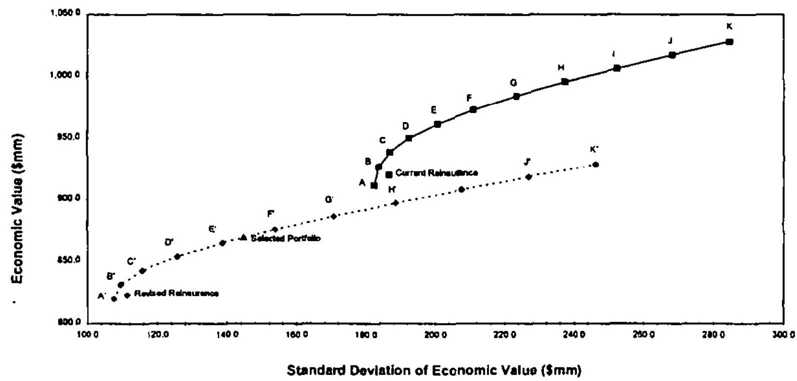
Run	Liabilities	Capital Market	Discount Rates	Std Dev (in $000s)	Variance (in $000s)
A	S	S	S	98.5	9,698.7
D	S	D	D	98.2	9,645.2
E	D	S	S	15.8	250.4

COV (Liab, Cap Mkt + Disc Rates)			
A	VAR (Liab+Cap Mkt+Disc Rate)	9,698.7	
D	VAR (Liab)	9,645.2	
E	VAR (Cap Mkt+Disc Rate)	250.4	
	COV (Liab,Cap Mkt+Disc Rate) = (A - D - E) * .5	(98.4)	
	CORREL (Liab,Cap Mkt+Disc Rate)	(0.063)	
VAR (Liab + Cap Mkt + Disc Rates)			% Total
D	VAR (Liab)	9,645.2	99.4%
E	VAR (Cap Mkt+Disc Rate)	250.4	2.6%
	COV (Liab,Cap Mkt+Disc Rate)* 2	(196.9)	
	VAR (Liab+Cap Mkt+Disc Rate)	9,698.7	
	STDDEV (Liab+Cap Mkt+Disc Rate)	98.5	

Figure 9

Economic Efficient Frontier

3-Year Time Horizon



Asset Allocation (%):	Current	A	C	E	G	K	A'	C'	E'	G'	K'
		Current Reinsurance					Revised Reinsurance				
Cash-U.S.A	20.0	79.2	0.0	0.0	0.0	0.0	30.6	0.0	0.0	0.0	0.0
Stck-U.S.A	0.0	8.5	22.7	44.8	64.7	100.0	5 4	24.5	45.9	65.3	100 0
Bonds 1-5	25.0	0.0	77.3	55 2	35.3	0.0	62.7	75 5	54.1	34.7	0.0
Bonds 5-10	50.0	0.0	0.0	0.0	0.0	0.0	1.3	0.0	0.0	0 0	0.0
Bond 10-30	5.0	12.2	0 0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Based on these results, PCIC was convinced that they could minimize the economic value reduction by taking on substantial additional risk on the asset side. Specifically, they were interested in a 50% stock, 50% short term bond allocation. This mix seemed to offer a reasonable trade-off between additional economic value (i.e., an increase from $823.0 to $869.5 thousand) and additional economic risk (i.e., an increase from $111.6 to $144.8 thousand) over just implementing the revised reinsurance. In addition, when we ran this strategy through the model, we discovered that the probability of needing a capital infusion was still roughly 1%. Finally, the decomposition of risk results for this asset allocation indicated a much better balance between liability and asset risks (see Tables 6 and 7).

Table 6

Decomposition of Total Economic Value Risk - Revised Asset Allocation

Run	Liabilities	Capital Market	Discount Rates	Std Dev (in $000s)	Variance (in $000s)
A	S	S	S	144.6	20,916.7
D	S	D	D	104.4	10,903.1
E	D	S	S	107.6	11,571.5

COV (Liab, Cap Mkt + Disc Rates)			
A	VAR (Liab+Cap Mkt+Disc Rate)	20,916.7	
D	VAR (Liab)	10,903.1	
E	VAR (Cap Mkt+Disc Rate)	11,571.5	
	COV (Liab,Cap Mkt+Disc Rate) = (A - D - E) * .5	(779.0)	
	CORREL (Liab,Cap Mkt+Disc Rate)	(0.069)	
VAR (Liab + Cap Mkt + Disc Rates)			% Total
D	VAR (Liab)	10,903.1	52.1%
E	VAR (Cap Mkt+Disc Rate)	11,571.5	55.3%
	COV (Liab,Cap Mkt+Disc Rate)* 2	(1,558.0)	
	VAR (Liab+Cap Mkt+Disc Rate)	20,916.7	
	STDDEV (Liab+Cap Mkt+Disc Rate)	144.6	

Table 7

Decomposition of Total Statutory Surplus Risk - Revised Asset Allocation

Run	Liabilities	Capital Market	Discount Rates	Std Dev (in $000s)	Variance (in $000s)
A	S	S	S	154.5	23,856.0
D	S	D	D	115.9	13,431.7
E	D	S	S	111.7	12,469.5

COV (Liab, Cap Mkt + Disc Rates)			
A	VAR (Liab+Cap Mkt+Disc Rate)	23,856.0	
D	VAR (Liab)	13,431.7	
E	VAR (Cap Mkt+Disc Rate)	12,469.5	
	COV (Liab,Cap Mkt+Disc Rate) = (A - D - E) * .5	(1,022.6)	
	CORREL (Liab,Cap Mkt+Disc Rate)	(0.079)	
VAR (Liab + Cap Mkt + Disc Rates)			% Total
D	VAR (Liab)	13,431.7	56.3%
E	VAR (Cap Mkt+Disc Rate)	12,469.5	52.3%
	COV (Liab,Cap Mkt+Disc Rate)* 2	(2,045.1)	
	VAR (Liab+Cap Mkt+Disc Rate)	23,856.0	
	STDDEV (Liab+Cap Mkt+Disc Rate)	154.5	

This outcome shows the importance of being able to analyze several different decisions (e.g., asset allocation and reinsurance) in a single, consolidated analysis. Specifically, PCIC would not have been able to assess this outcome using the traditional approach of evaluating these types of decisions independently. On a stand alone basis, PCIC's senior management would probably have rejected just the revised reinsurance structure since it gave up too much economic value. In addition, they would have never considered increasing PCIC's asset risk given their concern over requiring additional capital. As Figures 10 and 11 show, by combining the decisions, we have developed an economically viable alternative with substantially less downside exposure.

Figure 10

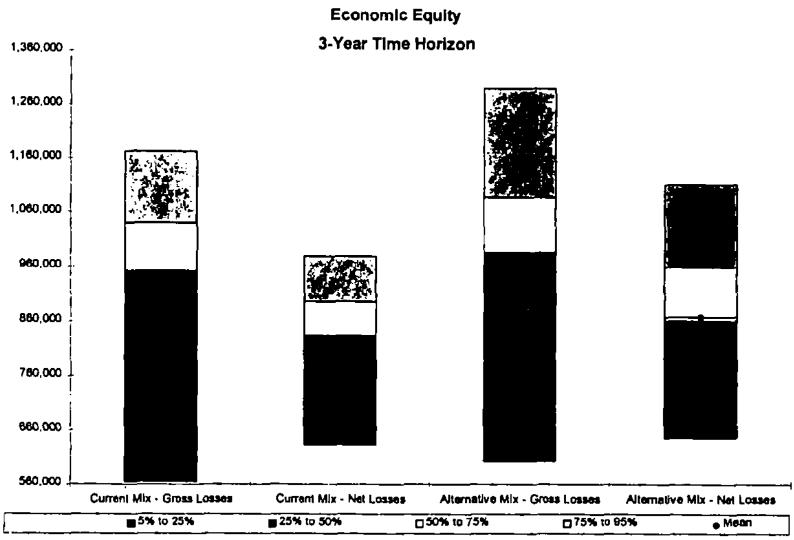
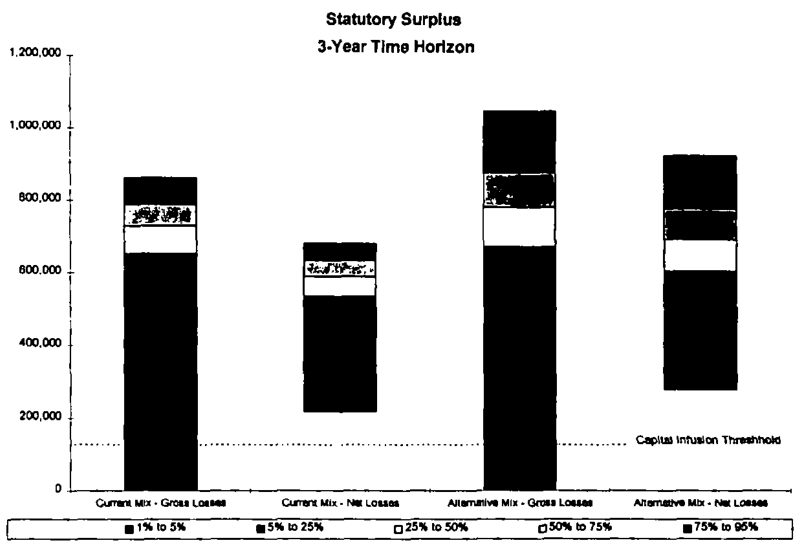


Figure 11



However, this combination is not without its own problems. One of its largest drawbacks is the large decrease in GAAP Net Operating Income and the resulting reduction in ROE. Specifically, when the business is profitable, the reinsurance cedes off a substantial amount of Operating Income. This is compounded by the fact that realized gains and losses, which comprise most of the total return for equities, are not included in Operating Income. One way to offset this impact would be for PCIC to swap its 150 million of debt from fixed to floating. While the model can be used to perform this type of analysis, the details of this strategy will be left for a subsequent paper.

Another issue is the impact this asset/reinsurance strategy would have on rating agency, regulatory and analysts' perceptions and views towards PCIC. Obviously, the strategies illustrated in this case study were extreme to demonstrate our point. Substantial work needs to be done to educate constituents on the benefits of a DFA type approach compared to the current piecemeal analysis which can be detrimental to the long term well being of the industry.

Conclusion

By undertaking this analysis, PCIC not only identified their asset and liability risk exposures, but, more importantly, their combined exposure. Armed with this information, they are able to revise both their reinsurance and asset allocation strategies to reduce their solvency concerns while minimizing the amount of decrease in expected economic value.

It must be made clear, however, that this analysis was based on a property/casualty insurance company with a large CAT exposure. Because the process is dependent on a company's general ALM characteristics (i.e., liability structure, surplus level) different companies will likely 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 different 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. 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.

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