A Cost/Benefit Analysis of Alternative Investment Strategies Using Dynamic Financial Analysis Tools

Gerald S. Kirschner, FCAS, MAAA

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Abstract

The focus of the 2000 Call for Papers, as put forth by the Casualty Actuarial Society's Committee on Dynamic Financial Analysis, is the "evaluation of strategic alternatives and presentations of conclusions." This paper presents such a study. The paper is laid out in much the same way the analysis was performed, as a journey of discovery, in which one set of conclusions would lead to another set of questions and so on and so forth. The journey is by no means complete. Many more questions are still to be asked and many more conclusions are yet to be drawn. However, one must recognize that most, if not all DFA analyses start by overcoming small hurdles on the way to addressing larger ones. That is what is presented here; a beginning, an analysis on a small scale that has laid the basic framework for more thorough and complex analyses down the road.

Acknowledgement

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Introduction

For the past several years, there has been an annual call for papers on Dynamic Financial Analysis (DFA).[1] The topics of these calls have progressed through many of the key elements in the creation and use of models appropriate for DFA. The current topic focuses on the use of a DFA model in order to achieve an objective – namely the use of a model to evaluate strategic alternatives and to develop information that can be presented as a series of conclusions and strategic recommendations. Previous topics have focused on more elemental aspects of the modeling process – designing a model, parameterizing it, etc.[2]

Since the presentation of results, not model description or model parameterization is the subject of the 2000 Call for Papers, this paper will not go into much detail on the underlying model itself. Readers interested in learning more about these aspects of DFA model development and usage are encouraged to review submissions from previous DFA Calls that do focus on the more technical aspects of dynamic financial modeling. Instead, this paper will follow the trail of

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[1] Dynamic financial analysis is defined by the Casualty Actuarial Society's Dynamic Financial Analysis Committee as "a systematic approach to financial modeling in which financial results are projected under a variety of possible scenarios, showing how outcomes might be affected by changing internal and/or external conditions." Furthermore, the Actuarial Standards Board defines a "scenario" as a set of economic, demographic, and operating assumptions on the basis of which projections are made." In the context of this paper, a scenario can be thought of as one possible combination of external economic conditions and random selections from a variety of statistical distributions that describe the variability inherent in certain aspects of the company's operations.

[2] The topics of the prior years' Call Papers are as follows:

- 1996: Papers that describe DFA models that have been put to use at property-casualty insurers;
- 1997: Papers that identify and explain the variables that should be incorporated into a DFA model;
- 1998: Papers that discuss the applications and uses for DFA models;
- 1999: Papers that discuss the parameterization of DFA models.

discovery that ultimately led to the framing of the question to be answered and the structuring and presentation of information in response to that question. As such, the paper is organized in a series of steps that build one upon the other. A brief overview of the steps is provided to assist the reader in following the discussion:

Step 1) Frame a question suitable for analysis using the entity's DFA model;

Step 2) Identify one or more key measurement values, or "metrics" that will be used to decide if one strategy[3] is "better" than another strategy;

Step 3) Analyze the environment in which the company operates in order to gain or improve the company's understanding of the importance of internal and external influences on the key metric or metrics;

Step 4) Establish the base strategy against which alternative strategies are to be compared;

Step 5) Postulate a series of alternative strategies against which the base strategy will be compared;

Step 6) Evaluate the model's results for the base strategy versus the alternative strategies. Compare results in the context of both a "return" metric and a "risk" metric;[4]

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[3] A strategy, in the context of this paper, can be thought of as a series of management decisions that are made with the goal of achieving certain objectives that are desirable to senior management.

[4] A "return" metric is one that seeks to maximize something of positive value or minimize something of negative value to the organization. Common examples of return metrics might include operating income or surplus growth. A "risk" metric is a measurement of the volatility associated with each strategy. A traditional statistical risk metric is the standard deviation or the variance of the return metric's observed values around the mean value. Anther risk metric might be the number of times an observation falls below a minimally acceptable threshold value.

Step 7) Refine the alternative strategies, discarding the ones that are not appealing, and adjusting the ones that are appealing in an effort to develop an "efficient frontier" of alternative strategies;

Step 8) Run the model using the refined strategies. Analyze results and develop final conclusions and recommendations.

The Client

The "client" for this project was the investment department of a large multi-line insurance company. The client wanted to understand how it could reposition the company's asset portfolio so as to increase the likelihood of raising the entity's net worth[5] while minimizing the potential of running afoul of the various capital adequacy tests that exist in the insurance marketplace.

For simplicity, the measure of net worth that will be used through the remainder of this paper is **economic net worth**. Economic net worth differs from statutory surplus in the following ways:

- All invested assets are marked to market;
- Uncollected premium is recorded at its present value;
- Loss and loss adjustment expense reserves are recorded at the present value of the "actual" future loss and loss adjustment expense cashflows.[6] Note that

[5] "Net worth" is a generic description of the value metric that the company wanted to maximize. The specific composition of the value metric is not relevant to the discussion at hand. It could be any number of things, including but not limited to statutory surplus, GAAP equity, economic net worth (all assets at their market values, all liabilities at their present values), or some combination of income and equity elements.

[6] The ability to accurately predict the amount and timing of actual future cashflows is not possible in real life. It is, however, possible in the modeled environment through the use of assumptions about the future. A real life calculation of this economic balance sheet item would be a "best estimate" at any given valuation date. In the modeled world, no such uncertainty exists. Through the assumptions included in the model, the modeled world removes uncertainty that exists in the real world.

from this point on, it is assumed that any discussion of losses or loss cashflows includes loss adjustment expenses as well as losses;

- The unearned premium reserve is recorded at the present value of the “actual” future loss outflows that will arise from that portion of in-force policies still to be earned.

The Question to be Addressed

The company began its research by thinking about the areas of operation within an insurance organization that could most easily be altered in search of improved economic net worth. The company concluded that there are really only three areas that would be both sizable enough and substantially controllable enough to warrant consideration:

- Asset mix – the company could modify how it reinvested available cashflow. Available cashflow is the net new money the company has collected during the year. It is composed primarily of cash from maturing and prepaying bonds, investment income collected, and net cash from underwriting. This is also referred to as a ”new money” reinvestment approach. The new money approach can be contrasted against a “portfolio rebalancing” approach, in which the entire portfolio is restructured at the end of each year so that the relative percentage of assets within each asset class matches a targeted overall asset distribution.
- Volume of new and renewal writings – the company could decide to write more or less business in the coming years.
- Profitability of new and renewal writings – to the extent that the company is not a price taker in any given market, the company could endeavor to increase the amount of premium received for policies written.

Of these three, the company focused only on the first one in this analysis. The latter two are to be the subjects of future analyses.

Quantifying Relative Influences of Different Areas of Variability

Establishing the Fully Deterministic State

To validate or disprove the thesis with regards to the major drivers of economic net worth, the company established what will be referred to as the results associated with a "**fully deterministic state**." The fully deterministic state uses as inputs:

- A static set of economic assumptions that were derived from a combination of current economic conditions and long term historical averages;
- A static set of underwriting assumptions, including the amounts of premium to be written, the loss and expense ratios that will be experienced on the premium writings, the and the timing of the payout of claims;
- A static estimate of the liability for unpaid claims as of the model start date (time T_0) and the timing of the future payment of the unpaid claims obligations;
- A static asset reinvestment strategy that defines how the model purchases new assets over the projection horizon (times T_1 through T_5).

Establishing the Stochastic Base Case

The "**stochastic base case**" differs from the fully deterministic state in six areas. These are the areas of variability or randomness within the model. The six variable elements were interest rates, inflation rates, stock market returns, the adequacy of time T_0 loss reserves, the loss ratio on future writings and the speed with which loss reserves and claims on future writings were paid out. Underlying the stochastic base case is a series of just over eight hundred different "iterations", or alternative projections of the company's financial performance in times T_1 through T_5.

Economic variability (i.e. variability in interest rates, inflation rates, and stock market returns) was derived by looking back into history. It was assumed that history

would provide a sufficiently robust range of economic conditions to reasonably predict the range of possible future economic conditions. The historical dataset used consists of monthly observations from January 1926 to November 1998. A series of 800+ "annual rates of change" was computed for each economic variable. For example, the first rate of change for long-term interest rates is the yield on a long-term bond issued in January 1927 divided by the yield on a long-term bond issued in January 1926. The second rate of change is the yield on a long-term bond issued in February 1927 divided by the yield on a long-term bond issued in February 1926. The final rate of change is the yield on a long-term bond issued in November 1998 divided by the yield on a long-term bond issued in November 1997.

The first iteration of the model would apply the January 1927/January 1926 rate of change to the actually observed economic conditions at time T_0 to develop the projected economic conditions at time T_1. The first iteration would then apply the January 1928/January 1927 rate of change to the projected time T_1 economic conditions to develop the projected economic conditions at time T_2. The January 1929/January 1928 rate of change would be used to project time T_3 conditions, the January 1930/January 1929 rate of change would be used to project time T_4 conditions and the January 1931/January 1930 rate of change would be used to project time T_5 conditions. The second iteration would use the rates of change between February 1926 and February 1927 to go from time T_0 to time T_1, and the rate of change between February 1927 and February 1928 to go from time T_1 to time T_2, etc., etc., etc.[7]

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[7] Two major benefits are achieved by using historical economic information. One is from the standpoint of the model builder/user. If future economic scenarios are generated by a model (see Ahlgrim, et al., "Parameterizing Interest Rate Models," Casualty Actuarial Society Forum, Summer 1999, pp. 1-50 for a description of different types of economic scenario generation models), appropriate cause and effect relationships must be established between the key economic drivers. This is one of the more difficult and contentious areas of model parameterization. By using historical data, there is no need to establish causal relationships. It is enough to know that in year A, interest rates moved by X%, while inflation rates moved by Y%, and the stock market moved by Z%. The underlying causal relationships become superfluous because all that is needed is the actual

The three non-economic sources of variability (loss ratios, loss reserve adequacy, and payout pattern randomness) were modeled through a more traditional process. Here, historical results were examined to develop the parameters of lognormal distributions that could be used to describe the observed variability. A series of random numbers were generated. These random numbers in turn were used to produce random values from each of the lognormal distributions. Each lognormal distribution was assumed to be independent of the others.

Figure 1 displays the difference between the company's economic net worth at the end of time T_5 under the fully deterministic state versus the values produced by "turning on" the variability and volatility in interest rates, stock market returns, inflation rates, loss ratios, loss reserve estimates and payout patterns.

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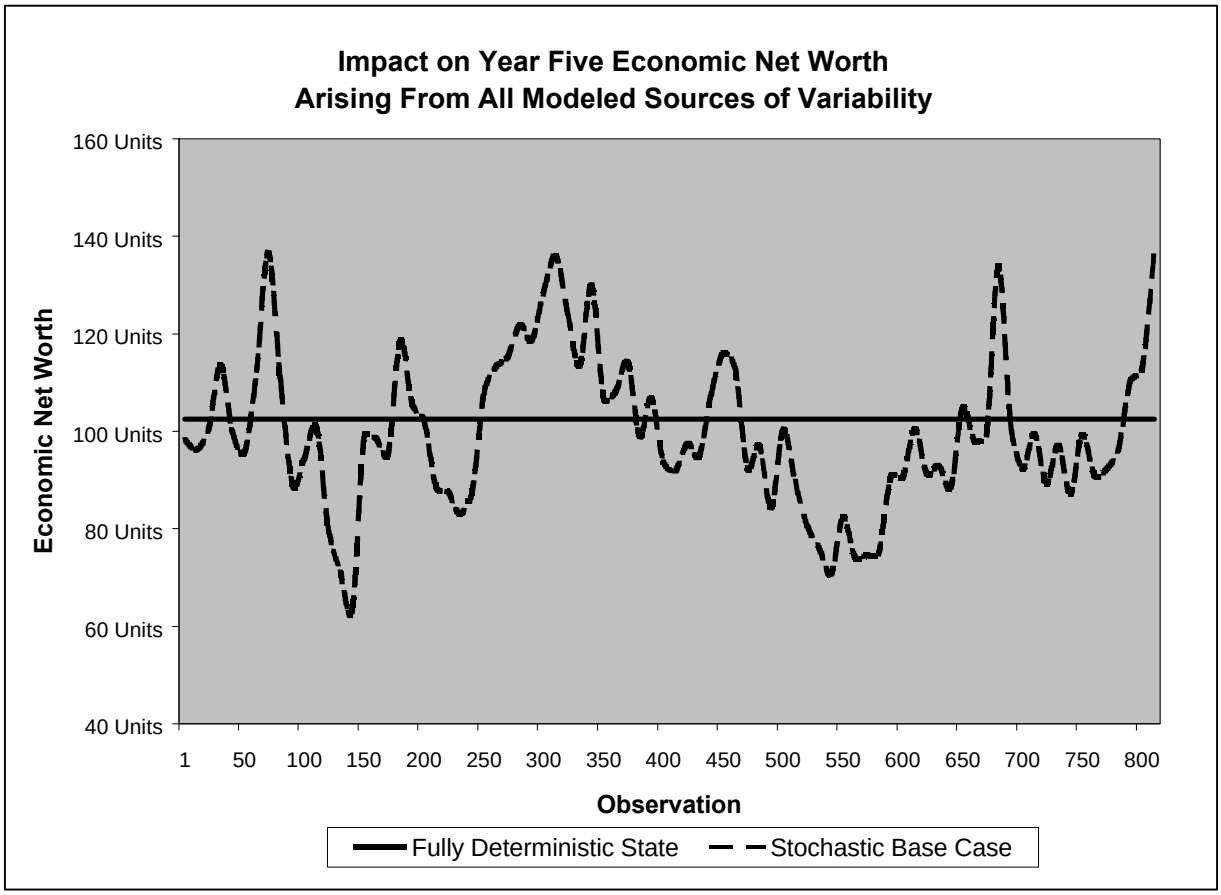
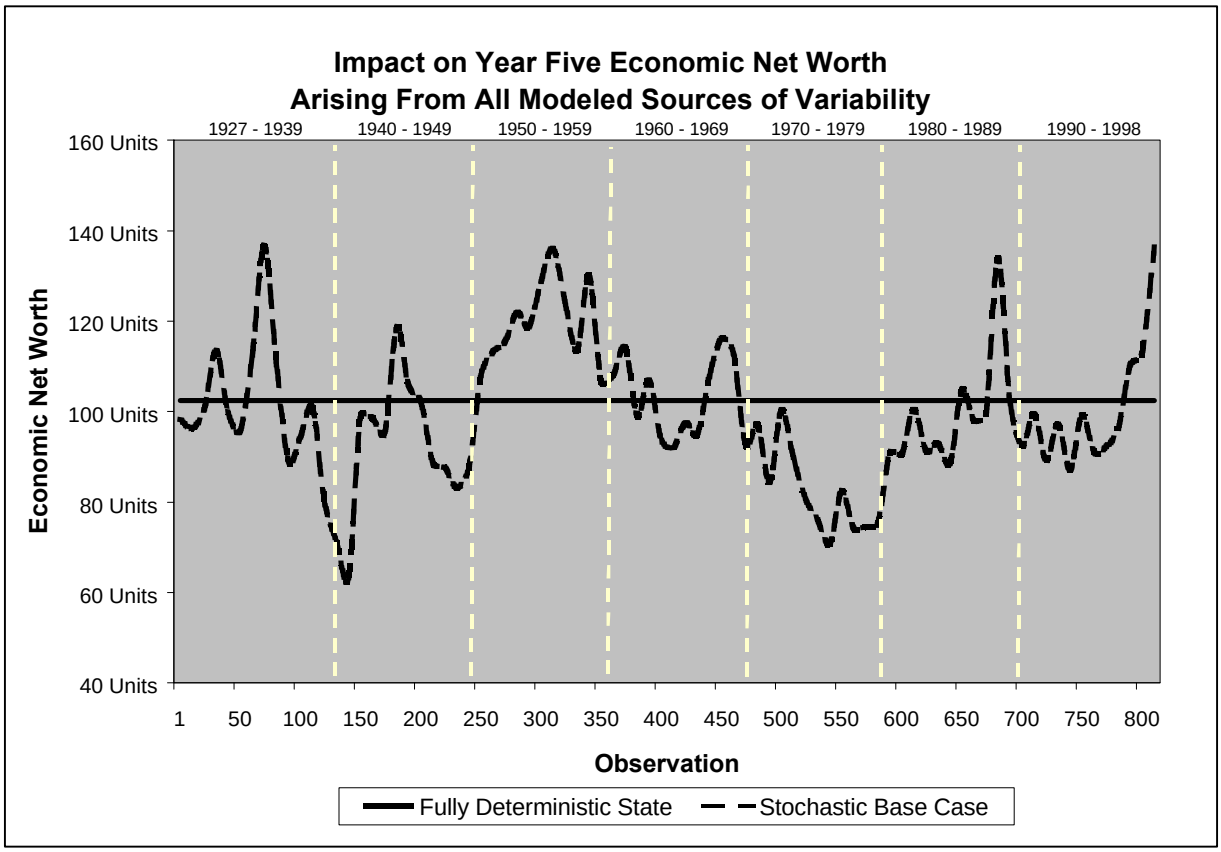
observations. The second benefit is from the standpoint of results presentation. Results can now be presented in the context of history. For example, the impact of a recurrence of the 1970's stagflation can be prefaced by a comment such as, "Now suppose we were to try this business plan while the economy goes through a crisis similar to what was endured in the late 1970s…"

Figure 1



As noted in the explanation of how the economic variability was created, if the progression of data points for the stochastic base case in Figure 1 seem as if they are based on some underlying time series, it is because they are. Observation one reflects the economic conditions between January 1926 and January 1931, observation two reflects the economic conditions between February 1926 and February 1931, and so on and so forth. By retaining the time series concept in the graphical display, it is possible to focus an audience's attention on the economic conditions in one period or another, a capability that would not exist if the results were sorted from low to high. Figure 2 redisplays the results from Figure 1, but this time with the historical context that underlies the economic conditions also displayed.

Figure 2

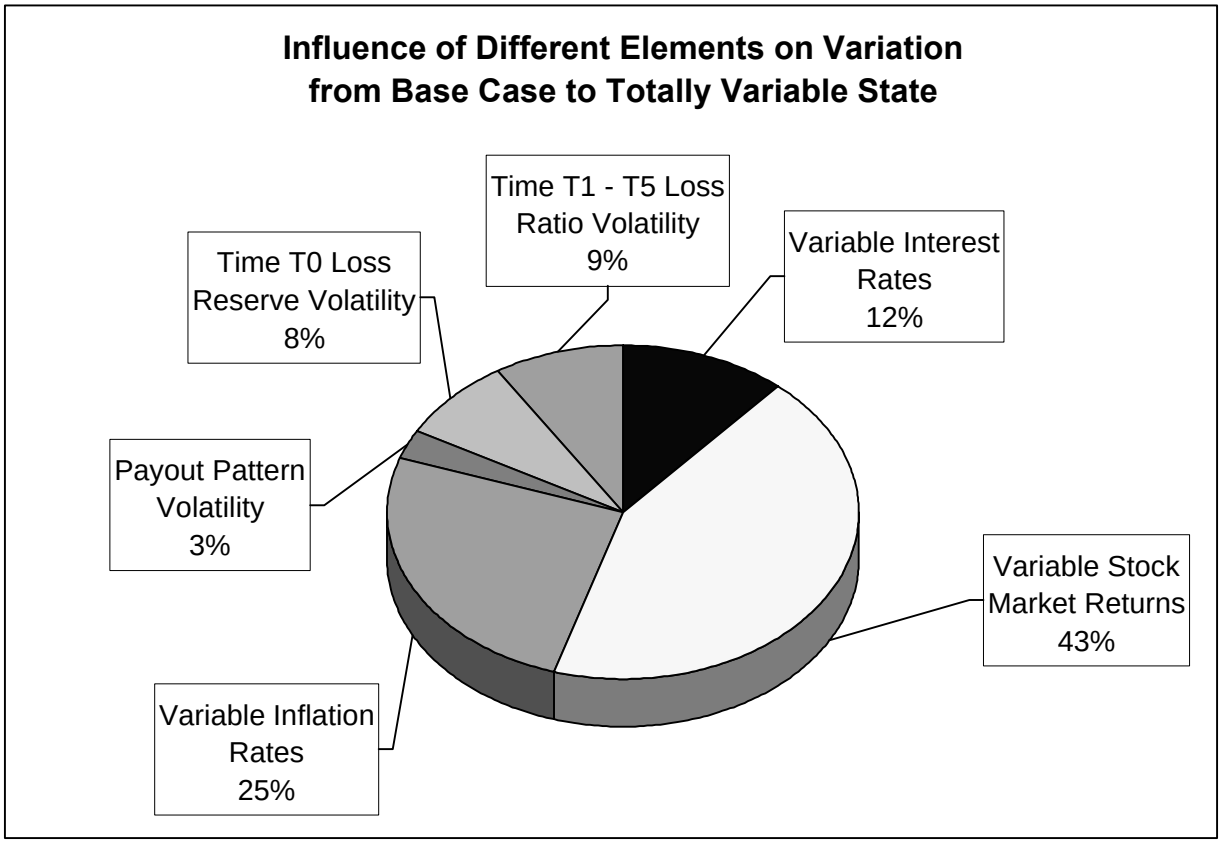


To understand how much of difference in observed net worth values could be attributed to the six volatile elements, the company regressed the difference between the deterministic state value and the stochastic base case values with regards to changes in the values of the volatile elements. The regression's R^2 value indicated that approximately 84% of the total variability was attributable to changes in the values of the six volatile elements.

To quantify the relative influence of each of the six volatile elements, the analysis compared the relative level of variation in the time T_5 net worth that was caused by making each individual element volatile. The pie chart in Figure 3 shows the relative influence of each of the six volatile elements in producing the change from the base case values to the volatile values. This supports the company's *a priori* hypothesis that the relative significance of the external environment is greater

than that caused by noise in the company's loss reserve, loss payout, or future loss ratio assumptions.

Figure 3



Asset Mix Alternatives

The company analyzed the relative influence of asset mix by turning "on" the volatility in all modeled elements with volatility provisions, namely interest rates, inflation rates, stock market returns, loss ratios, loss reserve adequacy and loss payout speed. The asset strategy used in this simulation was a "status quo" one, i.e. one in which the mix of new asset purchases was the same as the mix of assets at time T_0. As noted earlier, this is the "stochastic base case." The simulation model was then run six additional times, altering the asset reinvestment strategy in each of

the subsequent runs. The different asset reinvestment strategies tested are shown in Table 1.

Table 1

	Status Quo	Alternate 1	Alternate 2	Alternate 3	Alternate 4	Alternate 5	Alternate 6
Government bonds	6%	100%					
Corporate bonds	60%		100%				
High yield bonds	2%			100%			
Tax-exempt bonds	14%				100%		
Cash	5%					100%	
Common stock	13%						100%

It was assumed that the "government" bond was a ten-year Treasury bond and that bonds purchased in the other bond classes would have approximately a ten year average life and a seven year duration.[8] The interest rate applied to cash balances was assumed to be equal to the simulated interest rate for a one-year Treasury bond. The total return of common stocks was assumed to be equal to the simulated return of the overall stock market index. Table 2 shows the modeling parameters used to establish yield relationships between the different bond classes. The company's investment department established these parameters. They represent the

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[8] The weighted average life of a bond is calculated as $\sum_{t=1}^{n} CF_t * t \Big/ \sum_{t=1}^{n} CF_t$

The duration of a bond is calculated as $\sum_{t=1}^{n} \frac{t * CF_t}{(1+y)^t} \Big/ \sum_{t=1}^{n} \frac{CF_t}{(1+y)^t}$

where t = year of the cash flow (i.e. year 1, year 2, etc.)

CF_t = cash flow in year t

n = number of years to maturity

y = yield to maturity

company's expectations about average current and future yields available in the bond market.

Table 2

Bond	Coupon premium = assumed additional yield over the yield on a 10 year Treasury bill
Government bonds	No premium. The interest rate simulation process derives the yield.
Corporate bonds	+125 basis point premium
High yield bonds	+350 basis point premium
Tax-exempt bonds	-100 basis point premium
All Cash (a proxy for continuous reinvestment in short-term government bonds – bonds with maturities of 6 months to 1 year)	No premium over the yield on a 1-year Treasury bill. The interest rate simulation process derives the yield on a 1 year Treasury bill.

Table 3 shows the time T_5 economic net worths' mean values and standard deviations under the status quo and the six alternative reinvestment scenarios:

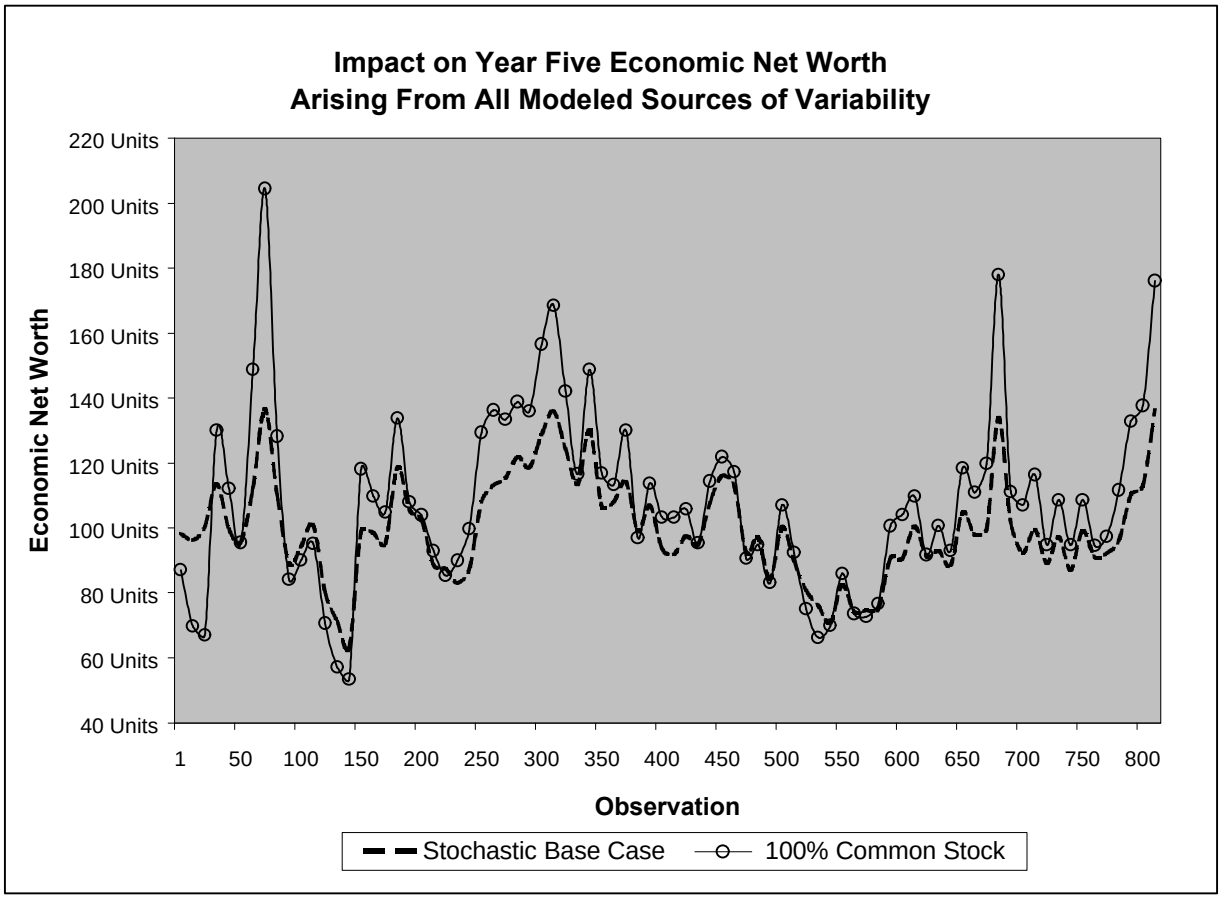
Table 3

	Base Status Quo	Alt. 1: All Govt. Bonds	Alt 2: All Corp. Bonds	Alt 3: All High Yield Bonds	Alt 4: All Tax Exempt Bonds	Alt 5: All Cash	Alt 6: All Common Stock
Economic Net Worth Mean Value	100.0	97.2	98.6	100.6	98.3	97.9	108.0
Percent increase over Status Quo	N/A	-2.8%	-1.4%	0.6%	-1.7%	-2.1%	8.0%
Standard Deviation	15.6	14.0	14.1	14.2	14.6	14.3	27.3
Percent increase over Status Quo	N/A	-10.6%	-9.9%	-8.8%	-6.6%	-8.5%	74.6%

From this perspective, it appears that the alternative of reinvesting all new money in common stocks is the preferred alternative. The average economic net

worth increases by 8.0% and, while the standard deviation of the results increases by 74.6%, it is only when the stock market experiences a substantial downturn that the economic net worth under the common stock reinvestment strategy falls below the base strategy. A graphical comparison of the status quo versus the "100% common stock" strategy is shown in Figure 4.

Figure 4



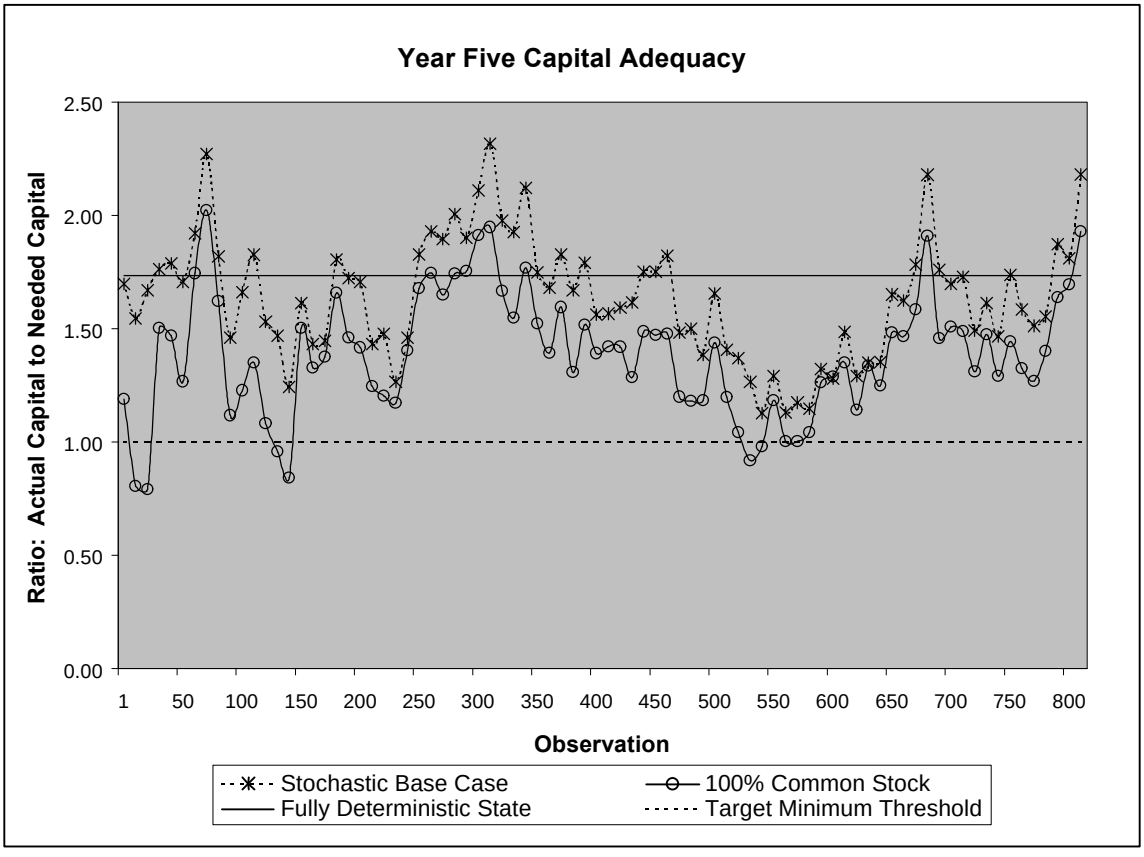
The Other Consideration: Risk Measurements

The desire to grow the company's net worth to the greatest degree possible is only half of the story. The other half of the story is the potential drop in asset values inherent in pursuing a more volatile investment strategy. The more volatile the investment strategy, the greater the potential swings in both economic net worth and statutory surplus. As the company pursues its quest for enhanced net worth, the company must remain cognizant of how it is being viewed by the outside world. The

company, through analyses of peer groups and through conversations with the different rating agencies, has developed a “targeted minimum capital” metric against which statutory surplus can be compared. (This threshold does not have to be equal to the level of capital needed to avoid regulatory oversight, i.e. twice the company’s Authorized Control Level. It can be something of the company’s choosing.) It is the company’s objective to never have statutory surplus fall below this threshold.

The chart in Figure 5 shows how the fully deterministic state, the stochastic base case and the “100% common stock” reinvestment strategies fare versus the threshold. As can be seen, the fully deterministic state is substantially in excess of the threshold. However, when the last seventy years of economic history are overlaid upon the current reinvestment strategy (the stochastic base case), instead of the deterministic economic conditions, it can be seen that the current reinvestment strategy at times places the company close to the threshold. If the strategy of reinvesting all new money into common stocks were to be followed and history were to repeat itself, there are several instances of stock market declines that would place the company below the targeted minimum threshold.

Figure 5



As indicated in the pie chart in Figure 3, the three major drivers of variation between the fully deterministic state and the stochastic base case were variations in common stock returns, interest rates, and inflation rates. To verify that the major cause of the situations in which the 100% common stock reinvestment strategy runs into trouble is due to stock market volatility and not interest rate or inflation rate volatility, a series of regression equations were developed. Each equation compares the held/needed capital ratio under the 100% common stock reinvestment strategy to an element in the economic environment. These can be seen in the graphs in Figure 6, Figure 7, and Figure 8. The significance, or lack thereof, of the regression equations displayed in Figures 6, 7, and 8 support the *a priori* expectation that neither interest rate volatility nor inflation rate volatility are major influences on the capital adequacy of the 100% common stock strategy.

Figure 6

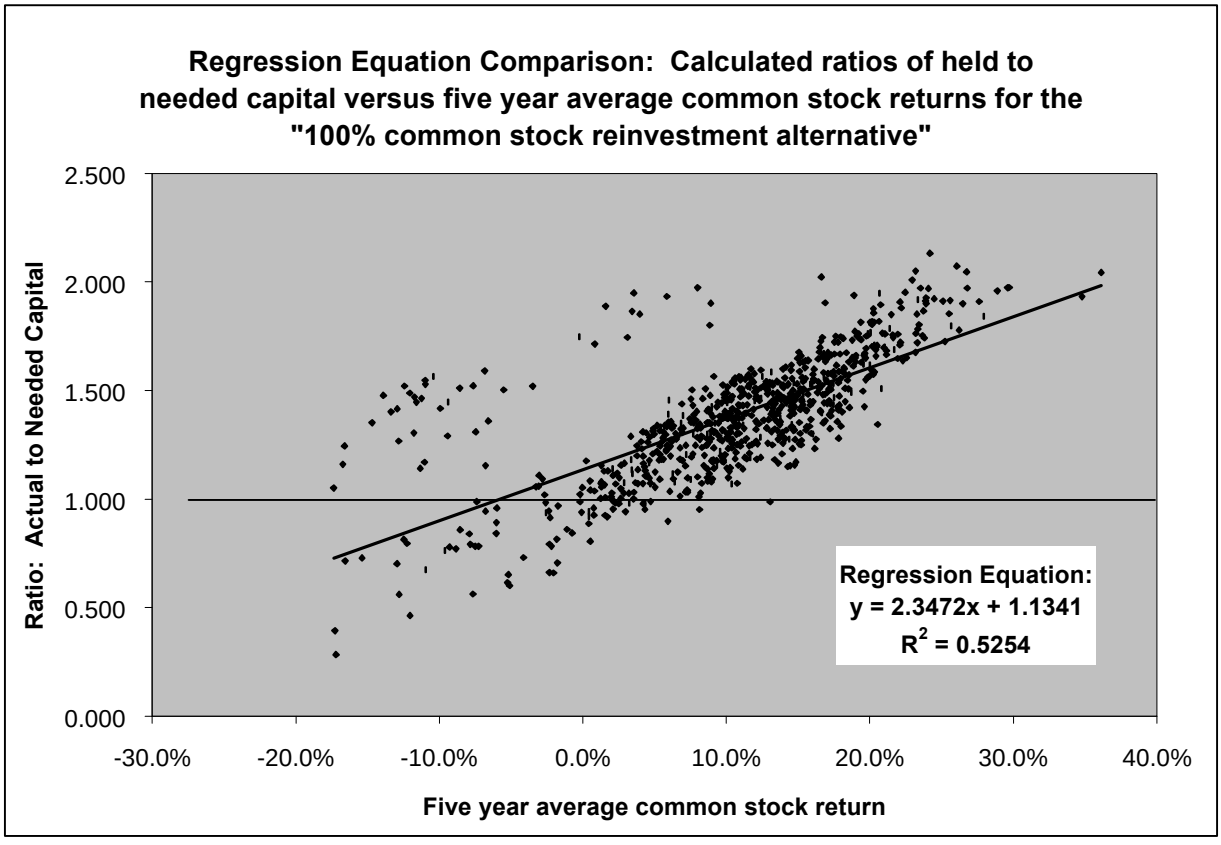


Figure 7

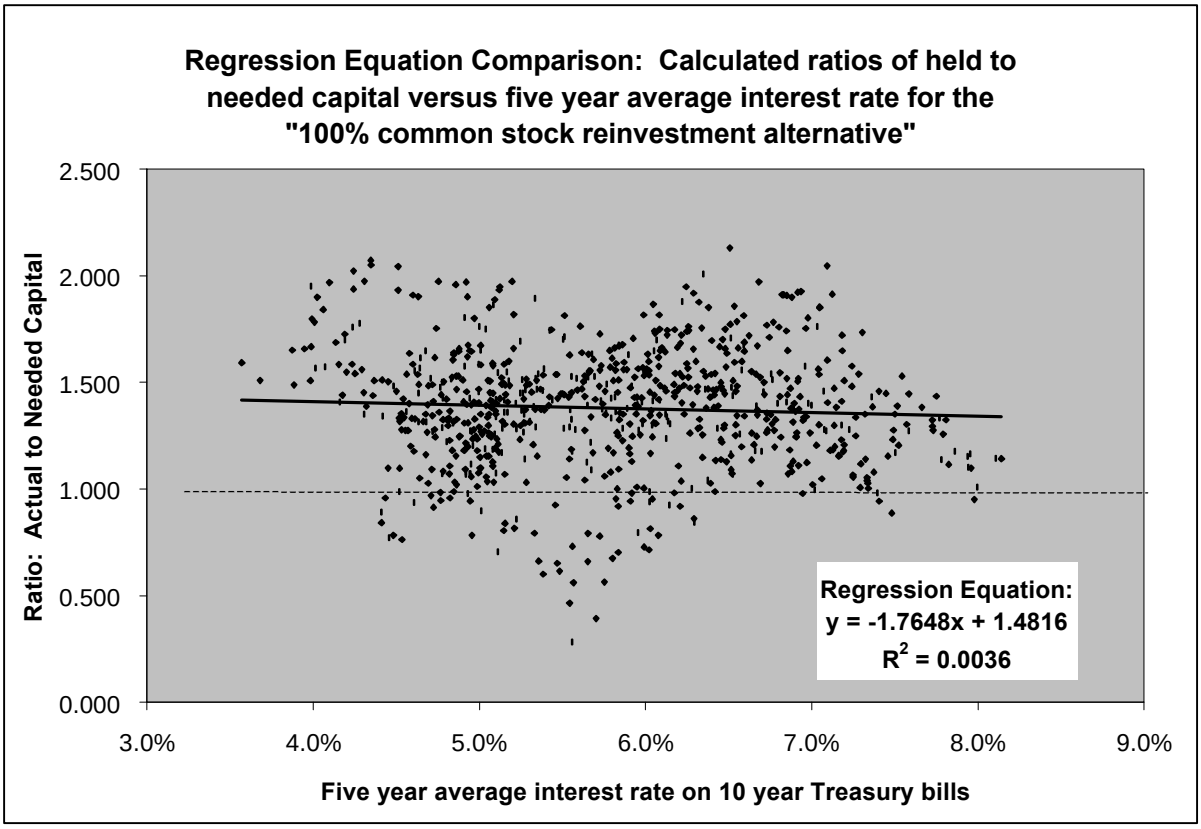
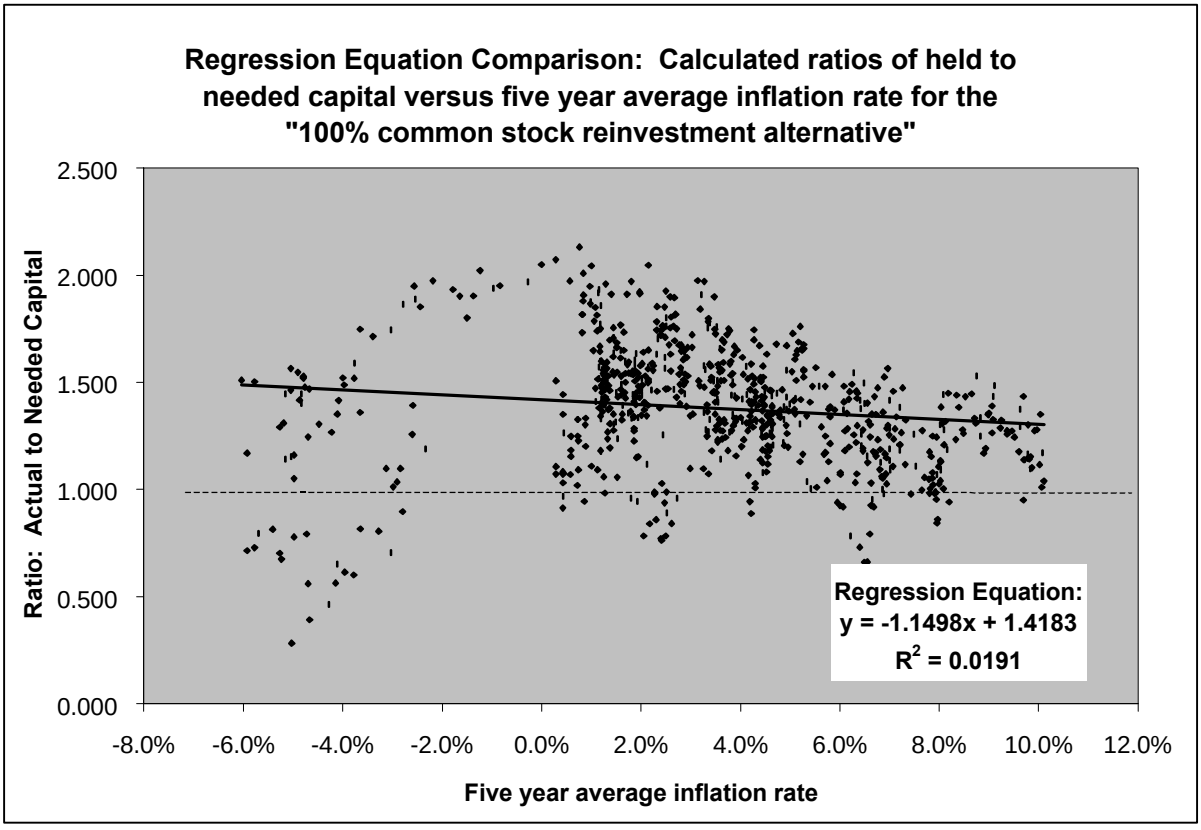


Figure 8



Clearly, then, the strategy of reinvesting all free cash flow in common stock leaves the company exposed to the possibility of an impaired capital base should common stock performance falter. The regression analysis in Figure 6 indicates that, on the average, a sustained common stock return of –5% will lead to an undesirably low level of held statutory capital.

Asset Mix Alternatives Revisited

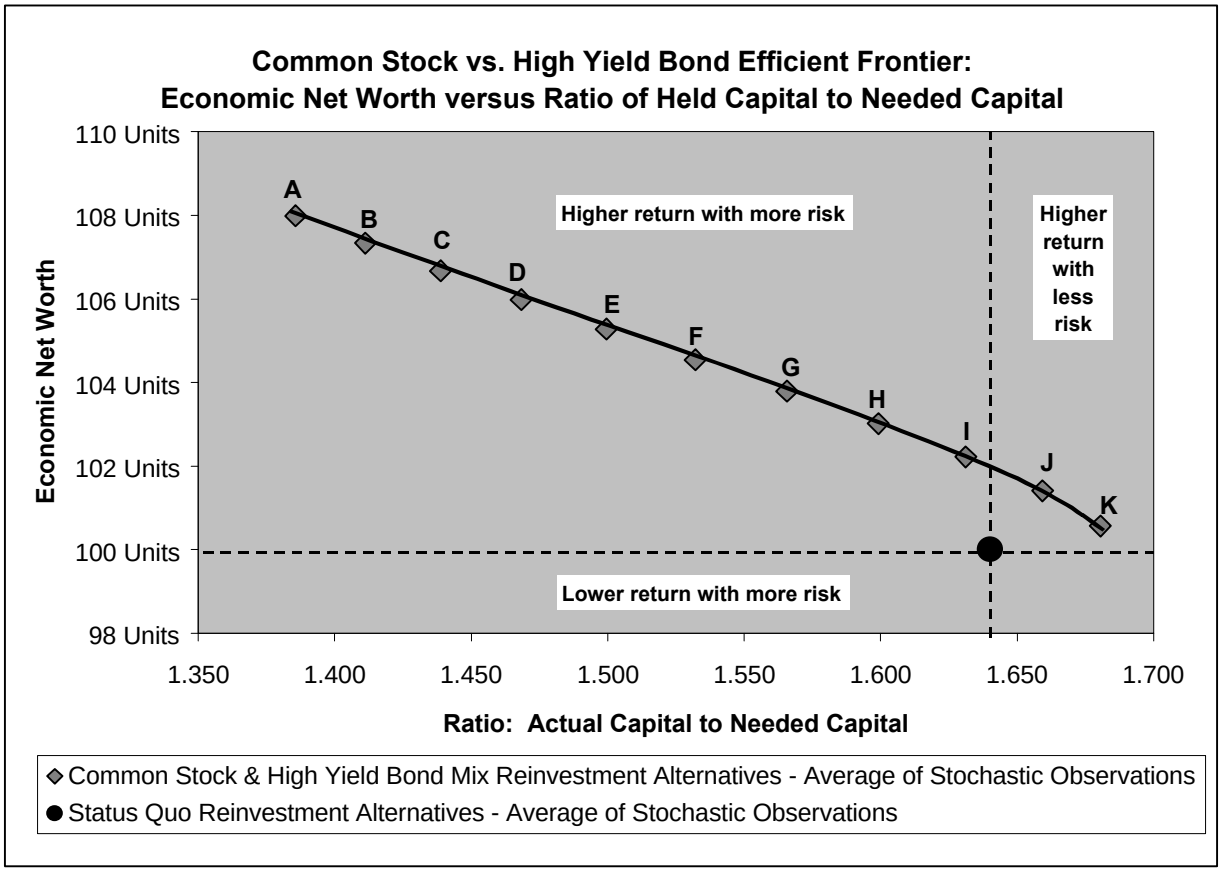
After seeing the potential downside risk of moving completely towards a strategy of common stock reinvestment, the company revisited the information in Table 3. This information is redisplayed in Table 4. The company's desire was to find an asset allocation strategy that enhanced future net worth beyond what the current "status quo" strategy would produce, yet would not result in quite so much downside risk exposure as was produced by the "100% common stock" strategy.

Table 4

	Base Status Quo	Alt. 1: All Govt. Bonds	Alt 2: All Corp. Bonds	Alt 3: All High Yield Bonds	Alt 4: All Tax Exempt Bonds	Alt 5: All Cash	Alt 6: All Common Stock
Economic Net Worth Mean Value	100.0	97.2	98.6	100.6	98.3	97.9	108.0
Percent increase over Base	N/A	-2.8%	-1.4%	0.6%	-1.7%	-2.1%	8.0%
Standard Deviation	15.6	14.0	14.1	14.2	14.6	14.3	27.3
% of simulated scenarios that fall below capital threshold	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	7.9%

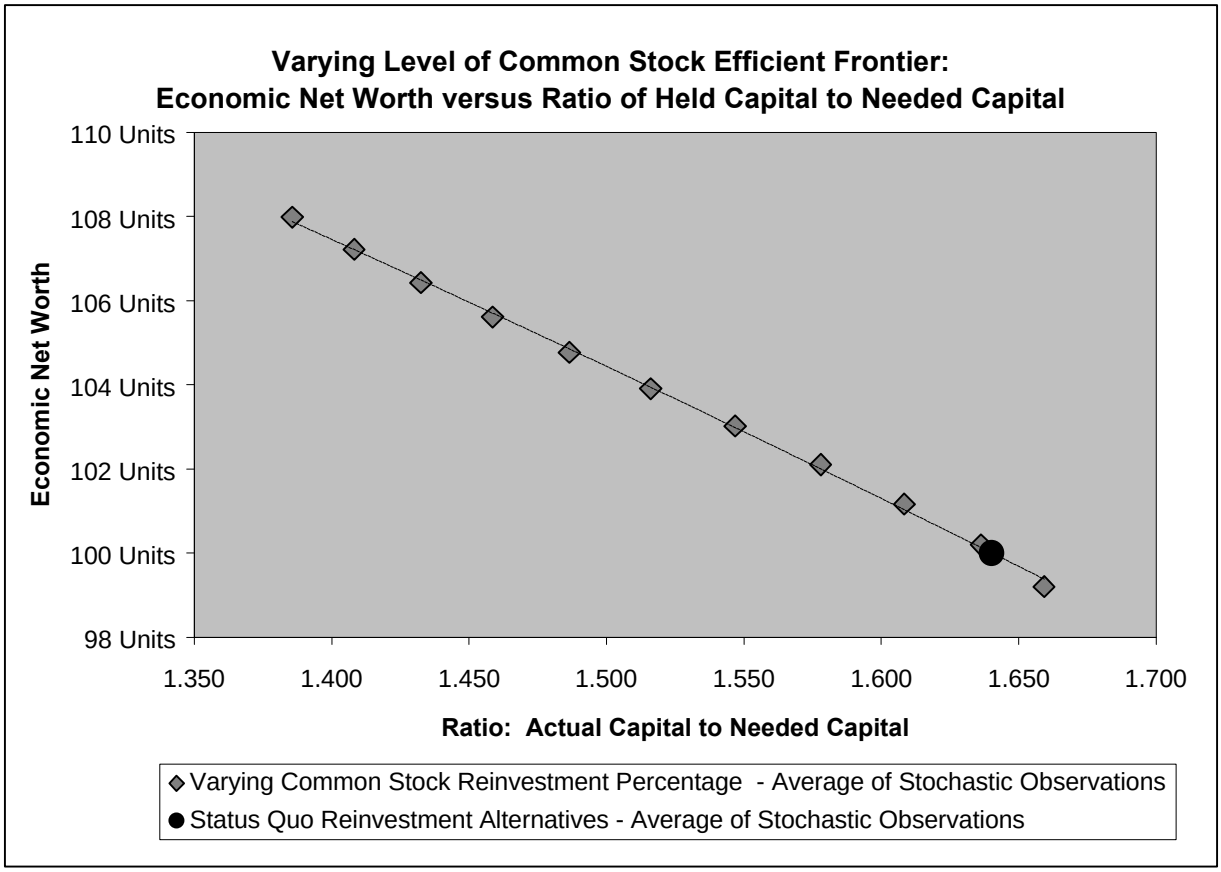
Upon reviewing the data, it was observed that the only two asset types producing higher economic net worth were high yield bonds and common stocks. Furthermore, high yield bonds produced the higher economic net worth with less volatility than the status quo reinvestment strategy. In theory, then, an efficient frontier could be established that ranged from reinvesting entirely in high yield bonds to reinvesting entirely in common stocks. Every point on the frontier would have a greater economic net worth than status quo reinvestment strategy. At least some of the points would also have less volatility than the status quo reinvestment strategy. Figures 9 shows graphically how the status quo reinvestment strategy compares to this efficient frontier. As can be seen in Figure 9, the reinvestment strategy underlying points "J" and "K" (J = 10% common stock, 90% high yield bonds, K = 100% high yield bonds) produce a higher economic net worth with less risk than the status quo strategy. Points "A" through "I" produce still higher economic net worth, but require more capital to support the higher level of risk.

Figure 9



The only problem with these results is that none of the strategies on the efficient frontier could realistically be implemented. Both the state insurance department and the company have limits on the amount of high yield bonds and common stocks that can be held. Since Table 4 indicates that no other asset class outperforms the status quo, the best the company can do is adjust the weighting of common stocks relative to the other assets in the status quo portfolio. Another way of looking at this is to think that the status quo portfolio ***is already*** an efficient frontier portfolio. The only thing the company can do is decide to move further up the risk curve in order to achieve a higher net worth expectation. Of the asset portfolios available to the company, there is no portfolio that will produce a higher net worth at a lower risk. Figure 10 shows the risk/return tradeoffs that are available to the company by varying the level of common stocks relative to the asset mix of the rest of the current portfolio.

Figure 10

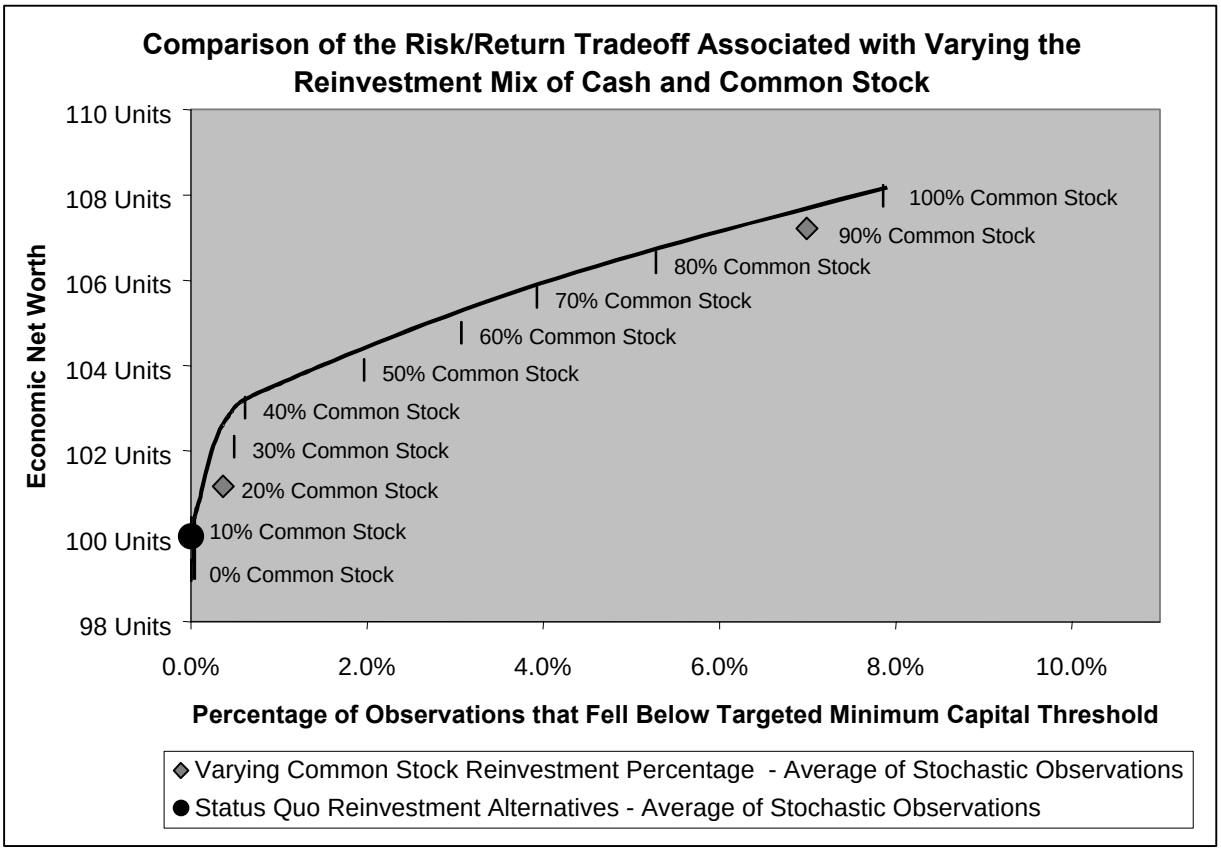


The question remains, though, “Which mix?” The data in Table 5 was prepared to help the company answer this question. Table 5 shows the same information that was displayed in Figure 10, but adds information about the number of times the company would fall below the target floor. Figure 11 displays this additional information in a graphical format.

Table 5

% Common Stock	Average economic net worth	Average ratio of statutory capital to capital threshold	% of simulated scenarios that fall below capital threshold
0%	99.2	1.659	0.0%
10%	100.2	1.636	0.0%
20%	101.2	1.608	0.4%
30%	102.1	1.578	0.5%
40%	103.0	1.547	0.6%
50%	103.9	1.516	2.0%
60%	104.8	1.487	3.1%
70%	105.6	1.459	3.9%
80%	106.4	1.432	5.3%
90%	107.2	1.408	7.0%
100%	108.0	1.386	7.9%

Figure 11


Comparison of the Risk/Return Tradeoff Associated with Varying the Reinvestment Mix of Cash and Common Stock
110 Units
108 Units
106 Units
104 Units
102 Units
100 Units
98 Units
Economic Net Worth
100% Common Stock
90% Common Stock
80% Common Stock
70% Common Stock
60% Common Stock
50% Common Stock
40% Common Stock
30% Common Stock
20% Common Stock
10% Common Stock
0% Common Stock
0.0%
2.0%
4.0%
6.0%
8.0%
10.0%
Percentage of Observations that Fell Below Targeted Minimum Capital Threshold
Varying Common Stock Reinvestment Percentage - Average of Stochastic Observations
Status Quo Reinvestment Alternatives - Average of Stochastic Observations

Conclusions and Recommendations to Management

From the previous charts and graphs and tables, it appears that, based on the risk and reward measurements used, a reinvestment strategy that mimics the current investment mix is an efficient option, albeit a conservative one. Senior management has expressed an interest in taking on more investment risk. From the results shown earlier in Figure 5 and Table 4 it was clear that, while the 100% common stock alternative might be the most advantageous in terms of long-term growth of economic net worth, too much volatility and risk accompanied this alternative. Finally, from the information in Figure 11 and Table 5, the basis for a recommendation appeared. The recommendation, which is still before senior management, is to move the level of unaffiliated common stock holdings from the eight percent level that it is at today towards a position somewhere in the range of twenty to thirty percent.

This recommendation to increase the company's common stock holdings is not a new revelation. Both Feldblum [3] and Noris [7] drew similar conclusions more than a decade ago. So one must ask, "Why has the percentage of assets invested in common stocks by insurance companies not grown more significantly, despite articles and recommendations to the contrary?"[9] Feldblum suggests a few reasons,

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[9] In 1988, according to A.M Best's 1989 Aggregates and Averages, unaffiliated common stocks accounted for 10% of the insurance industry's invested assets. In 1998, according to A.M. Best's 1999 Aggregates and Averages, unaffiliated common stocks accounted for 18% of total invested assets. Based on the performance of the stock market between 1988 and 1998, this actually represents a reduction in common stocks as a percentage of total invested assets. Suppose one assumes that the industry stock portfolio had returns similar to that of the broad S&P 500 index between 1988 and 1998. If the industry had just held onto all the stock owned at December 1988 and reinvested all dividends, the value of the industry's common stock holdings would have been 61% greater than it actually was at December 1998. If one were to adjust the total invested assets at December 1998 for this difference, it can be seen that unaffiliated common stocks would have grown to almost 27% of total invested assets. Of course, this is the value of 20/20 hindsight. Who knew in 1988 how well the stock market was going to do for the next ten years?

with the bottom line being that there are many more considerations that enter into the investment decision than just maximizing the growth of net worth. For example, two of the considerations Feldblum identifies are stability of statutory financial results and tax considerations.[10] To that, one might also add the maximization of current income.

How does owning bonds increase the stability of statutory financial results? Since bonds are recorded in the Annual Statement at amortized cost instead of at market value, changes in the underlying market value of owned bonds are not reflected in property-casualty financial statements. Except for bonds that are classified as being below investment grade, the only time the difference between market and book value becomes evident is when bonds are sold.[11] Common stocks, on the other hand, are recorded at market value. Any changes in the market value of stocks are immediately reflected in the company's surplus.

What is the influence of tax considerations? Once again, Annual Statement rules play a role. Statutory accounting does not require the establishment of a deferred tax asset (or liability) for unrealized gains (or losses) in a company's common stock portfolio. When a company tries to capture gains in a stock portfolio, then, the conversion of unrealized gains to realized gains triggers a previously unrecognized tax cost. A company that has a highly appreciated stock portfolio may

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[10] Feldblum [3] p.122. Statutory financial statement stability: Feldblum notes that "insurers do not want to add investment risks to the fluctuations of the insurance underwriting cycle…Common stocks must be reported at their market value on Annual Statements, so their [reported] values fluctuate more than those of bonds…Were bonds reported on the Annual Statement at their market values, instead of amortized values, their actual riskiness would be apparent, and insurers would invest more heavily in common stocks." Tax considerations: Feldblum comments that "federal income tax laws influence financial portfolios. Tax law changes affect asset holdings in ways that asset/liability matching theory does not recognize."

[11] Below investment grade bonds are carried at the lesser of market or book value. Therefore, changes in the market value of these bonds could appear in the financial statements without the bonds being sold.

be unwilling to take advantage of the appreciation because of the tax bite that will accompany selling the stock. This leaves the company in a position of having a highly valued asset, the value of which can't be touched unless the company either has losses from other operations that can be used to offset the capital gains realization or is willing to accept the loss of value arising from capital gains taxes on the asset sale.

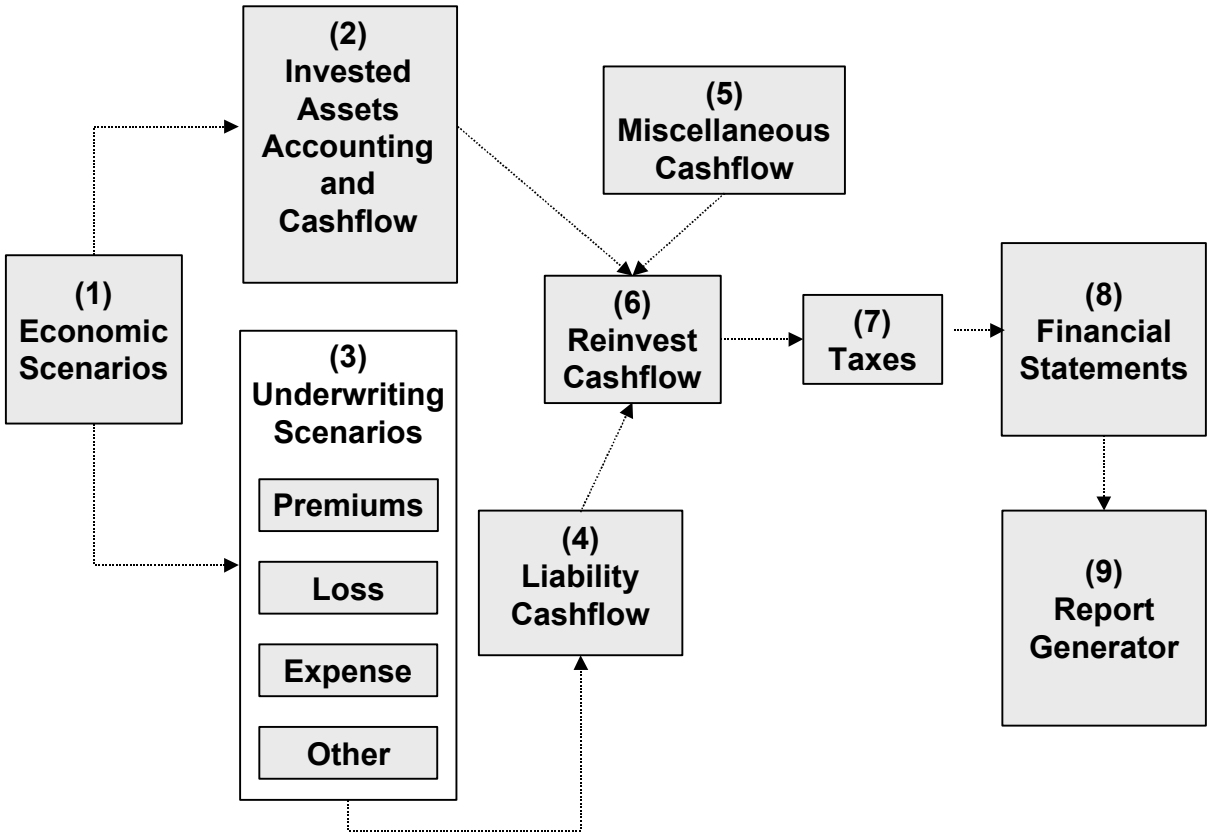
How does maximization of current income play a role? Property-casualty insurance companies expect a steady premium inflow that, along with investment income, can be used to pay current claims. Investing more heavily in common stocks will reduce a company's investment income inflow compared to making a similar investment in bonds. If a company does not have sufficiently large cash inflows from insurance operations and other sources to pay current claims, the company is forced into either short-term borrowing or the forced sale of assets. If the economic environment is not favorable for either of these actions, it could have a detrimental impact on the company's financial position. Since owning a higher percentage of common stocks reduces investment income, a company that invests more heavily in common stocks is assuming additional risk of having insufficient cash inflow to cover cash outflows.

Ultimately, senior management must decide which of these considerations is most important. Investing more heavily in common stocks will reduce current income and increase financial statement volatility. The act of accessing any gains that may be achieved on common stocks triggers tax consequences that the company may or may not want to incur. If senior management concludes that the maximization of net worth is worth incurring these costs, then the recommendation has merit. Otherwise, the analysis will have proven to be educational and informative but not sufficient to justify any action at this time.

Model Structure Overview

The model has nine basic sections, organized as shown in Figure A-1:

Figure A - 1



The structure and functionality of the model is similar in nature to those described in the following papers:

- D'Arcy, et al., "Using the Public Access DFA Model: A Case Study," Casualty Actuarial Forum, Casualty Actuarial Society, Summer 1998, pp. 53-118;
- Hodes, et al., "The Financial Modeling of Property/Casualty Insurance Companies," Casualty Actuarial Forum, Casualty Actuarial Society, Spring 1996, pp. 3-88;

- Kirschner & Scheel, "The Mechanics of a Stochastic Corporate Financial Model," Proceedings of The Casualty Actuarial Society 1998, Casualty Actuarial Society, Volume LXXXV, pp. 404-454;

- Witcraft, "Profitability Targets: DFA Provides Probability Estimates," Casualty Actuarial Forum, Casualty Actuarial Society, Summer 1998, pp. 273-302.

The following is a brief description of each section of the model.

1. Economic Scenario Generator

The economic scenarios used in this modeling exercise were rolling five-year observations taken from actual United States economic history. The economic variables captured in this way include the one year constant maturity US Treasury bill (a proxy for a short term risk free interest rate), the ten year constant maturity US Treasury bill (a proxy for a long term risk free interest rate), a stock market total return index that is proxied by the S&P 500, general inflation based on the overall Consumer Price Index, and medical inflation based on the medical component of the Consumer Price Index. The rolling five-year observations were used to develop economic projections for the model's five year time horizon. For example, the first simulation takes as its economic scenario the economic history from January 1926 through December 1930. The economic scenario for the first projection year is the twelve-month change in each index between January 1926 and December 1926. The economic scenario for the second projection year is the twelve month change in each index between January 1927 and December 1927, and so on and so forth for the third, fourth and fifth projection years. The second simulation takes as its economic scenario the economic history from February 1926 through January 1931. By using historical data as the basis for economic scenarios, the company avoids the problems inherent in a theoretical economic scenario generation process, namely the parameterization of the theoretical model, including the parameterization of internal correlations and interrelationships between the different economic variables.

2. Invested Asset Accounting and Cashflow

The economic scenario determines what happens to the fixed income assets and common stock holdings over the course of a projection year. Changes in interest rates cause a greater or lesser level of prepayments in each of the modeled bond classes, with rising interest rates resulting in less prepayment than falling interest rates. Changes in interest rates do not affect the investment income produced by each bond class – the investment income is a function of the coupon rate available at the time the bond was purchased.[12] The total return of the economic scenario's stock market index determines the market value change of all common stocks that were in the company's portfolio at the start of the projection year.

This module quantifies the cashflow arising from invested assets, before any forced asset sales might occur. The cashflow is comprised of investment income received, bond maturities and prepayments, less investment expenses paid.

3. Underwriting Scenarios

The Underwriting Scenario Module is divided into a series of line of business groupings. The functionality of the Underwriting Scenario Module is identical within each grouping. The grouping process allows the modeler to specify different characteristics for each line of business grouping. For each line of business grouping, the underwriting module takes as input information on a series of initial conditions and a series of anticipated future actions. The initial conditions include unearned and uncollected premium at time T_0, indicated and held loss reserves at time T_0, and unpaid underwriting expenses and policyholder dividends at time T_0. The anticipated future actions include projected premium writings during times T_1

[12] Bonds are grouped according to both type (government, municipal, etc.) and purchase year. Bonds purchased in one of the projection years are assumed to have coupon rates commensurate with the risk free long term interest rate in effect for that projection year, plus a user-specified risk spread. The coupon rates of bonds purchased before the model's "start date" are already known.

through T_5 and the loss, expense, and dividend ratios associated with the premium writings.

Additional inputs to the Underwriting Scenario Module include patterns for premium earning, premium collection, loss payout, expense payout, and dividend payout. These patterns are used to produce the necessary income statement and cash flow statement accounts from the initial conditions and anticipated future actions.

Lastly, information is included on key variability parameters. For each line of business grouping, the variability parameters allow the model to

- Randomly vary the profitability of future business by varying the user-entered expected loss ratio;
- Randomly vary the indicated time T_0 loss reserves (to simulate the uncertainty inherent in the time T_0 "best estimate" loss reserve indication);
- Randomly adjust loss payment speed;
- Randomly generate catastrophe losses;
- Quantify the effects of unanticipted inflation on loss payments.[13]

4. Underwriting Cashflow

The results from the line of business groupings within the Underwriting Scenarios Module are combined into one underwriting cashflow projection.

[13] Robert Butsic, in his 1981 paper [1, pp. 58-102] describes how inflation can impact losses. The model assumes that the loss reserves and the target loss ratio entered by the modeler include an implicit level of future inflation in the loss estimate, i.e. the expected future inflation rate. The model uses the techniques described by Butsic to adjust the projected payment levels by the difference between the "actual" inflation rate produced by the economic scenario generator and the modeler's expected inflation rate.

5. Miscellaneous Cashflow

This module quantifies all cashflows that are not otherwise accounted for in the Invested Asset or Underwriting Modules. Examples of items that might be captured here include capital infusions or payments of dividends to stockholders, payment of fixed expenses that are not directly related to either investment or underwriting activities, receipt of miscellaneous asset receivables or payment of miscellaneous asset payables. The specific assumptions used in the modeling exercise described in this paper are not material to the overall results and conclusions. What is relevant is that the model has the capacity to address miscellaneous items of this nature.

6. Cashflow Reinvestment

This module combines the cashflows from the Invested Asset Module, the Underwriting Module, and the Miscellaneous Module into a net cashflow for each time period being projected. Depending on the way the modeler has specified the asset reinvestment process should take place (either rebalancing the entire portfolio to a specified distribution or just reinvesting net cash flow), and whether or not the net cash flow is positive or negative, a series of reinvestment activities are triggered. The reinvestment activities could involve the sale of some or all existing assets in an asset class. This could be done to force turnover within an asset class, such as might exist in a company with an active strategy of realizing capital gains on a stock market portfolio, in which case the proceeds might be reinvested back into that asset class. Alternatively, the sale of assets could be done if the modeler has set limits on how much of a particular asset class the company can hold, and the asset sale is being done to bring the holdings within the desired limitation. In this case, the proceeds would be reinvested in a different asset class. Lastly, the reinvestment activity could trigger the purchase of new assets within an asset class. If the new assets to be purchased are bonds, the model uses the “actual” risk-free interest rate developed by the Economic Scenario Generator as the basis for determining the coupon rates the newly purchased bonds will pay in the future.

7. Taxes

After the asset reinvestment is completed, the model goes in a quantification of federal income taxes. The Tax Module captures information from the Underwriting Module about tax-discounted loss reserves. It captures information from the Invested Asset Accounting and Cashflow Module and the Asset Reinvestment Module that allows it to quantify the portion of investment income that arises from tax-free bonds and stock dividends. It also captures realized capital gain information from the Asset Reinvestment Module. All this information is used to produce the company's tax liability in each projection period.

The tax calculation in the model is a simplification of the actual tax calculation a company would have to follow. It includes a number of the provisions from the Tax Reform Act of 1986, including:

- Discounting of loss reserves using discount factors provided by the Internal Revenue Service;
- Unearned premium reserve revenue offset, whereby twenty percent of the change in the unearned premium reserve is added to statutory net income;
- Proration of investment income from tax-exempt bonds, whereby fifteen percent of tax exempt bonds' investment income is included in taxable income;
- Proration of the "dividends received deduction" on stock dividends. The model assumes that 59.5% of all stock dividends received are tax exempt. This is the net result of exempting from tax considerations 70% of all stock dividends, but then adding back fifteen percent of exempted amount;
- Calculation of an Alternative Minimum Tax.

It does not, however, include tax carryforwards or carrybacks. The model assumes that a tax loss results in a "rebate check" being issued to the company from the

Internal Revenue Service, instead of having a loss carryforward that can be used to offset future tax payments.

8. Financial Statement Module

This module rolls all the information produced by the other modules into a series of financial statements and associated risk measurements. This module produces balance sheets, income statements, and cash flow statements over the projection horizon. It also contains calculations of desired risk measurements, such as the NAIC Risk-Based Capital calculation or the Standard & Poor's Capital Adequacy test.

9. Report Generator

This module produces output reports that display statistical and graphical information for selected metrics. Information captured and displayed includes the specific values for each iteration as well as statistics such as mean, standard deviation and various percentiles. Graphical displays of results, either in the form of distributions for one particular time period or as time series over multiple time periods are also displayed.

References

[1] Butsic, Robert "The Effect of Inflation of Losses and Premiums for Property-Liability Insurers," Casualty Actuarial Society 1981 Discussion Paper Program, Casualty Actuarial Society, 1981, pp. 58-102.

[2] D'Arcy, et al., "Using the Public Access DFA Model: A Case Study," Casualty Actuarial Forum, Casualty Actuarial Society, Summer 1998, pp. 53-118.

[3] Feldblum, Sholom "Asset Liability Matching for Property Casualty Insurers," Casualty Actuarial Society 1989 Discussion Paper Program, Casualty Actuarial Society, April 1989.

[4] Hodes, et al., "The Financial Modeling of Property/Casualty Insurance Companies," Casualty Actuarial Forum, Casualty Actuarial Society, Spring 1996, pp. 3-88.

[5] Ibbotson Associates, Stocks, Bonds, Bills and Inflation, 1999 Yearbook, Chicago: Ibbotson Associates, 1999.

[6] Kirschner & Scheel, "The Mechanics of a Stochastic Corporate Financial Model," Proceedings of The Casualty Actuarial Society 1998, Casualty Actuarial Society, Volume LXXXV, pp. 404-454.

[7] Noris, Peter "Asset/Liability Management Strategies for Property & Casualty Companies" Fixed Income Analytical Research Series, Morgan Stanley & Co., May 1985.

[8] Witcraft, "Profitability Targets: DFA Provides Probability Estimates," Casualty Actuarial Forum, Casualty Actuarial Society, Summer 1998, pp. 273-302.