Dynamic Financial Analysis Issues in Investment Portfolio Management

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Abstract

This paper will discuss issues that arise when using dynamic financial models to assist in the management of a property/casualty insurer's investment portfolio. There are three areas covered in this paper. The first discusses how much detail should be included on the asset side of a dynamic financial model in order to make it useful in making investment decisions. The second section applies a dynamic financial analysis to more accurately determine the optimal after-tax income for an insurer. The third area offers some suggested approaches to summarizing and conveying the results of a dynamic financial model.

Detail to be Included in the Asset Side of a Dynamic Financial Model

Financial models have many uses in the property/casualty insurance industry. A few examples are solvency evaluation, tax and investment planning, evaluation of reinsurance agreements, and pricing. The purpose for which the model will be used will determine the amount of detail (or complexity) needed in each area of the financial model. If the primary intent of the model is to estimate variations in loss reserves and future loss costs, then a simplified investment model may be appropriate. However, when the financial model is to be used for tax and investment planning, a more robust investment section is necessary.

The following are elements that we feel a model must address to be of practical use to an asset manager in order to make coordinated investment decisions. These elements can be viewed as a minimum level of detail needed to handle the majority of decisions that enter the property/casualty insurer's investment process.

1. **Cash flows from invested assets and operations**

Accurately modeled cash flows are important for the proper calculation of income that will be earned on reinvestment of those cash flows. Additionally, investment decisions for a property/casualty insurer should be made to enhance the operational underwriting side of the business. One of the major areas where they interact is in the use of cash flows. A rapidly growing insurer would be generating a significant amount of positive cash flow and the investment manager's strategy should look to take advantage of that. On the other hand, an insurer whose premium volume is shrinking may look to its investment portfolio for cash to support its operations. The investment manager in this scenario should have an investment strategy that can provide ready cash. The ability to forecast the needs and opportunities in these scenarios depends on the accuracy of the projected cash flows produced by the financial model.

2. **Income generated by invested assets**

Insurance companies are taxed on the book income generated by their fixed income portfolio, not on cash flows. In some portfolios these numbers can be materially different. Therefore it is important to track book income as well cash flow, particularly for tax planning and the generation of income statements. Book yields and book value are important not only for the income they produce, but also because realized gains and losses are based on comparisons of market to book value.

3. **Varying interest rates**

Varying underlying interest rates and therefore varying the market values of the fixed income portfolio has many uses. They allow the manager to assess the risk that the market value of surplus will vary beyond acceptable bounds. It also allows the manager to test

different investment strategies (for example long duration versus short duration) given his future expectations of interest rates. The manager can then evaluate the risk and rewards to the company if those expectations do not come to fruition.

It is useful to have a model that varies interest rates in several different ways. The first way varies interest rates completely randomly according to a random interest rate generator (for example an autoregressive stochastic model). This can be useful for evaluating the effect of different investment strategies under uncertain future interest rate scenarios. There are, however, some shortcomings to this method. First, there is no guarantee that your model will accurately represent future interest rate changes. Second, it does not allow the manager to test scenarios given his (or her) expectations for the future. Third, the number of future scenarios can become so large that it becomes difficult to pull useful management information from them.

A second method is to allow the model to run a fixed set of scenarios that incorporate the major factors of what the investment manager is trying to analyze. For example, a manager may keep his portfolio at a short duration in the expectation that interest rates will rise and he will be able to invest at higher yields than are currently available. The trade off is that by currently being short on the yield curve he is giving up current investment income. This short term decrease is expected to be made up later by an increase in interest rates. Different interest rate scenarios can be run to evaluate how long the manager can wait for interest rates to rise before decreased investment income from the short portfolio cannot be recouped.

It is important to do these evaluations in the context of the insurance company's entire operations, since many companies have minimum income constraints needed to meet objectives such as policyholder dividends and minimum return on equity.

4. **Subclasses of invested assets**

The major decisions to made in this area are how many subclasses are needed and how much information needs to be entered for each subclass.

An advantage to having a large number of subclasses for the invested assets is that it allows the person doing the modeling to accurately capture the particular nuances of each type of security. An example of a necessary refinement is the need to differentiate between taxable and tax-exempt income for tax purposes. A more exact refinement, which may or may not be necessary depending on the use of the model, would be to subdivide bonds according to their call features. A simple model would price the market value of the portfolio simply according to interest rate changes. For many bonds the redemption date of the bond is actually dependent on current interest rate levels. If interest rates drop 100 basis points, the price increase will be much greater for non-callable bonds than for callable bonds. This is because interest rate decreases cause bonds to be called, which in turn shortens their duration, which leads to a smaller price change relative to interest rates. If the insurer has many callable bonds in its portfolio and the model varies interest rates but does not account for call features, errors in the projection will result. In particular, market value will be overstated and there will be a misallocation of cash flows from the maturing of these bonds.

A second advantage of more detail is that it allows for more accurate asset allocation strategies. A common approach in investing is to move between different "sectors" depending on the manager's feeling on how well they will perform after-tax and the needs of the insurance company. Sectors can be broad - taxable versus tax exempt securities; or they can be narrow - corporate bonds could be divided into bank & finance, industrial, and telephone & utilities. The refinement necessary would depend on the investment manager's style and the purposes for which the model will be used.

The major disadvantage of a highly refined model is the time it would add to the modeling process. More refinement adds more time up front. That is, there will be more detail that needs to be entered before the model is run. There is also more time added on to the back end. More data types results in more possible variations that can occur and need to be analyzed. There is also an increasing parameter risk. More variables mean there are more distributions and correlations to determine. With more variables it becomes more likely that the modeller will not be able to produce accurate estimates of these variables. A simpler model, combined with a modeller who understands the model's weaknesses can often produce more accurate answers than an overspecified model.

The following are some suggested subclasses of invested assets for a basic financial model:

4.1. ***Fixed Income*** (Note: For a good discussion of the characteristics of fixed income securities, an invaluable reference is "The Handbook of Fixed Income Securities" by Frank J. Fabozzi.[1])

4.1.1. *U.S Government Treasury and Agency Securities*

U.S Government securities make up the core portion of many insurers portfolios. These bonds are distinguished by their fixed cash flows from coupon payments, their taxable status, and by their lack of credit risk.

4.1.2. *Corporate Bonds*

These bonds are similar to U.S. Government securities in that they have fixed cash flows and are taxable. Corporate bonds add an extra dimension of credit risk. To account for credit risk, some probability of default needs to be built into the model. Subclasses of corporates should be created to attempt to create homogeneous groups with similar default characteristics. A simple categorization would be by the Standard and Poor's or Moody's ratings. At a minimum the classes should at least be divided into investment grade vs. below investment grade.

4.1.3. *Tax Exempts*

Tax-exempt bonds generally have fixed cash flows from coupon payments that are 85% tax-exempt for a property/casualty insurer. Most tax-exempt bonds can be classified into one of four categories: general

obligation, revenue, prerefunded, and insured. These classifications are one way to group these bonds.

A second method of grouping would be by credit risk in a manner similar to that suggested for corporates. An approximate order for creditworthiness would be prerefunded, insured, revenue, and general obligation. Prerefunded bonds are backed by U.S. Treasuries and are generally Triple A rated. Insured bonds are usually rated according to their insurer but are also generally Triple A rated. General Obligation are generally more credit worthy than revenue bonds, although there is significant overlap. A simple grouping would place prefundeds, insured, and investment grade general obligation and revenue in one group and everything else in another.

4.1.4. *Mortgage Backed*

Mortgage backed and other similar loan backed securities are generally taxable and may have some credit risk. Their most distinguishing feature is that their cash flows are not fixed and can vary widely depending on the current interest rate environment. For life insurer modeling, this can be a major issue because not only is their cash flow from mortgage backeds affected by interest rates but also their premium inflow.

A general rule for a property/casualty insurer is that the complexity of the mortgage backed modeling should increase with the extent that they are part of the insurer's portfolio. For many smaller insurers, the lack of

fixed cash flow from mortgage backed securities makes them unattractive and therefore they only compose a small part of their portfolio. If an insurer plans to make these a major part of their investment strategy, they need to have a good model to understand the interest rate risk they are assuming.

At a minimum, mortgage backeds should be put into as homogeneous groups as possible. One way to do this is by subdividing by expected prepayment pattern. The expected pre-payment patterns should be built into the model. If changes in interest rates are part of the model, then any change in interest rates must have some corresponding change in the prepayment pattern. In general, declining interest rate speed up pre-payments and higher interest rates slow them down.

4.2. *Cash*

Cash is generally completely liquid and is often invested in some type of money market fund. Fixed income maturities of less than one year can either be grouped with cash or with the longer term assets depending on the preference of the modeller. Some interest rate needs to be entered into the model for cash and should be distinguished between taxable and tax-exempt investments.

4.3. ***Equities***

After fixed income securities, equities are the next largest group of invested assets for property/casualty insurers. At a minimum, price changes and dividend level information for the equity investments need to be built into the model. For the

more complex modeller who believes in CAPM theory, equities could be grouped according to their beta and varied accordingly with some underlying market changes built into the model.

4.4. *Real Estate*

For many companies, real estate constitutes a minor portion of their invested portfolio. If a company does have significant holdings in real estate, it should be segregated out from the rest of the invested assets. The ability to model future price changes and income levels from real estate should be included in the model.

4.5. *Other Invested Assets*

The remaining invested assets can be grouped together and most of the time will total to an insignificant amount. The ability to model price changes and income from these assets should be included in the model.

5. **Timing of cash flows**

For short term planning the timing of cash flows and maturities from the assets is very important. For long term planning it may be enough to assume the average cash flow occurs in the middle of the year. But for making actual decisions about when to make shifts in the portfolio, a greater level of detail is necessary. The best approach would be to have cash flows and maturities summarized quarterly for at least the first two projection years of a financial model. For the following years annual cash flows will suffice.

6. **Tax calculation**

A model that can incorporate all of the nuances of the tax laws and accurately calculate taxes is invaluable. Without accurate tax calculations, many of the uses of a financial model from a management point of view disappear. All investment decisions should be evaluated on an after tax basis. Unfortunately, the tax position for an insurance company is not always that easy to evaluate. The combined impact of discount rates, changes in loss reserves, varying underwriting results, and carrybacks and carryforwards, make a simple evaluation of the final effects on taxes extremely difficult. A good tax model is important because it can perform the "black box" function of churning through the numbers to get to the after tax results. The investment manager can use this to evaluate the returns under different investment strategies given a variety of future scenarios. Without a good model to evaluate the tax consequences, the correct strategies on an after tax basis are not at all obvious.

Tax Optimization

It has been documented that after-tax income can be increased through the optimal mix of taxable and tax-exempt investments (the rest of this discussion will assume an understanding of the basic dynamics of tax optimization. For a discussion of the fundamental issues, see Almagro and Ghezzi[12]). A problem with many types of tax optimization analyses is that they assume the investment portfolio is either all cash (or totally liquid) and can be moved around to achieve any desired taxable / tax-exempt mix. This is not generally true. There is an optimal mix for each one year horizon, but given where the company's portfolio currently stands it may not actually add

value to sell bonds to reach the optimal point. If the portfolio was all cash, shifts in the portfolio would be frictionless. But a real portfolio has certain characteristics such as a maturity schedule, realized gains and losses, and imbedded yields that will affect the company's taxes and future income depending on what shifts are made.

It is useful to use a dynamic financial analysis to evaluate different optimization strategies under different scenarios. In reality, management expects the bond portfolio to produce certain results or puts certain limitations on the characteristics of the portfolio. Some examples of these expectations and limitations are:

- Restrictions on realizing capital gains and losses (and the accompanying effect on statutory surplus)
- Stability in investment income
- Duration constraints
- Credit constraints
- Maximum amount of AMT carryforwards allowed
- Imbedded yield of portfolio
- Market value of portfolio

Additionally, in trying to meet management's objective there are a number of variables that will affect future results. From the perspective of an investment manager, some of the these future variables are:

- Interest rates
- Ratio of taxable to tax-exempt interest rates
- Performance of stock portfolio (if included)

- Underwriting results
- Cash flow

We will use a financial model to examine two issues in particular. First, how does the choice of a time horizon affect the results of a tax optimization analysis. Second, we will undertake an evaluation of optimizing under scenarios of stochastic underwriting results.

The first example we will examine is an insurance company that at the end of 1995 is projecting to have too much tax-exempt income for 1996. This "excess" tax-exempt income would put them into AMT in 1996 and would imply a need to sell tax-exempts and buy taxable bonds. Additionally, assume that their entire bond portfolio is at an unrealized gain (This was a very common situation for companies at the end of 1995). Since realized gains are taxed as regular income, any movement towards the optimal point has two effects which must be considered.

First, selling bonds will add a one time boost to taxable income in 1996 (due to the booking of realized capital gains) which will not be there for 1997 and forward. Second, the effective tax rate on the income from tax-exempt bonds is 5.25%. By taking gains in the tax exempt portfolio the company is essentially increasing the tax rate on those bonds from 5.25% to 35%. We will show how multi -year modeling will produce different strategies based on the time horizon over which the company chooses to optimize.

The second example will take the same company and evaluate its possible optimization based on variable future underwriting results. Issues to be addressed include how variance of underwriting

results effect an optimal portfolio mix, the magnitude of that possible effect, and the implications of those effects.

For purposes of illustration, the financial model will be somewhat simplified. The most significant simplifications are regarding future cash flow into the investment portfolio and the loss reserve tax discount. We are assuming no future cash flows into the investment portfolio other than reinvestment of coupons. In other words, net cash from operations equals zero. Additionally, when we vary calendar year underwriting results, we will assume that there was no effect on the tax discount of the loss reserves. These are important variables when doing tax planning and should be considered. However, for the purposes of demonstrating our conclusions, they are not needed.

Example 1 - Tax Optimization on a Multi-Year Horizon

The following is assumed for the company being modeled:

- The company has $300 million in taxable securities with a market yield of 6% and a book yield of 7%. This implies an unrealized gain of $12.8 million dollars.
- The company has $700 million in tax-exempt securities with a market yield of 4.8% and a book yield of 5.6%. This implies an unrealized gain of $24.6 million dollars.
- The company owns no other invested assets.
- All bonds bought and sold mature at the end of the year 2000. Therefore, there are no issues of unrealized gains or losses in the portfolio at the end of the evaluation period.
- The company is expecting to take a one year prior year reserve hit (increase) of $37 million which will cause it enter AMT in 1996.

- For the calendar years 1997 to 2000 the company expects its underwriting results to return to a constant profit of $5 million per year.

The company is considering three strategies:

- **Strategy 1**: Do nothing. In the scenario constructed the company will go into AMT in 1996 by $4.9 million. It will exactly recoup all of the AMT carryforwards at the end of the year 2000.
- **Strategy 2**: Sell tax-exempt bonds and buy taxables so that the company will reach the "optimal" point in 1996. This is the point at which the regular tax and alternative minimum tax are equal. Continue to sell taxable or tax-exempt bonds to optimize on a one year basis for each year as needed. This is the traditional optimization strategy.
- **Strategy 3**: Sell and buy back taxable bonds to realize the capital gains and generate taxable income in 1996. This will lower the AMT carryforwards to $3.3 million at the end of 1996. The carryforwards will be exactly recouped at the end of the year 2000.

Table 1 outlines the portfolio transactions involved under the three strategies:

Table 1

	Strategy 1: Do Nothing		Strategy 2: "Optimize Each Year"		Strategy 3: Sell Taxables in 1996	
Year	Trade	Realized Gains	Trade	Realized Gains	Trade	Realized Gains
1996	None	$0	Sell 34% of Tax-Exempt Buy Taxables	$8.5 million	Sell 100% of Taxables Buy Taxables	$12.8 million
1997	None	$0	Sell 54% of Taxables Buy Tax-Exempts	$5.7 million	None	$0
1998	None	$0	Sell 3% of Tax-Exempts Buy Taxables	$0.3 million	None	$0
1999	None	$0	Sell 9% of Taxables Buy Tax-Exempts	$0.2 million	None	$0
2000	None	$0	Sell 8% of Taxables Buy Tax-Exempts	$0.1 million	None	$0

The three strategies lead to the following after-tax income results:

Table 2

In $000s	1996	1997	1998	1999	2000
Strategy 1: Do Nothing					
Taxable Investment Income Earned	22,680	26,138	29,801	33,681	37,790
Tax-Exempt Investment Income Earned	39,301	39,509	39,730	39,964	40,211
Realized Capital Gains	0	0	0	0	0
After-tax Income	24,815	58,357	61,473	64,774	68,270
Cumulative Income	24,815	83,172	144,646	209,420	277,690
Cumulative AMT Carryforwards	4,895	4,492	3,564	2,078	2
Strategy 2: "Optimize" Each Year Strategy					
Taxable Investment Income Earned	37,699	19,808	24,576	25,852	27,468
Tax-Exempt Investment Income Earned	25,799	42,010	41,081	43,110	45,039
Realized Capital Gains	8,486	5,686	274	231	96
After-tax Income	32,195	59,906	58,607	61,331	64,121
Cumulative Income	32,195	92,100	150,707	212,038	276,159
Cumulative AMT Carryforwards	0	0	0	0	0
Strategy 3: Sell Taxables in 1996 Strategy					
Taxable Investment Income Earned	20,385	23,715	27,243	30,979	34,936
Tax-Exempt Investment Income Earned	39,297	39,498	39,710	39,935	40,174
Realized Capital Gains	12,795	0	0	0	0
After-tax Income	33,212	56,409	59,410	62,588	65,951
Cumulative Income	33,212	89,622	149,032	211,620	277,571
Cumulative AMT Carryforwards	3,319	3,279	2,732	1,649	0

More complete tax calculation exhibits can be found in Appendix B, Exhibits 1-3.

Based on the results of the financial model under the three chosen strategies, the following conclusions can be drawn:

1) ***In trying to optimize after-tax investment income, the choice of a time period over which to optimize will affect the choice of the optimal strategy.***

Strategy 2 is the strategy that is often implemented by insurance companies. When it appears financial results will put a company into AMT the immediate reaction is to sell tax-exempt securities. If those bonds are at a gain, it is considered to be a bonus since realizing gains will add to statutory surplus. Unfortunately, by selling those bonds the company will take an income stream that would have been taxed at 5.25% and increase the effective tax rate to 35%. This effect will not show up in a one year financial model. It is only when viewed from a multi-year horizon that the negative effect on after-tax investment income begins to emerge. In Strategy 2 the company continues to optimize until the end of the year 2000. Its cumulative net income over this period is $266.2 million. This is $1.5 million dollars less than Strategy 1.

Although Strategy 1 is labeled the "Do Nothing" strategy, that is not really accurate. What Strategy 1 really is a strategy that optimizes after-tax income on a multi-year horizon. The advantage of tax optimizing over multiple years is that it allows the full after-tax income effects of portfolio transactions to emerge and also takes into account future underwriting expectations.

One additional note on comparing Strategies 1 and 2. The observer might look at the cumulative income amounts and say $1.5 million on about $277 million in income is a small variation. There are two points we would make in response to this.

First, the $1.5 million was actually lost when the gains were taken in 1996. It was only as the bonds began to mature that it showed up in income. Additionally, consider that $1.5 million is not an unrealistic amount for an outside manager to charge for a portfolio of that size. By simply optimizing over a multi-year horizon, the fees would have been paid for the year.

The second point is that the company may have been under the impression that the transaction in Strategy 2 was actually adding value to the bottom line. When viewed on a one year horizon this would appear so. In order to implement Strategy 2, the company had to turnover 34% of their tax-exempt portfolio. The income lost in this transaction is significant when you consider that doing nothing would have added more income.

2) Optimizing on a one year horizon adds significant turnover into the portfolio strategy.

In Strategy 2, the company had to sell 34% of their tax-exempt securities in 1996. Since the poor calendar year results in 1996 were due to a one time increase in prior years' reserves, their underwriting results were expected to improve in 1997. This would call for a shift back into tax-exempt securities. In the model, 54% of the taxable securities had to be sold in 1997 to return to the optimal point. This turnover can be contrary to other operational and investment objectives. Taking gains in taxables or tax-exempts when viewed on a cash flow basis simply accelerates tax payment and often costs the company money on a horizon analysis (The Prime Advisor, "Evaluating Bond Swaps"[3]). Realized losses directly reduce statutory surplus which may not be acceptable to the company at that time. Furthermore, the portfolio manager may be involved in a sector strategy that involves waiting for a price shift before selling the current securities. Optimizing over a multi-year horizon allows the smoothing of these shifts in the portfolio for better overall management.

3) ***Realizing gains will lower the income stream going forward.***

We have already described the penalizing effects of realizing gains in the tax-exempt portfolio. But there is a more subtle effect that affects both taxable and tax-exempt securities that is worth mentioning. When estimating the effects of taking gains in a portfolio, many managers assume that if you realize the gain and simply buy back the same bonds, the income generated by those bonds going forward will be unaffected by realizing the gain. It is true that on a pre-tax market value basis the economic value a holding or selling the bonds is the same, but that does not mean after-tax income is unchanged.

In Strategy 3, the company realizes all of its gains in its taxable portfolio in 1996 and buys back the same taxable bonds. Other than the realizing of the gains, this is the same as Strategy 1. The two strategies cumulative after-tax income in the year 2000 is very similar. The difference in the two numbers is due to cash flow affects from realizing the gains and the different amount of AMT carryforwards in the two strategies. Although the cumulative after-tax income is similar, the way that income is achieved is not.

Strategy 3 has realized gains from the taxable portfolio of $12.8 million in 1996. This realized gain is simply the acceleration of future income. So now going forward for the next five years investment income is lowered by about $2.5 million per year, when compared to Strategy 1.

What does this mean? Investment income has been lowered going forward and more instability has been added to that income steam. This can adversely affect an insurer in several ways. For example, more stress will be put on a company's ability to pay its policyholder or stockholder dividends, since they are based on expected amount of income each year. Operating ratios will

have more volatility and will decrease going forward, even if underwriting results remain constant. Regulators and rating agencies are often more concerned with a consistent income stream than realized gains, which they consider to be a one time deal. Additionally, the value for the NAIC IRIS test for investment yield will be decreased.

Example 2 - Tax Optimization with Stochastic Underwriting Scenarios

When trying to determine an optimal tax mix, one of the inputs into the process is the expected underwriting results. Of course for a property/casualty insurer, future calendar year results are uncertain (or else why would there be reinsurance?). Attempting to understand tax optimization with uncertain underwriting results can be accomplished with dynamic financial modeling. This analysis involves running the model for different mixes of taxable and tax-exempt securities in an environment where the underwriting results are determined by a probability distribution.

The model used is similar to that in the prior section. The following are the significant changes in the assumptions:

- The company has $1 billion in combined taxable and tax-exempt securities where the unrealized gain or loss equals zero. Therefore this company is able to switch to any mix of taxables and tax-exempts without the implications of realized gains and losses.
- The company's expected underwriting loss is a constant $13 million each year.
- If the underwriting results were certain, the optimal mix would be 50% taxables and 50% tax-exempts.

The goal of this analysis will be to optimize after-tax income over a two year period. Each strategy consists of a specific mix of taxable and tax-exempt bonds. This varies from $320 million

in taxables and $680 million in tax-exempts and shifts by $20 million until the mix is from $680 million in taxables and $320 million in tax-exempts (19 strategies). For each strategy, 5000 simulations are run selecting the varying underwriting result from a given distribution. The strategies were tested using four different distributions (these were chosen for illustrative purposes):

- **Scenario 1: Fixed Underwriting**

  Expected Underwriting Gain or Loss = E(x) = -$13 million

  Mass: p(x) = 1 if x = -$13 million

  p(x) = 0 otherwise

  This is the deterministic model assuming underwriting results are known.

- **Scenario 2: Uniform Underwriting**

  E(x) = -$13 million

  Density: f(x) = 1/ 42,000,000 if -$34 million <= x <= $8 million

  f(x) = 0 otherwise

  This is could be interpreted as the projections for a company that has an idea of the range of its results (due to reinsurance, policy limits, etc.) but does not know the relative likelihood of any value within that range.

- **Scenario 3: Skewed Left**

  E(x) = -$13 million

  Density: f(x) = .3/ 23,800,000 if -$34 million <= x <= -$10.2 million

  f(x) = .7/ 2,200,000 if -$10.2 million < x <= -$8 million

f(x) = 0 otherwise

This is could be interpreted as the projections for a company that expects it underwriting results to come in within a narrow range that is slightly better than the mean. But when results are outside this range, they have the potential for becoming much worse than normal.

- **Scenario 4: Skewed Right**

  E(x) = -$13 million

  Density: f(x) = .7/ 2,200,000 if -$18 million <= x <= -$15.8 million

  f(x) = .3/ 23,800,000 if -$15.8 million < x <= $8 million

  f(x) = 0 otherwise

  This scenario is the reverse of Scenario 3.

Note that for each of the four scenarios above, the expected value of the underwriting results are the same. It is the effects of the form of the distribution we are trying to estimate, not the expected value. Graphs of the probability density functions Scenarios 2-4 can be found in Appendix C, Exhibits 1-3. Appendix C, Exhibit 4 display the summary statistics for the different combinations of optimization strategies and underwriting scenarios. Chart 1 summarizes the two year after-tax income for the various combinations.

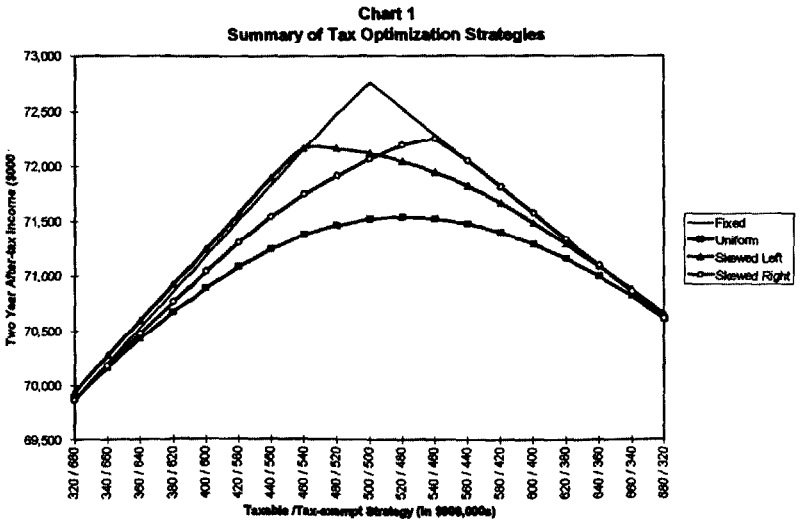

Table 3 summarizes the optimal strategies.

Table 3
In ($000s)

Underwriting Scenario	Optimal Tax Mix		Two Year After-tax Income
	Taxables	Tax-exempts	
Fixed	500,000	500,000	72,764
Uniform	520,000	480,000	71,539
Skew Left	480,000	520,000	72,162
Skew Right	540,000	460,000	72,254

Based on this information, the following conclusions can be drawn:

1) ***As the variance of the underwriting results increase, the expected value of after-tax income at the optimal mix decreases.***

This conclusion has several implications. First is that as underwriting variance increases, the penalty for missing the optimal point becomes less. Therefore, there is a broader range of acceptable portfolio mixes that will be within an acceptable range of optimal. This also means that the value added through tax optimization becomes less with increased variance. A company may want to undertake an analysis of this type to better understand the value that can be added through tax optimization. With increasing variance of underwriting results, it may be determined that there are other areas of the investment process through which income can be increased more effectively.

Secondly, if a company does decide that it wants to pursue a strategy of tax optimization, it must also take the time to understand its underwriting. As the ability to accurately estimate the expected results and the likelihood of variance from the expectations increases, so does the value added through tax optimization.

These results lead to the following question: As calendar year results emerge, can a company increase after-tax income by re-optimizing mid year? The answer is both yes and no. Yes, the company may be able to more accurately hit the optimal point for that year as the results become known. But no, that strategy may not add any more value to the company. Income will be earned as the year begins to emerge. In order to optimize for that year, larger shifts will have to take place in the portfolio to reach the optimal point to compensate for the income already

earned. This will most likely put the company in a position where it will be far off optimal for the next year. This implies another large shift in the portfolio to re-optimize and so on and so on. As described in the previous section, this large turnover in the portfolio to chase a one year optimal strategy may hurt the company in terms of after-tax yields, managing realized gains and losses, and implementing portfolio strategies.

2) Skewed distributions will shift the optimal mix.

Intuitively, the results from the skewed distributions make sense. If the distribution is skewed left, there is a greater likelihood that the underwriting results will come in better than the mean. Therefore more tax-exempts are need than in the fixed underwriting scenario. For a skewed right distribution, the reverse is true. For property companies who are exposed to occasional catastrophic loss or companies with particularly limiting reinsurance agreements, it may be wise to understand the variation of the underlying net losses when undertaking tax optimization.

These conclusions intuitively make sense and will hold in general. The magnitude of the conclusions will vary by company. With the increased interest in dynamic financial modeling, one practical application should be to help companies better understand the risks and rewards involved in different portfolio strategies such as tax optimization. As demonstrated, stochastic modeling improves a company's understanding of the different strategies it undertakes better than simpler deterministic models.

Data Analysis and Presentation

In the previous modeling, some simplifying assumption were made. Additionally we only varied three variables - the amount of bonds to sell, underwriting results, and time period of evaluation. The need to simplify the financial model highlights the paradoxical nature of a good financial model. An advantage of a good financial model is that the flows from different areas and the calculations of an insurer's taxes are too difficult to track and calculate without such a model. So many of the variables are interdependent, that it is often difficult to get an intuitive feel for what is the appropriate management decision. Thus a financial model can be an invaluable tool for decision making.

However, this ability to evaluate different strategies under varying scenarios also leads to a disadvantage. The model may be evaluating so many variables, times so many years of evaluation, times so many model runs, that the amount of output data produced can be overwhelming. This enormous amount of data may itself become too much to summarize and explain to management. Thus, limiting its effectiveness as a decision making tool.

There are at least two issues to be dealt with when confronted with this large amount of output. The first area is electronic data processing issues. Where will you find the computer space to store all of the data? Also, what software will you use to effective manipulate and sort the data? The second issue is interpretation. What techniques can be used to understand the results? Also, how can these results be presented in a way that is understandable to others? We will briefly discuss this second issue below.

One issue that affects the ease of understanding the model's results is the choice between stochastic and deterministic variables. Each variable that is stochastically varied increases the range of possible outputs exponentially. When building a model the careful selection of stochastic variables is very important.

One approach to assist in this selection is through the use of sensitivity testing. An initial model may built with many stochastic variables. After some initial runs have been completed, it is useful to summarize the results of the output results you are tracking relative to the underlying stochastic variables. For example, a company may want to see how cash flow from operations is affected by changes in written premium, future loss ratios, loss payment speed, and adverse development of loss reserves. If the initial results show that cash flow only decreases when either written premium decreases or the payment pattern speeds up, it may be helpful to eliminate the other stochastic variables. This gives a priority order for which variables the model must most accurately reflect the true underlying distributions.

There is another tool in helping to understand the results of a dynamic model which may seem obvious, but often is hard to remember when the modeller is faced with the results of 100 variables for 100 scenarios for 10 years of projections. This is to simply take a step back and ask, "Do these results make sense?" Often a model is confirming what a manager already knows but can't quantify. If it feels wrong, an understanding of how the model produced that answer should be determined before the results are accepted and further work is done.

Results that differ from expectations usually follow from either of two possibilities (assuming there are no hardware or software errors). The first is that an assumption was made that was wrong or oversimplified which caused the model to run incorrectly. The second possibility is that

the model produced new information that wasn't previously apparent. This is one of the most beneficial uses of a financial model. Its ability to take into account all of the different interrelationships of an insurance company that can not be easily understood otherwise.

Once the model has incorporated all of the important factors and the results are accepted as reasonable, there is one last step. This is how to present results to the appropriate audience. After all of the data has been compiled and some information has been gleamed from it, there is often a feeling that the task is completed. But in reality, this is usually only the halfway point. One of the strengths of actuaries is their ability to understand numbers and make decisions based on those numbers. But others in insurance company management may not share that same ability. Even in summarized form, the amount of numbers in a report of a dynamic financial model can be intimidating and confusing. One solution to this is an increased use of color graphs and charts.

Often making an effort to create good summary charts may seem like a superfluous effort that can be very time consuming. If it is not analytical, it may not be considered "real" work. But if a manager is not able to make a decision based on the results of the data, all of the effort put into creating a good financial model was for naught. In the current world of computers and software, this has never been easier. There are numerous software programs available that can be used to create clear and attractive tables, charts, and presentations with relative ease. With access to color printers becoming more and more the norm, the use of contrast in color in a presentation can make a point much more quickly and effectively than words or rows of numbers ever could.

Conclusions

Dynamic financial models can be a important tool for helping an investment manager to assess risk and increase returns for a property/causality insurer's portfolio. Although historically much of the actuary's work has been on the liability side of the balance sheet, there is a great opportunity for actuaries to add value in the investment area. With respect to financial modeling, this can be accomplished by first making sure that enough attention is given to the development of the asset side of the financial models. The next step is to then use those models to develop new and useful analytical techniques. Finally, these techniques must be presented in a way so that are understood and accepted into a company's strategic investment planning methodology.

Appendix A

Bibliography

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[3] "Evaluating Bond Swaps", The Prime Advisor, 1995 Series, Issue 3.

Appendix B

Appendix B **Exhibit 1**

TAX ABLE INCOME CALCULATIONS

(In $000s)

	Statutory Income Calculation	1996	1997	1998	1999	2000
(1)	Net Underwriting Gain / (Loss)	(32,000)	5,000	5,000	5,000	5,000
(2)	Taxable Investment Income Earned	22,680	26,138	29,801	33,681	37,790
(3)	Tax-Exempt Investment Income Earned	39,301	39,509	39,730	39,964	40,211
(4)	Realized Capital Gains	0	0	0	0	0
(5)	TOTAL STATUTORY INCOME	29,981	70,647	74,531	78,645	83,001
	Regular Tax Adjustments to Statutory Income					
(6)	85% Tax Exempt Interest Income	33,406	33,583	33,770	33,969	34,179
(7)	20% Change in UEPR	200	200	200	200	200
(8)	Loss Reserve Discount	4,000	(1,000)	(1,000)	(1,000)	(1,000)
(9)	Total Adjustments	(29,206)	(34,383)	(34,570)	(34,769)	(34,979)
(10)	REGULAR TAXABLE INCOME	775	36,265	39,961	43,876	48,022
	AMT Adjustments to Regular Taxable Income					
(11)	85% Tax Exempt Interest Income	33,406	33,583	33,770	33,969	34,179
(12)	Tax Preferred Ratio	0.75	0.75	0.75	0.75	0.75
(13)	Total AMT Adjustment	25,054	25,187	25,328	25,477	25,635
(14)	AMT INCOME	25,829	61,452	65,289	69,352	73,657
	Net Income					
(15)	Regular Tax	271	12,693	13,986	15,356	16,808
(16)	Alternative Minimum Tax	5,166	12,290	13,058	13,870	14,731
(17)	AMT Carryforward Used	0	402	929	1,486	2,076
(18)	Federal Income Tax Incurred	5,166	12,290	13,058	13,870	14,731
(19)	AMT Carryforward Incurred	4,895	0	0	0	0
(20)	NET INCOME	24,815	58,357	61,473	64,774	68,270
	Cumulative Totals					
(21)	Cumulative Net Income	24,815	83,172	144,646	209,420	277,690
(22)	Cumulative AMT Carryforwards	4,895	4,492	3,564	2,078	2

TAX ABLE INCOME CALCULATIONS

(In $000s)

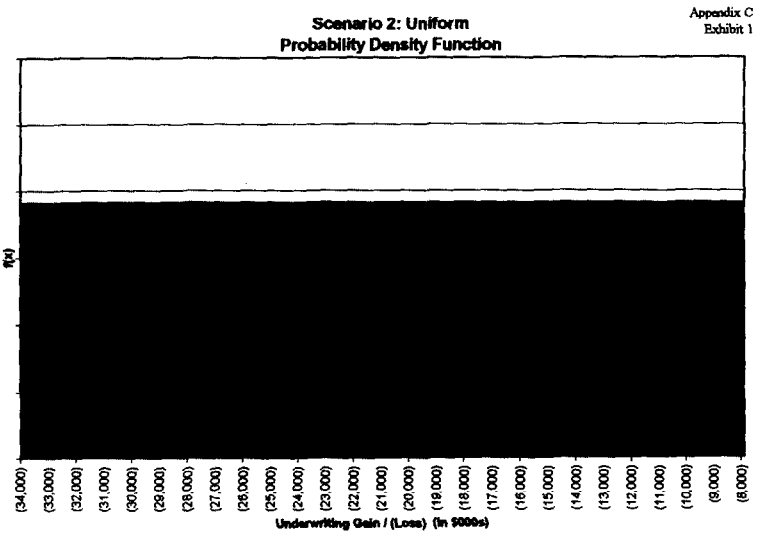
	Statutory Income Calculation	1996	1997	1998	1999	2000
(1)	Net Underwriting Gain / (Loss)	(32,000)	5,000	5,000	5,000	5,000
(2)	Taxable Investment Income Earned	37,699	19,808	24,576	25,852	27,468
(3)	Tax-Exempt Investment Income Earned	25,799	42,010	41,081	43,110	45,039
(4)	Realized Capital Gains	8,486	5,686	274	231	96
(5)	TOTAL STATUTORY INCOME	39,984	72,504	70,931	74,193	77,603
	Regular Tax Adjustments to Statutory Income					
(6)	85% Tax Exempt Interest Income	21,929	35,708	34,919	36,643	38,283
(7)	20% Change in UEPR	200	200	200	200	200
(8)	Loss Reserve Discount	4,000	(1,000)	(1,000)	(1,000)	(1,000)
(9)	Total Adjustments	(17,729)	(36,508)	(35,719)	(37,443)	(39,083)
(10)	REGULAR TAXABLE INCOME	22,255	35,996	35,212	36,750	38,520
	AMT Adjustments to Regular Taxable Income					
(11)	85% Tax Exempt Interest Income	21,929	35,708	34,919	36,643	38,283
(12)	Tax Preferred Ratio	0.75	0.75	0.75	0.75	0.75
(13)	Total AMT Adjustment	16,447	26,781	26,189	27,483	28,712
(14)	AMT INCOME	38,702	62,777	61,401	64,232	67,233
	Net Income					
(15)	Regular Tax	7,789	12,598	12,324	12,862	13,482
(16)	Alternative Minimum Tax	7,740	12,555	12,280	12,846	13,447
(17)	AMT Carryforward Used	0	0	0	0	0
(18)	Federal Income Tax Incurred	7,789	12,598	12,324	12,862	13,482
(19)	AMT Carryforward Incurred	0	0	0	0	0
(20)	NET INCOME	32,195	59,906	58,607	61,331	64,121
	Cumulative Totals					
(21)	Cumulative Net Income	32,195	92,100	150,707	212,038	276,159
(22)	Cumulative AMT Carryforwards	0	0	0	0	0

TAX ABLE INCOME CALCULATIONS

(In $000s)

	Statutory Income Calculation	1996	1997	1998	1999	2000
(1)	Net Underwriting Gain / (Loss)	(32,000)	5,000	5,000	5,000	5,000
(2)	Taxable Investment Income Earned	20,385	23,715	27,243	30,979	34,936
(3)	Tax-Exempt Investment Income Earned	39,297	39,498	39,710	39,935	40,174
(4)	Realized Capital Gains	12,795	0	0	0	0
(5)	TOTAL STATUTORY INCOME	40,478	68,213	71,953	75,914	80,109
	Regular Tax Adjustments to Statutory Income					
(6)	85% Tax Exempt Interest Income	33,403	33,573	33,754	33,945	34,148
(7)	20% Change in UEPR	200	200	200	200	200
(8)	Loss Reserve Discount	4,000	(1,000)	(1,000)	(1,000)	(1,000)
(9)	Total Adjustments	(29,203)	(34,373)	(34,554)	(34,745)	(34,948)
(10)	REGULAR TAXABLE INCOME	11,275	33,840	37,399	41,169	45,162
	AMT Adjustments to Regular Taxable Income					
(11)	85% Tax Exempt Interest Income	33,403	33,573	33,754	33,945	34,148
(12)	Tax Preferred Ratio	0.75	0.75	0.75	0.75	0.75
(13)	Total AMT Adjustment	25,052	25,180	25,315	25,459	25,611
(14)	AMT INCOME	36,327	59,020	62,714	66,628	70,772
	Net Income					
(15)	Regular Tax	3,946	11,844	13,090	14,409	15,807
(16)	Alternative Minimum Tax	7,265	11,804	12,543	13,326	14,154
(17)	AMT Carryforward Used	0	40	547	1,084	1,649
(18)	Federal Income Tax Incurred	7,265	11,804	12,543	13,326	14,158
(19)	AMT Carryforward Incurred	3,319	0	0	0	0
(20)	NET INCOME	33,212	56,409	59,410	62,588	65,951
	Cumulative Totals					
(21)	Cumulative Net Income	33,212	89,622	149,032	211,620	277,571
(22)	Cumulative AMT Carryforwards	3,319	3,279	2,732	1,649	0

Appendix C


Appendix C
Exhibit 1
Scenario 2: Uniform
Probability Density Function
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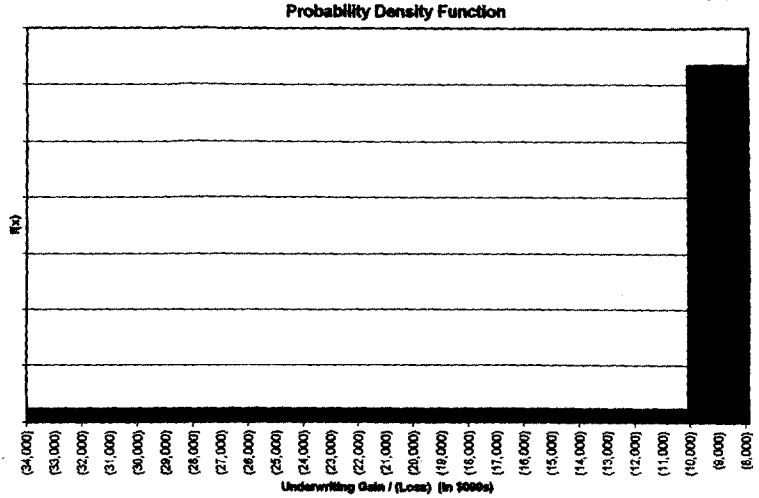
Underwriting Gain / (Loss) (In $000s)

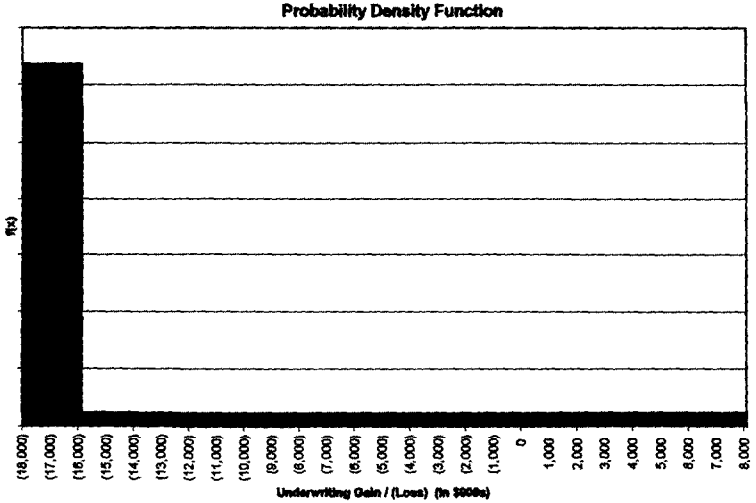
Appendix C
Exhibit 2

Scenario 3: Skewed Left
Probability Density Function



Appendix C
Exhibit 3

Scenario 4: Skewed Right
Probability Density Function



Tax Optimization: Summary of Two Year After-tax Income
(In $000s)

Appendix C
Exhibit 4

Strategy	Scenario 1: Fixed Underwriting				Scenario 2: Uniform				Scenario 3: Skewed Left				Scenario 4: Skewed Right			
Taxables / Tax-exempts	Mean	Standard Deviation	10th Percentile	90th Percentile	Mean	Standard Deviation	10th Percentile	90th Percentile	Mean	Standard Deviation	10th Percentile	90th Percentile	Mean	Standard Deviation	10th Percentile	90th Percentile
320 / 680	69,885	0	NA	NA	69,882	13,616	51,240	88,399	69,950	7,988	58,499	76,793	69,874	7,964	63,011	81,633
340 / 660	70,209	0	NA	NA	70,165	13,565	51,564	88,683	70,274	7,988	58,823	77,117	70,180	7,928	63,334	81,823
360 / 640	70,533	0	NA	NA	70,429	13,489	51,888	88,927	70,597	7,988	59,147	77,441	70,477	7,875	63,658	82,012
380 / 620	70,857	0	NA	NA	70,670	13,390	52,212	89,040	70,921	7,988	59,471	77,765	70,763	7,805	63,982	82,149
400 / 600	71,181	0	NA	NA	70,885	13,265	52,536	88,922	71,245	7,988	59,795	78,089	71,040	7,720	64,306	82,323
420 / 580	71,505	0	NA	NA	71,074	13,121	52,860	88,734	71,569	7,988	60,119	78,413	71,301	7,614	64,630	82,523
440 / 560	71,828	0	NA	NA	71,237	12,959	53,184	88,528	71,893	7,988	60,443	78,737	71,534	7,469	64,954	82,488
460 / 540	72,152	0	NA	NA	71,369	12,780	53,508	88,317	72,157	7,946	60,761	78,854	71,739	7,297	65,278	82,361
480 / 520	72,476	0	NA	NA	71,464	12,588	53,832	88,078	72,162	7,763	60,951	78,615	71,917	7,105	65,602	82,282
500 / 500	72,764	0	NA	NA	71,521	12,388	54,156	87,840	72,119	7,571	61,127	78,376	72,070	6,904	65,926	82,182
520 / 480	72,525	0	NA	NA	71,539	12,188	54,480	87,601	72,045	7,379	61,295	78,138	72,195	6,703	66,250	82,066
540 / 460	72,286	0	NA	NA	71,523	11,992	54,804	87,362	71,946	7,195	61,485	77,899	72,254	6,521	66,574	81,900
560 / 440	72,048	0	NA	NA	71,475	11,807	55,107	87,124	71,819	7,029	61,632	77,660	72,050	6,495	66,462	81,669
580 / 420	71,809	0	NA	NA	71,396	11,636	55,427	86,885	71,664	6,892	61,822	77,422	71,811	6,495	66,223	81,430
600 / 400	71,570	0	NA	NA	71,289	11,486	55,582	86,646	71,483	6,787	61,713	77,183	71,573	6,495	65,985	81,191
620 / 380	71,332	0	NA	NA	71,155	11,358	55,793	86,408	71,289	6,699	61,638	76,944	71,334	6,495	65,746	80,953
640 / 360	71,093	0	NA	NA	70,996	11,257	55,765	86,169	71,086	6,626	61,515	76,706	71,096	6,495	65,507	80,714
660 / 340	70,854	0	NA	NA	70,814	11,182	55,644	85,930	70,875	6,565	61,443	76,467	70,857	6,495	65,269	80,475
680 / 320	70,616	0	NA	NA	70,612	11,131	55,447	85,692	70,655	6,521	61,305	76,229	70,618	6,495	65,030	80,237