THE MYERS–COHN PROFIT MODEL, A PRACTICAL APPLICATION

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Abstract

The Myers–Cohn Profit Model is presented via both a simple example and a practical application. The practical application is shown in considerable detail in order to illustrate some of the techniques required in applying theory in the real world. This should help actuaries understand the model as well as illustrate the importance of the inputs chosen and assumptions made. Since most of the inputs used in this profit model are required by other profit models, the illustrations of how to quantify these input values should be of more general applicability.

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1. INTRODUCTION

Beginning with Commissioner James M. Stone's automobile bodily injury liability decision for 1976 state set rates, explicit account has been taken of investment income in ratemaking for the major lines of automobile and workers compensation insurance in Massachusetts. Although the computational techniques have changed over the years, the common thread has been to attempt to allow insurers a fair return on their equity.

This paper will present one profit model that has been used. A simple example will be presented as well as a practical application.

2. THE MYERS–COHN MODEL

The Myers–Cohn net present value model was developed for the Massachusetts Rating Bureaus by Professors Stewart Myers and Richard Cohn. It was intended as an improvement of the Fairley model which was used previously.[1] The basic concepts underlying the Fairley model, the model shown in Mahler [2][2] and the Myers–Cohn model are all similar. Given similar inputs all three models give similar (but not identical) results. The Myers–Cohn model was first presented in the fall of 1981 at the 1982 automobile rate hearings. Then Commissioner Sabbagh used a modified version of this model to fix and establish the 1982 private passenger automobile rates. The Massachusetts Rating Bureaus used the Myers–Cohn model to derive its proposed workers compensation underwriting profit provision as well. It is currently used, with some technical refinements, to set profit provisions for both automobile and workers compensation insurance in Massachusetts.

The basic premise underlying the Myers–Cohn model can be stated this way: a fair premium must be equal to the expected losses and expenses discounted to present value at a risk-adjusted rate, plus the present value of the federal income taxes on underwriting and investment income discounted at an appropriate rate.[3] Premiums calculated this way should preserve the equity invested in the company and give the investor a fair return for the risk of underwriting by the company.

The Myers–Cohn model shares many features of other profit models. One estimates the length of time an insurer can invest

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[1]The original Fairley Model, an improvement by Hill and Modigliani, and the Myers–Cohn Model, are all presented in *Fair Rate of Return in Property-Liability Insurance* [1].

[2]This model was first presented in the spring of 1981 and is described as "Model A" in Part III of the 1984 NAIC Study of Investment Income [3].

[3]As shown in Exhibits 3 and 5, and as discussed below, those underwriting taxes corresponding to the loss and expense payments are discounted at a risk-adjusted rate, while the other income taxes are discounted at the risk-free rate.

premium dollars prior to paying losses and expenses.[4] One estimates the investment income an insurer will earn on this cashflow and the necessary equity (surplus) backing up the policies. One takes into account the resulting income tax payments. Finally, one incorporates a reward to the insurer for taking the risk of writing insurance.

While this feature is shared with many other profit models,[5] the manner of doing so in the Myers–Cohn model is different. In the Myers–Cohn model selecting a risk-adjusted discount rate takes the place of selecting an appropriate rate of return on equity.

In the application of the Myers–Cohn model shown here, as well as the original paper by Myers and Cohn [1], the risk of writing insurance is quantified via the Capital Asset Pricing Model (CAPM). However, this is not a requirement. The Myers–Cohn model uses a risk-adjusted discount rate as an input. The difference between the risk-free and risk-adjusted rate determines the reward for taking the risk of underwriting. How this difference is selected is up to the person using the model. The CAPM is only one way to go about selecting this difference.

Once all the inputs have been determined, the Myers–Cohn equation yields the necessary premium as a ratio to losses and expenses. As shown in Exhibit 5,[6]

$$\frac{P}{L+E} = \frac{\kappa_1 - \tau_1\kappa_5}{\kappa_2 - \tau_2 r\kappa_3 - \tau_1\kappa_4 - \tau_1\alpha\kappa_6}.$$

Then one calculates the corresponding underwriting profit provision as 1 – (Losses + Expenses)/Premiums.

In order to illustrate the use of the Myers–Cohn model, a simplified example will be presented first. Later a practical application to Massachusetts workers compensation will be shown.

[4]Consideration of policyholder dividend payments may also be included in the model.
[5]See for example, Mahler [2].
[6]The terms in the equation are defined and discussed in Section 3 and in Exhibit 5.

It is neither the purpose nor intention of this paper to justify particular selections of inputs nor to determine the appropriate underwriting profit provision for use in any particular circumstance. All chosen inputs and calculated profit provisions are solely for illustrative purposes. As with all profit models, the profit provision calculated using the Myers–Cohn model is very sensitive to the inputs chosen and assumptions made. This sensitivity will be illustrated.

3. SIMPLE EXAMPLE

This section will illustrate the Myers–Cohn model via a simple example. The corresponding calculations are shown in Exhibits 1 through 5.

3.1. Simple Example, Inputs and Assumptions

For this simplified example, make the following assumptions:

- All premiums are collected in Quarter 1.
- All losses are paid in Quarter 5.
- Variable expenses are 20% of premiums, and are paid in Quarter 2.
- The ratio of fixed expenses to losses is 5%.
- Fixed expenses are paid in Quarter 2.
- Loss adjustment expenses are 10% of losses, and are paid when losses are in Quarter 5.
- The federal income tax rate on underwriting is 35%.
- Investments are made solely in risk-free Treasury securities.
- There are no investment expenses.
- The federal income tax rate on investment income is 35%.
- There is no discounting of reserves for tax purposes and no revenue offset feature of the tax code.

- There are no dividend payments.
- The risk-free rate is assumed to be 9%.
- A risk-adjusted rate of 7% is used. The important concept is that discounting "risky" loss and expense flows at the smaller risk-adjusted rate is intended to compensate insurers for the risk of underwriting insurance.[7]
- A 2-to-1 initial premium-to-surplus ratio is chosen.
- The surplus allocated to this policy is assumed to decline in proportion to the losses and expenses paid.

3.2. *Simple Example, Result and Outputs*

Using the Myers–Cohn profit model, the calculated underwriting profit provision is -3.0% as shown in Exhibit 1. The purpose of this example is to illustrate and help to understand the method of calculation, rather than concentrate on the answer itself. Exhibits 2, 3 and 4 show in detail how the cashflows are constructed and how the kappa values are determined. The kappa values are "timing parameters." They are calculated by discounting the various cashflows at either the risk-free or risk-adjusted rate. Exhibit 2 shows the cashflows for the initial set of weights.[8] However, as the profit provision varies so does the relative weight given to variable expenses, so that the profit model is solved via iteration.[9] The initial weights based on a profit provision of zero are used to calculate a profit provision which in turn yields a new relation of premiums to losses and a new set of

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[7] One could combine a 9% risk-free rate with an assumed beta of liabilities of $-.2$ and a market risk premium of 10%, to get a risk adjusted rate of 7%. $7\% = 9\% - .2 \times 10\%$. This is the method used in Section 4.8. While this is based on the Capital Asset Pricing Model, some other means could be used to get the risk-adjusted rate.

[8] The cashflows are constructed for a single policy (or set of policies with the same effective date), with a policy effective period of Quarters 1, 2, 3, and 4. Thus, the policy effective date (time=0) is at the end of Quarter 0, and the beginning of Quarter 1.

[9] While one might attempt to solve for P in closed form, this would be very complicated and have little if any practical value. For an analogous situation, Mahler [2, p. 257] discusses an approximation which allows one to solve for P in closed form.

weights. This new set of weights is used to calculate a new profit provision. The process continues until the iteration converges to the "final weights" and profit provision.[10] Exhibit 4 shows the cashflows for the final weights.

3.3. *Simple Example, Details*

The top portion of Exhibit 1 shows the inputs and assumptions chosen for this example. Next are shown the various kappa values, which are defined as follows:[11]

κ_1 = Risk-adjusted discounted losses and expenses factor

κ_2 = Risk-free discounted premiums factor

κ_3 = Risk-free discounted investment balance tax factor

κ_4 = Risk-free discounted underwriting profit tax factor (contribution of premiums)

κ_5 = Risk-adjusted discounted underwriting profit tax factor (contribution of losses and expenses)

κ_6 = Risk-free discounted revenue offset tax factor.

The calculation of the kappa values is shown in Exhibit 3, for the initial weights. κ_1 is the risk-adjusted discounted loss and expense factor. It is calculated by discounting the loss and expense flows from Exhibit 2 at the risk-adjusted rate of 7%. The result is divided by the sum of losses and expenses, which has been selected as 1,000.

κ_2 is the result of discounting the premium flow at the 9% risk-free rate.

[10]Generally, this takes three or four iterations.

[11]The Myers–Cohn paper had only four kappas. One additional kappa was introduced in implementation to allow for the difference in timing between the payment of losses and expenses, and the timing of the tax consequences of incurring losses and expenses. κ_6 was introduced in order to take into account the "revenue offset" feature of the Tax Reform Act of 1986.

κ_3 is the result of discounting the investment balance for taxes at the risk-free rate. The investment balance for taxes shown on Exhibit 2 is the sum of the surplus plus the premium dollars collected that have yet to be paid out as losses, expenses, or dividends.

κ_4 is the discounted contribution of premiums to the underwriting profit tax. κ_5 is similar but for losses and expenses, and thus discounted at a risk-adjusted rate. It's assumed these take place evenly in the four policy quarters.

κ_6 is the discount factor used to take into account the revenue offset feature of the tax code.

The bottom portion of Exhibit 1 shows how the different factors are put together to calculate the ratio of premiums to losses and expenses and in turn the underwriting profit provision:

$$P/(L+E) = (\kappa_1 - \tau_1\kappa_5)/(\kappa_2 - \tau_2 r\kappa_3 - \tau_1\kappa_4 - \tau_1\alpha\kappa_6).$$

Those terms involving losses and expenses are in the numerator. The terms involving taxes include the tax rates, either τ_1, the underwriting tax rate, or τ_2, the investment income tax rate.

The term $\tau_2 r\kappa_3$ is the tax rate τ_2 times the investment income of $r\kappa_3$, which is the quarterly rate of return times the (discounted) investment balance.

Once the ratio of $P/(L+E)$ is calculated as 0.9712, the profit provision is $1-(1/0.9712) = -3.0\%$. This can be thought of as a target combined ratio of 103%.

4. PRACTICAL APPLICATION, MASSACHUSETTS WORKERS COMPENSATION

This section describes a practical application to Massachusetts workers compensation insurance. The calculations are shown in Exhibits 5 through 23.

Exhibit 5 shows the equations for the Myers–Cohn model.[12] As in the simple example in the previous section, the various inputs are brought together to calculate the profit provision shown in Exhibit 5.

In many cases, inputs have been taken from elsewhere in the ratemaking procedure.[13] The calculations that produced those inputs are beyond the scope of this paper. However, in general it is important to choose a set of consistent inputs to any underwriting profit model. The set of inputs should be consistent both internally and with other parts of the ratemaking process.

Certain complications present in recent rate filings have been removed to aid in exposition. Enough complications have been left to illustrate the usual types of difficulties that arise in practical situations. However, every application can have its own peculiar details that require special treatment. Many of those that have arisen in Massachusetts workers compensation are beyond the scope of this paper.

For completeness, the changes that were made from the filing for 1/1/98 rates to get the practical application shown here are listed in the Appendix.[14]

4.1. *Calculation of the Underwriting Profit Provision*

As in the simple example in the previous section, the various inputs are used to calculate six timing parameters, κ_1 through κ_6. These are then combined in Exhibit 5 using the formulas:

$$\frac{P}{L+E} = \frac{\kappa_1 - \tau_1\kappa_5}{\kappa_2 - \tau_2 r\kappa_3 - \tau_1\kappa_4 - \tau_1\alpha\kappa_6} \qquad \text{and}$$

$$\mu = 1 - (P/(L+E))^{-1},$$

[12] These were also used in the simple example in the previous section.

[13] For example, the estimate of loss flows employs estimates of ultimate losses by accident year.

[14] Among the complications not presented here, is the use of a simulation model (along the same general lines as in Venter and Gillam [4]) in order to estimate the impact on the indemnity loss flows of a major law change.

where r is the quarterly risk-free rate, τ_1 is the underwriting income tax rate, τ_2 is the investment income tax rate and α is a factor related to the revenue offset feature of the tax law.

As shown in Exhibit 5, this results in a model profit provision of -3.6% for the Massachusetts workers compensation example.[15] In order to apply this model profit provision in the usual Massachusetts workers compensation ratemaking procedure one final step is needed.[16]

Premium discounts are reductions in premiums for larger insureds to reflect their lower expense needs as a percent of Standard Premium. Standard Premium is prior to the impact of premium discounts.[17]

Ignoring the existence of Standard Premium and premium discounts in the profit model should have no economic impact since premium discounts merely represent money the insurer did not receive and never expected to receive.[18]

This idea is implemented as follows:

> The premium flow is net of premium discounts. (See Exhibit 6.)
>
> The expense flows do not include any weight for premium discounts. The initial weights are determined without the premium discount. Variable expenses are a percent of net premiums rather than Standard Premiums. (See Exhibit 9.)

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[15]This result should be viewed as illustrative. Many of the input values (even if selected by the same individual) would vary considerably over time, state, line of insurance, etc.

[16]This step is needed because the rate indication is based on Standard Premiums (plus ARAP), prior to the impact of any premium discounts.

[17]Standard Premium can be thought of as the product of payroll, manual rate, and experience modification. (As reported on Financial Aggregate Data Calls, it includes expense constants as well.)

[18]The size of the premium discount is not uncertain.

Then as shown in Exhibit 5, one calculates the Underwriting Profit Allowance to load into the ratemaking procedure as:

$$\begin{aligned}&\text{Underwriting Profit Allowance}\\&\quad = (\text{Model Profit Provision})\\&\qquad \times (1 - \text{Premium Discount as \% of Standard Premium})\end{aligned}$$

In this case, the

$$\begin{aligned}&\text{Underwriting Profit Allowance}\\&\quad = (-3.6\%)(1 - 6.8\%) = -3.4\%.\end{aligned}$$ [19]

4.2. Premium Cash Flow

The premium flow used in the profit model is shown in Exhibit 6, Part 1. It is estimated from a study conducted by the Rating Bureau and reported in the filing for rates to be effective 1/1/91.

Fourteen separate flows were calculated by combining the sample returns into categories formed by stock/non-stock, retro/non-retro, and size characteristics. Four premium size intervals, 0–4,999; 5,000–99,999; 100,000–499,999; and over 500,000 were used to distinguish among the premium flows for small, medium, and large risks.[20] The 14 flows were determined by calculating the time, in days, from the policy's effective date to the actual payment date. Summaries were then made for 90 day periods.

A raw combined flow was constructed by combining the fourteen individual flows with industrywide weights obtained from Unit Statistical Plan data and representing actual Mas-

[19]Thus, if expected losses, expenses including premium discounts, plus any provision for policyholder dividends, is equal to $1,000, then indicated Standard Premiums would be: $\$1{,}000/(1-(-0.034)) = \$967.12$.

[20]These are the same size intervals that were used in the schedule of premium discounts at the time of the study.

sachusetts distributions of premium. The individual flows were first weighted by the stock/non-stock/retro/non-retro distribution. A final combination of those flows by size was accomplished using prospective Standard Premium size distributions at projected rates for each combination of stock/non-stock/retro/non-retro.

The raw weighted flow is shown in Exhibit 6, Part 2 as the "untrimmed" flow. Modifications are performed in order to arrive at a final company premium flow. First, the data for the quarter directly preceding the effective date is biased toward the end of that quarter. Most of that data represents deposit premiums which are made immediately prior to the effective date. Indeed, the average date in the sample for that quarter was only 6.5 days prior to the effective date. The use of this aggregate data valued as of the middle of the quarter (45 days) would produce erroneous results. In order to take this effect into account, the data was combined with the first quarter after the effective date for discounting purposes. The average date of the combined data should produce reasonably unbiased discounting results.[21]

Along with the above refinement, the tails of the "untrimmed" flows were truncated to eliminate the noise in the sample data and the remaining flow was normalized to unity. This result is shown in Exhibit 6 as the "trimmed" flow. It will serve as the paid premium flow, the flow pattern for commissions and as the net premium flow.

4.3. Policyholder Dividends

Historically, policyholder dividends have played an important part in a healthy workers compensation insurance market. Dividend plans have provided a means to reward those insureds with better experience. "Sliding scale" dividend plans, in which the payment of the dividend depends on the insured's loss ratio, have provided important incentives for safety and loss control.

[21] It is the discounted value of the flows that affects the underwriting profit provision calculated by the model.

Historically, substantial dividend payments have been made to Massachusetts workers compensation policyholders.

It is expected that companies will continue to pay dividends to policyholders to maintain their competitive position, particularly if the rates are adequate, as they are intended to be. Therefore, these anticipated policyholder dividend payments have been reflected in the cash flows used in the profit model, in the same way as all other flows are recognized. If these policyholder dividend flows were not recognized, imaginary investment income would be imputed to companies on funds they do not hold.

The payment of policyholder dividends has been estimated to occur at the seventh quarter. The magnitude of dividend payments is calculated in Exhibit 7 from the Massachusetts ratios of policyholder dividends to the earned premium from the previous year.

Since the proposed expenses and premium discounts elsewhere in the ratemaking process are based on all companies, the estimate of the level of policyholder dividends is based on the most recently available 11-year average ratio of dividends to net earned premiums for Massachusetts workers compensation for all companies.[22]

4.4. *Expense Flows*

The expense flows were derived using a weighted average of separately determined flows for commissions, premium and other taxes, general expenses, other acquisition expenses, allocated loss adjustment expenses, and unallocated loss adjustment expenses.

The magnitude of each of these flows is determined by the corresponding expense provisions determined elsewhere in the ratemaking process. The pattern of each of these flows is determined as described below.

[22]To the extent that in many of these years the rates were inadequate, this procedure may underestimate dividends expected in a healthy market with an adequate rate level.

In order to run the Myers–Cohn profit model, expenses that vary with premium are aggregated into one flow while expenses that do not vary with premiums are aggregated into another flow. Each of these combined expense flows is a weighted average that reflects the relative expense provisions in this filing. The weights are shown in Exhibit 9.

The resulting expense flows used in the profit model are displayed in Exhibit 8.

A study of general expense flow patterns was performed by the Rating Bureau and were reported in the July 13, 1977 filing for Massachusetts workers compensation rates. Briefly, general expenses were divided into general administration, audit, inspection, and Bureau expenses. A time line was constructed to indicate a particular type of expenditure's distance from the effective date of a typical policy. Expenses by cost center, including home and field office expenses, were analyzed to establish those patterns of expenditures relative to the effective date of the policy. The combination of all such expense patterns resulted in the overall general expense pattern listed in Exhibit 10.[23]

The distribution of other acquisition costs was estimated from the same time pattern study that was used for general expense. Marketing field offices and services, billing and collection, policy issuance, and advertising expenses were examined for their occurrence relative to the issuance of a policy. The combination of all such expense patterns resulted in the other acquisition expense pattern listed in Exhibit 10.

Premium taxes are estimated and paid quarterly based upon a flat percentage of a flat amount (the previous year's net written premium). An adjustment is made to this estimation process in the first quarter of the following year. For purposes of estimating the expense flows we assume that adjustment will be zero. Based on these statutory provisions, the premium tax liability for any

[23]The profit provision is insensitive to the precise timing of general expenses and other acquisition expenses.

individual policy is assumed to be incurred and paid as the policy is written. The other tax payment pattern was estimated from the same time pattern study that was used for general expense.

The commission flow pattern is assumed to coincide with the paid premium flow.[24]

The loss adjustment expense (LAE) flow patterns, both allocated and unallocated, are based on the loss flow. The allocated LAE flow is assumed to have the same pattern as the loss flow. This corresponds to an assumption that on average the allocated LAE payments occur at approximately the same time as claim payments.

The pattern of the unallocated LAE flow is assumed to be the same as the straight average of the loss flow and an earned premium flow. This corresponds to an assumption that on average half of the unallocated LAE payments are made as accidents occur over the course of the policy effective period and that the other half of the unallocated LAE payments are made as claims are paid.

The weights used to combine the various expense flow patterns into final expense flows are calculated using the expense provisions used elsewhere in the ratemaking process. Since the premium flow is constructed net of premium discounts, it is necessary to calculate the proportions of expenses to net premiums. The acquisition expense and premium taxes are treated as varying in proportion to net premium. Loss adjustment expense is treated as varying in proportion to losses. General expense and other taxes are assumed not to vary with premium levels. These shall be referred to as fixed expenses.

Since the underwriting profit provision is one factor that determines the premium, and since losses, loss adjustment expense, and fixed expenses are all treated as not varying with premium

[24]The commission flow is the same as the flow of premium payments (the trimmed flow). See Exhibit 6.

levels, their fraction of premiums depends on the underwriting profit provision. Thus, their weight relative to those items that vary in proportion to premiums will change as the profit provision does. However, their weight relative to each other will not change. Thus, it is important that the weights for loss adjustment expense and fixed expenses be in the proper ratio to losses. A set of such initial weights is calculated in Exhibit 9.

The profit model is run through several iterations until the weights and profit provision converge to their final values.[25] At each iteration the weights assigned to losses, loss adjustment expense, fixed expenses, and variable expenses are adjusted for the profit provision. These new weights are then used to calculate another profit provision which in turn leads to another set of weights. The final weights are shown in Exhibit 9.

4.5. Loss Cash Flow

A medical and an indemnity loss cash flow have been estimated from the most recent available Financial Aggregate data.[26] The combined loss flow used in the profit model reflects a weighted average of the medical and indemnity flows and is shown in Exhibit 11.[27]

As shown in Exhibit 12, the flow for medical losses is based on the paid losses combined with an estimate of ultimate medical losses for each accident year taken from elsewhere in the ratemaking process. The percent of these ultimate losses paid in each year is computed. (See Exhibit 12, Part 2.) The increment between reports for each accident year is then computed (see Exhibit 12, Part 3), and the latest three-year average has been calculated for each reporting interval until the 17th report.[28] Beyond that report, the selected percentage of paid to ultimate loss

[25] Usually convergence takes 3 or 4 iterations.

[26] These are the same data relied upon elsewhere in the ratemaking process in order to estimate ultimate losses.

[27] The loss flow in Exhibit 11 sums to 1,000 solely for convenience.

[28] A two year average was calculated for the 17th report.

has been extended judgmentally.[29] The resulting medical loss flow is shown in Part 4 of Exhibit 12.

The indemnity flow is estimated in a similar manner in Exhibit 13. The indemnity and medical flows are then weighted together using an estimate of the percentage of total losses represented by each type,[30] in order to get the loss flow shown in Exhibit 11.

4.6. Determination of the Risk-Free Rate of Return

The risk-free rate of return is calculated as an average, weighted by annual net cash flows of duration-matched Treasury yields. This calculation is displayed in Exhibit 14.[31] The yields are taken from Part 4 of Exhibit 14 and are calculated from the observed yields over the most recent 12 months for the different maturities of Treasury securities.[32] The weights are taken from Part 5 of Exhibit 14 and reflect the length of time between receipt of premiums and payment of losses and expenses for Massachusetts workers compensation estimated in prior exhibits.

4.7. Federal Income Tax Rate[33]

For the federal income tax rate on investments, the corporate 35% tax rate currently applicable to Treasury securities has been used. This corresponds to the so-called "statutory/regulatory company" assumption, which is used with the Myers–Cohn Model.

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[29]The manner in which this is done has no significant impact on the net present value of the flow or the resulting profit provision.

[30]This estimate is taken from elsewhere in the ratemaking process. For this illustration the indemnity flow has been weighted 68%, while the medical flow has been weighted 32%.

[31]The risk-free rate resulting from this calculation (as applied to Massachusetts workers compensation) is approximately the yield available on seven-year treasury bonds. A more elaborate method of duration matching could be employed if desired. Any uncertainty in the timing of the cashflows (as well as their magnitude) is not taken into account here, but should be incorporated in the selection of the risk-adjustment.

[32]The yield on Treasury securities usually increases as the term increases.

[33]See Almagro and Ghezzi [5] for a discussion of federal income tax provisions affecting property/casualty insurers.

The model company is assumed to invest in risk-free U.S. government securities matched to the length of the expected cashflow. The statutory/regulatory company assumption was adopted by former Commissioner of Insurance Stone in 1976, and was used by both the Rating Bureau and former Commissioner of Insurance Sabbagh in the original implementations of the Myers–Cohn profit model. The assumption that the model insurer's entire portfolio is invested in taxable government securities has several important implications:

- The investment income to be imputed to insurers is to be determined by matching the maturities of taxable government securities with the investment cash flow.
- The tax rate to be applied to determine the after-tax investment income should be the tax rate applicable to taxable government securities.
- No adjustment for investment risk needs to be made, because the investment is "risk-free."
- A smaller allowance for investment expenses is appropriate, because such a model insurer would have smaller investment expenses than would an insurer investing in a variety of other assets.[34]
- No adjustment need be made to take into account the Alternate Minimum Tax.

In the author's opinion, this assumption has a number of advantages.[35] The assumption makes the measure of investment income relatively stable and predictable; it establishes an investment standard that real world companies can meet; and it insulates the policyholders from the fluctuations in the stock and bond market to which they might be exposed if an actual portfolio model were used. Using the statutory/regulatory assump-

[34]No provision for investment expenses has been included.
[35]At least when used by a Rating Bureau. Different considerations would apply in other situations.

tion, current purchasers of insurance are neither penalized by, nor credited with, past investment decisions of the insurer. Rather we assume that the insurer will invest the fresh funds supplied by the premium of the insured at the currently available rates of return. The policyholder is thus credited with investment income at the risk-free rate. The policyholder shares neither the risk nor the reward of any more risky investment strategy.[36]

A 35% tax rate for underwriting income (or losses) has also been used. Underwriting credits will be available at 35%, because this model insurer has investment income taxed at 35% which can be offset by an underwriting loss. Such a model insurer will also not be subject to the Alternate Minimum Tax. In any case, the investment income tax rate, investment strategy, investment return, reward for risk, etc., used in the profit model need to all be consistent.

How one might incorporate some assumed set of investment other than Treasury securities into the Myers–Cohn model has been a controversial subject from the model's inception. Other investments would have differing risk, return, and tax implications than Treasury securities. One requires a consistent set of inputs that properly takes into account all of the impacts on the operation of the model company, including its required rate of return.

While some calculations of profit provisions using the Myers–Cohn model assuming other investments have been presented, I am not convinced that the resulting profit provisions are reasonable. In my opinion, the structure of the Myers–Cohn model without an explicit rate of return on equity makes it very difficult to properly consider the impacts of investment choices on risk and the needed profit provision. In any case, this subject is beyond the scope of this paper.[37]

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[36]Consistent with the model company, there is no loading for investment expenses. So the policyholder is not being asked to share the cost of any investment strategy.

[37]See for example, Derrig [6], which discusses the "Myers Theorem," which states that the present value of the tax on investment income does not depend on the risk of the securities held by the insurance company.

4.8. *Risk-Adjusted Rate of Return*

An input to the Myers–Cohn model is the risk-adjusted rate of return. In this implementation of the model, as well as the paper by Myers and Cohn, the risk-adjusted rate (r_L) is set equal to the risk-free rate (r_f) plus the product of the negative liability beta (β_L) and the long term market risk premium (M). As calculated in Exhibit 15:

$$r_L = r_f + \beta_L M.$$

Exhibit 16 displays the estimation of the market risk premium. For each available year the total return on large company stocks has subtracted from it the return on U.S. Treasury Bills.[38] Then, per the recommendation of Ibbotson Associates [7], the long term (unweighted arithmetic) average of these differences is taken as the estimate of the market risk premium.

The yearly points that form the basis for this average are an extremely volatile data series.[39] For example, Figure 1 shows the yearly points while Figure 2 shows the ten year moving average, which is still fairly volatile.

Figure 3 shows the average of the series starting in various years since 1926 through the present. Depending on when one starts, the average can range from about 6% to about 11%.

Thus, the years of data relied upon can have a significant impact on the estimated market risk premium. The use of a long term average is consistent with an assumption of a stable or relatively stable expected value over time, which Ibbotson believes is the case. Mahler [8] briefly discusses the insensitivity of the estimate to somewhat different weights rather than the long term unweighted average, provided one assumes a relatively slow rate of shifting parameters over time.

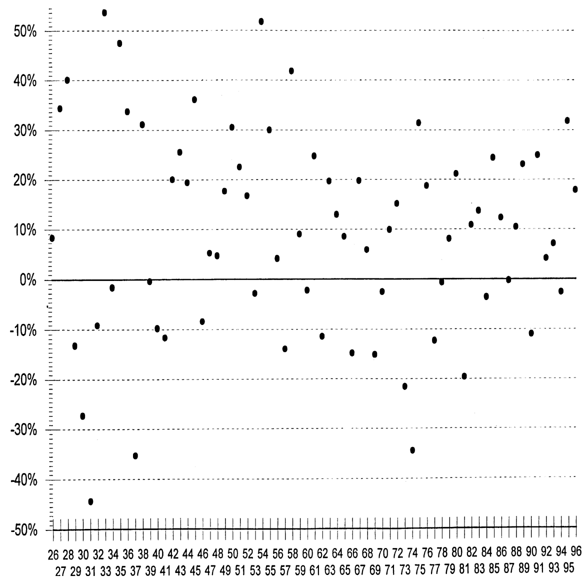
In any case, a value of the market risk premium between about 8.5% and 9% seems to be regarded as reasonable. There is noth-

[38] See Ibbotson [7].

[39] While the mean is between 8% and 9%, the standard deviation is about 21%.

FIGURE 1

DIFFERENCE IN TOTAL RETURN ON LARGE COMPANY STOCKS AND U.S. TREASURY BILLS



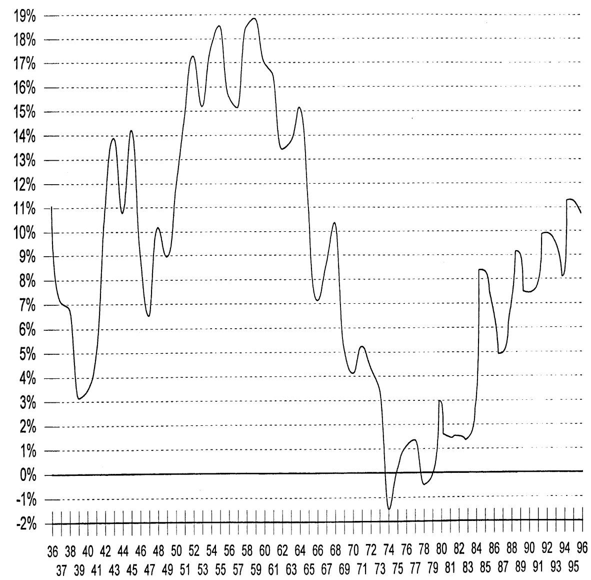
ing insurance specific about this value. This contrasts with the beta of liabilities which is insurance specific and for which there is no method of estimation generally regarded as reliable.

The beta of liabilities is intended to measure the covariance of insurance underwriting (as opposed to investing) with the stock market.[40] When combined with the market risk premium, it is intended to reward the insurer for the risk of underwriting insurance. Provided the beta of liabilities is negative, the risk-adjusted rate is smaller than the risk-free rate. Discounting the risky loss and expense flows at this smaller risk-adjusted rate results in a larger indicated premium than if these flows were discounted at

[40]This is based on the Capital Asset Pricing Model (CAPM).

FIGURE 2

DIFFERENCE IN TOTAL RETURN ON LARGE COMPANY STOCKS AND U.S. TREASURY BILLS
TEN YEAR MOVING AVERAGE OF THE SERIES



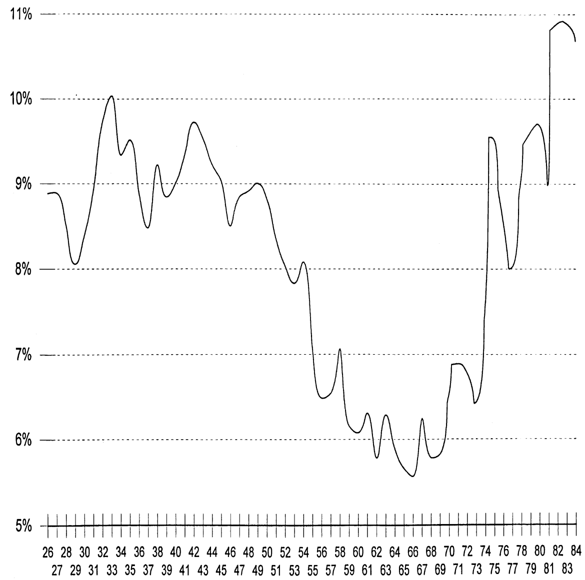
the risk-free rate. For this calculation a value of −0.21 used by the Massachusetts Commissioner of Insurance has been used for the beta of liabilities.

Unfortunately, as concluded by Kozik [9], "reliable estimates of the underwriting beta do not exist."[41] Thus, this is a major potential weakness of the Myers–Cohn model. Some technique must be employed to select or estimate the appropriate risk-adjustment. (The Capital Asset Pricing Model is the only

[41] As stated by Kozik, "Perhaps better methods of estimation may some day be developed." The discussion by Feldblum [10] is even more negative towards the whole idea of even considering something like a beta of liabilities.

FIGURE 3

DIFFERENCE IN TOTAL RETURN ON LARGE COMPANY STOCKS AND U.S. TREASURY BILLS
AVERAGE OF SERIES FROM THE GIVEN YEAR THROUGH 1996



technique the author has seen used for this piece of the Myers–Cohn model.) However, this is the same basic difficulty that one encounters in the use of other profit models that require the selection or estimation of the target rate of return or target internal rate of return. So while this presents a serious difficulty with the use of the Myers–Cohn model, it should be weighed against the similar difficulties in the use of other profit models.[42]

It should also be noted that since the reward for risk is based on using a risk-adjusted rate, the Myers–Cohn model would provide little risk return for a line of insurance that had a very quick

[42]This paper, in describing one profit model, is neither advocating for or against its use compared to some other profit model.

payment of losses such as hurricane insurance, unless one used a very large per-period risk-adjustment. Since it is very difficult to select an overall risk-adjustment to use on average for insurance, it would be extremely difficult, if not impossible, to come up with a risk-adjustment by line of insurance.

Exhibit 21, Part 1 displays the calculation of the "risk load." Let Z be the expected risk loading. Then $Z = 1 - (P^*/P)$, where P is the premium using a risk-adjusted discount rate while P^* is the premium (for the same cashflows) calculated with only the risk-free discount rate ($\beta_L = 0$). P^* is less than P, and the risk loading Z is positive.[43]

While in this illustrative calculation no specific use is made of Z,[44] it does quantify the effect of the risk-adjustment in the Myers–Cohn model.

4.9. Surplus

Initially surplus is assumed to be one-half of premiums and is assumed to decline in proportion to outstanding liabilities.[45] Thus, the surplus allocated to this policy or policy cohort is assumed to decline in proportion to the losses and expenses paid, as shown in Exhibit 17.

It should be noted that the Myers–Cohn model, as in the case with most profit models, is able to accommodate any magnitude or pattern of surplus flow selected by the user. However, for purposes of running the model, one does have to allocate surplus.

All of an insurer's surplus is in theory available to back up each policy, so in that sense one cannot allocate surplus to pol-

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[43] For Massachusetts workers compensation, for $\beta_L = -0.21$, $Z \approx 5\%$ or 6% of premiums.

[44] As explained in the Appendix, in recent rate filings, Z has been used in a technical refinement that alters the investment balance for taxes.

[45] As explained in Mahler [2], the premium-to-surplus ratio one would observe for a given calendar year differs from the initial premium-to-surplus ratio selected here. Given the timing and magnitude of surplus flow selected here, one could compute what calendar year premium-to-surplus ratio would be observed for an assumed growth rate in premiums.

icy cohort, to line, or to state. On the other hand, each year, line, and state is expected to help contribute to the profitability of the insurer. The allocation of surplus for purposes of running the profit model allows one to allocate the needed *return* on surplus[46] among the different lines and states.[47] In that sense it is analogous to allocating by line and state certain expenses that have no direct relationship to any particular line or state. Expense allocation in the ratemaking process allows the collection of dollars needed to pay for these expenses. Similarly, surplus allocation allows the collection of dollars needed to achieve the desired return on surplus on an expected basis.

4.10. Construction of the Investment Balance for Tax Flow

The Investment Balance for Taxes is shown in Exhibit 18, Part 1.

The investment balance for any quarter is calculated as the sum of two components: assets available from the policy cash flow and those available from shareholders' equity. These two components are quantified each quarter as:

1. cumulative premiums minus cumulative losses, expenses, and dividends[48] (see Exhibit 18, Part 2) and

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[46]While we have used the term "surplus" as per Myers and Cohn, a better term would be "equity." The concepts of surplus and equity are closely related but not identical. Surplus generally refers to statutory surplus while equity refers to economic net worth.

[47]Bingham [11], [12], and [13] discusses how one insurer uses allocation methods to measure returns and set targets by line of insurance. It is necessary to assign "benchmark" surplus to each line of insurance in order to apply the methodology used by Bingham. Bingham in his papers as well as Bender [14] discuss the relationship of risk, return, and required surplus. These issues apply when using the Myers–Cohn or most other profit models.

[48]It is important to note that in this computation the total premium equals the total losses, expenses, and dividends. In other words, this computation is performed using a profit provision of zero. This produces the appropriate estimate of investment income excluding any underwriting income (or loss). Mahler [2, Appendix VI] shows that the method used in Myers–Cohn to compute the investment income tax corresponds to a particular set of assumptions on the timing of income that is used in the model in that paper. Under these assumptions, the ratio of the present value of the income on the cashflows to the income on the cashflows is equal to the ratio of the present value of the outflows to the outflows.

2. surplus[49] (See Exhibit 17).

The tax on investment income can then be quantified by advancing the investment balance by one quarter (to the quarter in which the income is earned) and applying the quarterly investment rate and income tax rate.

4.11. Underwriting Tax Flows

The underwriting tax flows are shown in Exhibit 19, Part 1.

Premiums are earned equally throughout the year of the policy. This results in the premium portion of the underwriting tax flow shown in Exhibit 19, Part 1. This flow will be discounted to get κ_4 as shown in Exhibit 21.

The loss plus expense and dividend portion of the underwriting tax flow is shown in Exhibit 19, Part 1. This flow will be discounted to get κ_5 as shown in Exhibit 21.

The contribution of expenses (other than loss adjustment expense) and dividends to the underwriting tax flow is determined in Part 2 of Exhibit 19 by summing expenses and dividends paid in each quarter.

The contribution of losses and loss adjustment expense to this underwriting tax flow is determined in Part 3 of Exhibit 19, based on the reserve discount factors calculated in Exhibit 20. This follows the Tax Reform Act of 1986, which required insurers to discount loss reserves for tax purposes and specified how this was to be done.

The incurred loss plus LAE calculated in Part 3 of Exhibit 19 can be thought of as the sum of two pieces.[50] The first piece is the difference between the amount paid in a year and the discounted reserve previously held for those losses. The latter amount is

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[49] As used in the Myers–Cohn model, "surplus" actually refers to shareholder equity rather than statutory surplus.

[50] Column 8 = Column 6 + Column 7, in Part 3 of Exhibit 19.

the paid losses in that year[51] times the appropriate reserve discount factor. Thus, the difference is the losses paid times unity minus the reserve discount factor.[52] The second piece is the change in discounted reserves on subsequent years. This is the product of the losses paid in subsequent years and the difference in reserve discount factors.[53]

The reserve discount factors are calculated in Exhibit 20 using a rolling sixty-month average of the mid-term "Applicable Federal Rate" (AFR) effective as of the beginning of each calendar month, and the reserve loss flow for workers compensation prescribed by the Internal Revenue Service.[54]

4.12. Discounted Flows

Each flow in the Myers–Cohn profit model has to be discounted at the appropriate risk-free or risk-adjusted rate. The risk-free discount rate is determined in Exhibit 14. The premium flow, the investment balance for tax, and the underwriting tax premium flow are discounted at the risk-free rate.

The risk-adjusted rate is determined in Exhibit 15. Discount factors based on the risk-adjusted rate are applied then to the total loss and expense flow and the underwriting tax loss flow.

Exhibit 21 shows the resulting values of the kappas. Also shown is the expected compensation to shareholders, i.e., the risk premium. This compensation for taking the risk of writing insurance is computed as unity minus the ratio of the premium

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[51]For modeling purposes, the reserves and loss payments are assumed to be based on the same expected value. Also, the reserve discount factors are applied as if year one of the policy flow were accident year one in the Annual Statement, etc. This is only true for policies written January 1. This simplification has no significant impact on the calculation of the underwriting profit provision.

[52]Column 6 = 1 − Column 2 $\times$ Column 4, in Part 3 of Exhibit 19.

[53]Column 7 = Column 3 $\times$ Column 5, in Part 3 of Exhibit 19.

[54]For additional details, see Almagro and Ghezzi. [5, pp. 144, 145]. The reserve loss flow is updated by the IRS once every five years.

calculated using a risk-free discount rate ($\beta = 0$) and the premium calculated using a risk-adjusted rate.[55]

4.13. Revenue Offset Provision of the Tax Reform Act of 1986

Exhibit 22 contains the calculation of the unearned premium reserve "alpha" factor. When multiplied by κ_6 and the Federal Income Tax rate on underwriting, the alpha factor incorporates into the profit model the "revenue offset" provision of the 1986 Tax Reform Act.

This provision is explained in Almagro and Ghezzi [5]:

> Statutory income includes the change in unearned premium reserve during the tax year as a deduction. Insurers' acquisition expenses, however, are generally incurred and deducted near the time premiums are collected. Therefore, the statutory calculation does not accurately match recognition of premium income with recognition of related expenses.
>
> To approximately adjust for this mismatch, the IRS allows only 80% of the change in unearned premium reserve as a deduction. The limitation of the deduction is accomplished through an adjustment to statutory income, referred to as "revenue offset," whereby 20% of the unearned premium reserve change is added to statutory income for tax purposes.

This can be usefully thought of as accelerating the taxation of 20% of the premium income from a policy. Prior to this change, premium would be taxed as earned. Now 20% of premium is taxed as it is written or more precisely as an unearned premium reserve is set up. Then when the unearned premium reserve is

[55]This risk premium is calculated for informational purposes. While it is not used in the calculation of the underwriting profit provision, it is implicitly part of the profit provision calculated by the Myers–Cohn model. The value of the risk premium depends on the inputs chosen, most importantly the beta of liabilities, the market risk premium, and the timing of the cashflows.

taken down, 20% of the reduction in unearned premium reserve balances 20% of premium being earned at the same time. Thus, the timing of the reflection of this premium income has been moved from when it is earned to when the unearned premium reserve is set up.

Alpha is calculated in Exhibit 22 as 20% times the ratio of unearned premium reserves to premium times four times the quarterly risk-free rate.[56] κ_6 is calculated in Exhibit 23 based on the timing of the unearned premium reserves illustrated in the following example.[57] Table 1 shows how to specify the timing of the tax flows (due to the revenue offset) resulting from writing a new policy.

Assume \$1,000 in written premiums and \$120 in unearned premium reserves.[58] This 12.0% ratio of unearned premium reserves to premium approximates the current figure for workers compensation.

Continuing this example, let us assume a risk-free rate of 6% for illustrative purposes.[59] At 6%, the present value of the income tax due to the revenue offset is 0.4784.

Let κ_6 be the present value at 6% of a vector starting in Quarter 1[60] with the assumed pattern of unearned premium reserves:

$$\frac{180}{480}, \frac{140}{480}, \frac{100}{480}, \frac{60}{480}.$$

Then $\kappa_6 = 0.9702$.

---

[56]Thus alpha is approximately 20% of the unearned premium reserves times the annual risk-free rate.

[57]The final profit provision is insensitive to the particular choice of timing made.

[58]The sum over quarters is $4 \times \$120 = \$480$; this is \$120 in unearned premium reserves on an annual basis.

[59]The actual calculation of κ_6 and alpha used in the calculation of the profit provision use the risk-free rate determined in Exhibit 14. The 6% value has been selected solely for illustrative purposes.

[60]The vector starts in Quarter 1 rather than Quarter 0 as per the unearned premium reserve. Advancing one quarter adds a factor of $(1+r)^{-1}$ which is required in order to match the present value of the income tax due to the revenue offset.

TABLE 1

Quarter	Unearned Premium Reserve	Change in Unearned Premium Reserve	Income Tax Due to Revenue Offset[61]
0	180	180	12.60
1	140	−40	−2.80
2	100	−40	−2.80
3	60	−40	−2.80
4	0	−60	−4.20
Total	**480**	**0**	**0**

It is the case that:

$$0.4784 = 480 \times 35\% \times 20\% \times 0.01467 \times \kappa_6$$

where:

480 is the unearned premium reserve (UPR),

35% is the federal income tax rate on underwriting (FITU),

20% is the revenue offset factor, and

0.01467 is the quarterly risk-free rate of return (assuming a 6% annual rate).

Thus, the present value of the income tax due to the revenue offset is

$$\begin{aligned} &UPR \times FITU \times 20\% \times r \times \kappa_6 \\ &\quad = 4 \times P \times UPRR \times FITU \times 20\% \times r \times \kappa_6 \\ &\quad = P \times FITU \times \alpha \times \kappa_6, \end{aligned}$$

where

$$\alpha = 4 \times UPRR \times r \times 20,$$

$UPRR$ = unearned premium reserve ratio (to premiums),

r = quarterly risk-free rate, and

P = written premium.

[61] Change in unearned premium reserve × 35% × 20%.

This is the formula for alpha that is used in Exhibit 22. The impact of the revenue offset enters into the Myers–Cohn profit calculation via the term $FITU \times \alpha \times \kappa_6$, as shown in Exhibit 5.

5. SENSITIVITY ANALYSIS

For the practical example described in the previous section, the inputs combine to produce a model underwriting profit provision of -3.6%, as shown in Exhibit 5. As with any model, the result depends on both the structure of the model and particular inputs chosen.

Exhibit 24 shows the sensitivity of the Myers–Cohn model to the choice of different inputs. While individual inputs are varied one at a time for illustrative purposes, it is important to choose a consistent *set* of inputs for use in the profit model.

The risk-free rate of return can vary by several percentage points from one year to the next. Generally, in Massachusetts an average of the last year's rates available on a duration-matched portfolio of Treasury securities has been used to estimate the risk-free rate. For long-tailed lines like workers compensation, the profit provision is very sensitive to changes in interest rates. The higher the risk-free rate of return, the more investment income that can be earned, and therefore, the less premium is needed. Thus, all other things being equal, a higher risk-free rate of return corresponds to a more negative underwriting profit provision.

The more negative the beta of liabilities, the more positive the underwriting profit provision. If one assumed that underwriting was risk-free (beta of liabilities equal to zero), there would be a more negative profit provision. The difference between this profit provision and the calculated profit provision represents the reward for taking the risk of writing insurance. In recent workers compensation filings this risk premium has been about 5% or 6%. More generally, the further the risk-adjusted rate[62] is

[62] Whether one uses the CAPM or some other method to determine to the risk-adjusted rate.

from the risk-free rate the larger the risk load and the higher the profit provision.

Since the market risk premium and the beta of liabilities enter into the calculation only as a product,[63] their effect on the profit provision is similar. For a larger (magnitude) market risk premium, the profit provision is less negative, since the risk-adjustment is larger. The same effect is seen as for a similar increase in the magnitude of the beta of liabilities.

The investment income tax rate and premium-to-surplus ratio are other important and sometimes controversial inputs. The higher the assumed investment income tax rate, the more positive the profit provision. The insurer earns less investment income after taxes and thus needs more income from underwriting.

The higher the premium-to-surplus ratio, the more negative the profit provision. The more leveraged the insurance operation, the more important investment income considerations become. It should be noted that in this implementation of the Myers–Cohn model, the beta of liabilities is assumed to be independent of the premium-to-surplus ratio.

The sensitivity of the underwriting income tax rate depends on the profit provision. For profit provisions near zero, there is little underwriting income assumed and therefore little sensitivity to the tax rate. For substantially negative profit provisions, there is an assumed underwriting loss which is assumed to generate a credit against other taxable income. Thus, the higher the assumed underwriting tax rate, the more valuable is this tax credit. Therefore, the higher the underwriting tax rate the more negative the profit provision. The situation is reversed for a substantially positive underwriting profit provision. All other things being equal, the higher the underwriting tax rate, the further the underwriting profit provision is from zero. (A negative provision becomes

[63]The risk-adjusted rate is equal to the risk-free rate plus the product of the market risk premium and the beta of liabilities.

more negative, while a positive provision becomes more positive.)

It should be noted that in this example, the investments are assumed to be solely in Treasury securities taxed at the marginal corporate rate. Therefore, if the underwriting income tax rate were to change, one would also change the investment income tax rate. For example, in 1987 the marginal corporate tax rate declined from 46% to 34%. For a long-tailed line of insurance such as workers compensation, such a decline in *both* tax rates in the Myers–Cohn model would lead to a more negative profit provision. This is an example of why varying the inputs one at a time can only be for illustrative purposes.

The target underwriting profit provision calculated here includes the effect on investment income of the payment of expected policyholder dividends. In this case, policyholder dividends are paid out earlier than the average payment of losses plus expenses. Thus, dividend payments reduce expected investment income compared to the average payment for losses plus expenses. Therefore, the more that is assumed to be paid out in policyholder dividends (compared to losses and expenses) the more positive the underwriting profit provision.

The Tax Reform Act of 1986 introduced the discounting of loss reserves for tax purposes and the revenue offset feature. As expected, since each of these changes was intended to produce more taxes for the federal government, they each lead to a less negative underwriting profit provision. Insurers need more money to pay these taxes, all other things being equal.

Finally, the average timing of the loss payments is an extremely important input. The longer it takes to pay losses the more negative the profit provision. Investment income considerations are generally more important for long-tailed lines of insurance.

The risk-free rate, the size of the adjustment for risk, the investment income tax rate, the premium-to-surplus ratio, and the timing of the loss flow are usually the inputs to the Myers–Cohn model with the most significant impact on the underwriting profit provision. Of these, the investment income tax rate and the size of the adjustment for risk[64] have been the most intensely debated at rate hearings.

6. CONCLUSION

In Massachusetts, the Myers–Cohn model has been used to set many profit provisions over the last decade. As with any profit model, in any real world application, one must carefully examine the underlying assumptions and inputs to make sure that everything is consistent. It has proven very easy for two people to get extremely different profit provisions using the same model.[65]

The last two decades have demonstrated the impossibility of coming up with either a universally accepted profit model or profit provision. However, the possibility of differing answers no more makes profit models useless than would the inability to agree on future loss levels make trending and loss development techniques useless. Profit models provide a framework for a rational discussion and allow the testing of the effect of changes to the tax law, investment policy, claims payment patterns, economic conditions, etc. The Myers–Cohn model provides one framework in which to attempt to quantify these effects.

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[64] In the CAPM implementation, the adjustment for risk is the product of the beta of liabilities and the market risk premium.

[65] Disagreements about the risk-free rate, the risk-adjusted rate, the investment income tax rate, the amount of surplus, etc., can quickly add up to a substantial disagreement on the overall profit provision. Even when using the same profit model for workers compensation insurance, disagreements of 10% or more in proposed profit provisions are not unheard of. These disagreements parallel those that can occur at contested rate hearings with respect to the indicated rate change, where expert witnesses can have very significant disagreements with respect to loss development, trend, law impacts, etc.

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EXHIBIT 1

MYERS–COHN PROFIT MODEL
EXAMPLE OF CALCULATION OF UNDERWRITING PROFIT PROVISION

Inputs

Risk-Free Rate = 9%
Beta of Liabilities = −.20
Market Risk Premium = 10%
Risk-Adjusted Rate = 9% − .20 × 10% = 7%
Premium-to-Surplus Ratio = 2
Federal Income Tax Rate on Underwriting = 35%
Federal Income Tax Rate on Investment = 35%
Expenses (other than loss adjustment expense) are all paid in Quarter 2.
Variable Expenses are 20% of Premium.
Fixed Expenses are 5% of Losses.
Loss Adjustment Expenses are 10% of Losses.
Premiums are collected in Quarter 1.
Losses and loss adjustment expense are paid in Quarter 5.
There are no Policyholder Dividends paid.
There is no discounting of reserves (for tax purposes).
There is no revenue offset provision; alpha = 0.

Kappas	Initial Weights	Final Weights	
κ_1	.9380	.9378	Risk-adjusted discounted losses and expenses factor.
κ_2	.9893	.9893	Risk-free discounted premiums factor.
κ_3	4.8935	4.9165	Risk-free discounted investment balance tax factor.
κ_4	.9478	.9478	Risk-free discounted underwriting profit tax factor.
κ_5	.9588	.9588	Risk-adjusted discounted underwriting profit tax factor.
κ_6	N.A.	N.A.	Risk-free discounted revenue offset tax factor.

Profit Provision

$$\frac{P}{L+E} = \frac{\kappa_1 - \tau_1\kappa_5}{\kappa_2 - \tau_2 r\kappa_3 - \tau_1\kappa_4 - \tau_1\alpha\kappa_6}$$

$$= \frac{.9378 - .35(.9588)}{.9893 - (.35 \times .021778 \times 4.9165) - (.35 \times .9478)}$$

$$= .9712$$

$$\mu = 1 - (P/(L+E))^{-1} = -3.0\%$$

EXHIBIT 2

EXAMPLE CASHFLOWS
(Initial Weights)

Quarter	Premiums	Losses	Expenses[1]	Cumulative Difference	Surplus[2]	Investment Balance[3]
0	0	0	0	0	250.00	250.00
1	1,000.00	0	0	1,000.00	500.00	1,500.00
2	0	0	234.78	765.22	382.61	1,147.83
3	0	0	0	765.22	382.61	1,147.83
4	0	0	0	765.22	382.61	1,147.83
5	0	695.65	69.57	0	0	0
Total	1,000.00	695.65	304.35			

[1] Expenses are the sum of $200 (20% of premium) representing variable expense in Quarter 2, 34.78 (5% of losses) representing fixed expense in Quarter 2, and 69.57 (10% of losses) representing LAE in Quarter 5. Note that for the initial weights, losses plus expenses = 1,000 = premiums.

[2] Initially, surplus is taken as half of premiums at policy inception. (This is approximated by having $250 of surplus flow in during Quarter 0, prior to policy inception and an additional $250 of surplus flow in during Quarter 1.) The suplus allocated to this policy is assumed to decline in proportion to the payment of losses and expenses.

[3] Investment Balance is the sum of the surplus and the cumulative difference of premiums and losses plus expenses.

The policy inception date is at the end of Quarter 0 and the beginning of Quarter 1.

EXHIBIT 3

EXAMPLE CALCULATION OF KAPPAS (Initial Weights)

κ_1 = Risk-adjusted discounted losses and expenses factor
$.76522 \times (1.07)^{-4.5/4} + .23478 \times (1.07)^{-1.5/4}$
= .9380

Note: Losses and loss adjustment expenses discounted to the middle of the fifth quarter. Expenses discounted to the middle of the second quarter.

κ_2 = Risk-free discounted premiums factor
= Discounted Value of Premium Flow
= .9893

Note: Discounting to the middle of the first quarter $.9893 = (1.09)^{-.5/4}$.

κ_3 = Risk-free discounted investment balance tax factor
= Discounted Investment Balance for Taxes
= $\{(250 \times .9893) + (1500 \times .9682) + (1147.83 \times .9476) + (1147.83 \times .9274) + (1147.83 \times .9076)\}/1000$
= 4.8935

κ_4 = Risk-free underwriting profit tax factor (contribution of premiums)
= $(.25 \times .9787) + (.25 \times .9578) + (.25 \times .9374) + (.25 \times .9174)$
= .9478

Note: Discounting to the end of the first, second, third, and fourth quarters.

κ_5 = Risk-adjusted discounted underwriting profit tax factor (contribution of losses and expenses)
= $(.25 \times .9832) + (.25 \times .9667) + (.25 \times .9505) + (.25 \times .9346)$
= .9588

Note: Discounting to the end of the first, second, third, and fourth quarters.

κ_6 = Not applicable since no revenue offset provision is assumed.

EXHIBIT 4

EXAMPLE CASHFLOWS (Final Weights)[1]

Quarter	Premiums[2]	Losses	Expenses[3]	Cumulative Difference	Surplus	Investment Balance[4]
0	0	0	0	0	250.00	250.00
1	1,000.00	0	0	1,000.00	500.00	1,500.00
2	0	0	229.27	770.73	385.37	1,156.10
3	0	0	0	770.73	385.37	1,156.10
4	0	0	0	770.73	385.37	1,156.10
5	0	700.66	70.07	0	0	0
Total	1,000.00	700.66	299.34			

[1]As the profit provision varies so does the relative weight given to variable expenses, so that the profit model is solved via iteration.
[2]Premiums shown are prior to the profit loading. The premium loaded for profit is 971.18.
[3]Expenses are the sum of 194.24 (20% of premiums loaded for profit of 971.18) representing variable expense in Quarter 2, 35.03 (5% of losses) representing fixed expense in Quarter 2, and 70.07 (10% of losses) representing LAE in Quarter 5. Note that losses plus expenses = 1000.
[4]Investment Balance is the sum of the surplus and the cumulative difference of premiums and losses plus expenses.

The policy inception date is at the end of Quarter 0 and the beginning of Quarter 1.

EXHIBIT 5

PART 1

THE MYERS–COHN COST OF CAPITAL UNDERWRITING PROFIT PROVISION MODEL[1]

Let

Flows		Capital Market Rates	
P	= Premium	r	= Risk-Free Rate
L	= Losses	r_L	= Risk-Adjusted Rate (Adjusted for Risk of Underwriting by Line)
E	= Expenses	τ_1	= Federal Underwriting Income Tax Rate
IVB	= Investment Balance	τ_2	= Federal Investment Income Tax Rate
IVBT	= Investment Balance for Tax	μ	= Underwriting Profit Margin
UWP	= Underwriting Profit	α	= Revenue Offset Factor for Taxes

Then, given the basic valuation equations of the Myers–Cohn model,

Present Value of Premium	=	Present Value of Losses and Expenses plus Present Value of Federal Tax Liabilities on Underwriting Profits and Investment Income on the Investment Balance,

or

$$\text{PV}(P) = \text{PV}(L + E) + \text{PV}(\text{UWP}\tau_1) + \text{PV}(\text{IVBT}r\tau_2) \quad (1)$$

where

> UWP is Underwriting Profit and IVBT is the Investment Balance for Taxes. The investment balance flow, IVB, is defined as the funds available for investment from the policy cash flow, cumulative premium minus cumulative losses, plus those funds available from other supporting assets. IVBT is IVB advanced one quarter to the time period when the income is earned and the tax liability is incurred.

Then, if premiums and investment income are valued at the risk-free rate r, losses and expenses valued at a risk-adjusted rate r_L; underwriting and investment income taxed at

[1] Chapter 3 of *Fair Rate of Return on Property-Liability Insurance* [1].

rates τ_1 and τ_2; and underwriting profits taxed using discounted loss reserves:

(2) $$\mathrm{PV}_r(\mathrm{P}) = \mathrm{PV}_{r_L}(L+E) + \mathrm{PV}_r(P\tau_1\mathrm{UWP}/(P-(L+E))) - \mathrm{PV}_{r_L}((L+E)\tau_1\mathrm{UWP}/(P-(L+E)) + \mathrm{PV}_r(r\tau_2(\mathrm{IVBT})).$$

The various discounted values can be rewritten in terms of the kappas defined below. Note that the term involving κ_6 relates to the revenue offset provision, which as explained in Section 4.13 adjusts the timing for income tax purposes of the premium portion of the underwriting profit.

$$P\kappa_2 = (L+E)\kappa_1 + P\tau_1\kappa_4 + P\alpha\tau_1\kappa_6 - (L+E)\tau_1\kappa_5 + Pr\tau_2\kappa_3$$

$$P(\kappa_2 - \tau_2 r\kappa_3 - \tau_1\kappa_4 - \alpha\tau_1\kappa_6) = (L+E)(\kappa_1 - \tau_1\kappa_5)$$

or

(3) $$\frac{P}{L+E} = \frac{\kappa_1 - \tau_1\kappa_5}{\kappa_2 - \tau_2 r\kappa_3 - \tau_1\kappa_4 - \alpha\tau_1\kappa_6}$$

and

$$\mu = 1 - (P/(L+E))^{-1}$$

where κ_1 = Risk-adjusted discounted losses and expenses factor
κ_2 = Risk-free discounted premiums factor
κ_3 = Risk-free discounted investment balance tax factor
κ_4 = Risk-free discounted underwriting profit tax factor
κ_5 = Risk-adjusted discounted underwriting profit tax factor
κ_6 = Risk-free discounted revenue offset tax factor

EXHIBIT 5

PART 2

MASSACHUSETTS WORKERS COMPENSATION

(1)		Model Profit Allowance (Part 4)	−3.6%
(2)		Average Premium Discount as a Percent of Standard Premium plus ARAP[2]	6.8%
(3)		Adjustment for Investment Expenses	0.0%
		Underwriting Profit Allowance	
(4)	=	$[(1) \times (1 - (2))] + (3)$	−3.4%

Parameters

1.	Cash Flows		
	a.	Premium	Exhibit 6
	b.	Expenses	Exhibit 8
	c.	Losses	Exhibit 11
	d.	Expense/Loss Weights	Exhibit 9
	e.	Policyholder Dividends	Exhibit 7
	f.	Surplus	Exhibit 17
	g.	Underwriting Tax Flow	Exhibit 19
2.	Capital Market Rates		
	a.	Risk-Free Rate	6.60%
	b.	Risk-Adjusted Rate (Beta = −.21, Market Risk Premium 8.9%)	4.73%
3.	Federal Income Tax Rates		
	a.	Underwriting	35%
	b.	Investment	35%
4.	Initial Premium/Surplus Ratio		2 to 1

[2]From elsewhere in the ratemaking process. ARAP (All Risk Adjustment Program) is applied in Massachusetts workers compensation as a surcharge on top of experience rating. The rate indication is calculated in terms of Standard Premium plus ARAP = payrolls × manual rates × experience modification × ARAP surcharge, if any.

EXHIBIT 5

PART 3

MASSACHUSETTS WORKERS COMPENSATION CALCULATION OF UNDERWRITING PROFIT PROVISIONS USING MYERS–COHN COST OF CAPITAL MODEL

$$\frac{P}{L+E} = \frac{\kappa_1 - \tau_1\kappa_5}{\kappa_2 - \tau_2 r\kappa_3 - \tau_1\kappa_4 - \tau_1\alpha\kappa_6}$$

$$\mu = 1 - (P/(L+E))^{-1}$$

$r = 0.016107$ $\quad r_L = 0.011623$ $\quad \tau_1 = 0.35$ $\quad \tau_2 = 0.35$

$\beta = -0.21$ $\quad r_M - r = 0.089$ $\quad \alpha = 0.00155$

Discounting Factors

$\kappa_1 = .856659$

$\kappa_2 = .962190$

$\kappa_3 = 14.558852$

$\kappa_4 = .960994$

$\kappa_5 = .949474$

$\kappa_6 = .967392$

$$\frac{P}{L+E} = \frac{0.856659 - 0.35(0.949474)}{0.962190 - 0.35(0.016107)(14.558852) - 0.35(0.960994) - 0.35(0.00155)(0.967392)}$$

$$= 0.965210$$

$$\mu = 1 - (.965210)^{-1} = -0.0360$$

Model Provision = −3.6%

EXHIBIT 6

PART 1

MASSACHUSETTS WORKERS COMPENSATION PREMIUM FLOW

Quarter	Premium Flow
1	0.2397
2	0.2120
3	0.2355
4	0.1948
5	0.0462
6	0.0159
7	0.0271
8	0.0043
9	0.0060
10	0.0148
11	0.0043
12	0.0007
13	0.0001
14	−0.0007
15	0.0000
16	−0.0002
17	−0.0006
18	0.0000
19	0.0000
20	−0.0002
21	−0.0001
22	0.0004
Sum	1.0000

From Exhibit 6, Part 2, selected net premium flow.

EXHIBIT 6

PART 2

DETERMINATION OF SELECTED PREMIUM FLOW FROM PREMIUM CALL

Days From Effective Date		(1) Untrimmed Flow	(2) Trimmed Flow*	(3) Selected Net Premium
−89–	0	0.0082		
1–	90	0.2316	0.2397	0.2397
91–	180	0.2120	0.2120	0.2120
181–	270	0.2355	0.2355	0.2355
271–	360	0.1948	0.1948	0.1948
361–	450	0.0462	0.0462	0.0462
451–	540	0.0159	0.0159	0.0159
541–	630	0.0271	0.0271	0.0271
631–	720	0.0043	0.0043	0.0043
721–	810	0.0060	0.0060	0.0060
811–	900	0.0148	0.0148	0.0148
901–	990	0.0043	0.0043	0.0043
991–	1080	0.0007	0.0007	0.0007
1081–	1170	0.0001	0.0001	0.0001
1171–	1260	−0.0007	−0.0007	−0.0007
1261–	1350	0.0000	0.0000	0.0000
1351–	1440	−0.0002	−0.0002	−0.0002
1441–	1530	−0.0006	−0.0006	−0.0006
1531–	1620	0.0000	0.0000	0.0000
1621–	1710	0.0000	0.0000	0.0000
1711–	1800	−0.0002	−0.0002	−0.0002
1801–	1890	−0.0001	−0.0001	−0.0001
1891–	1980	0.0003	0.0004	0.0004
1981–	2070	0.0000		
2071–	2160	0.0000		
2161–	2250	0.0001		
2251–	2340	0.0000		
2341–	2430	0.0000		
2431–	2520	0.0000		
2521–	2610	0.0000		
2611–	2700	0.0000		
2701–	2790	0.0000		
2791–	2880	0.0000		
2881–	2970	0.0000		
2971–	3060	0.0000		
3061–	3150	0.0000		
3151–	3240	0.0000		
3241–	3330	0.0000		
3331–	3420	0.0000		
		1.0000	1.0000	1.0000

*The quarter preceding the effective date in (1) was biased toward the end of the quarter (average time from effective date = −6.5 days). Therefore, that percentage of premium from quarter zero was added into the first quarter. The combined first quarter in (2) has a resulting average effective date at 56 days.

EXHIBIT 7

MASSACHUSETTS WORKERS COMPENSATION RATIO OF POLICYHOLDER DIVIDENDS TO THE EARNED PREMIUM FROM THE PREVIOUS YEAR*

Massachusetts				Countrywide			
Year	Total Stock	Non-Stock	All Companies	Year	Total Stock	Non-Stock	All Companies
				85	9.72	15.32	11.34
86	6.36	12.04	7.85	86	8.26	13.09	9.79
87	5.05	9.57	6.24	87	7.41	11.11	8.70
88	3.55	6.43	4.32	88	6.52	10.17	7.88
89	2.70	2.37	2.60	89	6.30	8.55	7.08
90	2.62	2.10	2.44	90	5.66	8.88	6.74
91	1.76	1.81	1.77	91	4.82	7.69	5.78
92	1.19	2.19	1.57	92	3.91	6.72	4.81
93	1.04	2.30	1.52	93	4.19	6.44	4.96
94	0.87	1.79	1.21	94	5.25	9.02	6.54
95	1.14	2.44	1.57	95	4.72	9.48	6.38
96	1.84	3.47	2.25	96		Not Available	
Average	2.56	4.23	3.03	Average	6.07	9.68	7.27

*Computed using the data compiled from Annual Statements.

Policyholder Dividends Net Premium[1]	Policyholder Dividends Premium Tax Rate[2]	Net of Premium Tax
3.03%	2.30%	3.0%

Policyholder dividends are assumed on average to be paid in quarter 7.[3]

[1] Average for all insurers in Massachusetts.
[2] From elsewhere in the ratemaking process.
[3] This corresponds to 19.5 months on average from policy inception.

EXHIBIT 8

MASSACHUSETTS WORKERS COMPENSATION EXPENSE FLOWS

	Fixed Expense Flow[1]		Variable Expense Flow[2] Plus Dividend Flow			Fixed Expense Flow[1]		Variable Expense Flow[2] Plus Dividend Flow	
Quarter	Initial Weights	Final Weights	Initial Weights	Final Weights	Quarter	Initial Weights	Final Weights	Initial Weights	Final Weights
−3	0.690	0.694	0.580	0.560	36	0.374	0.376	0.000	0.000
−2	0.740	0.744	1.740	1.679	37	0.266	0.268	0.000	0.000
−1	10.300	10.355	3.480	3.359	38	0.266	0.268	0.000	0.000
0	16.170	16.256	12.760	12.316	39	0.266	0.268	0.000	0.000
1	27.883	28.032	43.925	42.397	40	0.266	0.268	0.000	0.000
2	20.093	20.200	11.392	10.996	41	0.118	0.118	0.000	0.000
3	19.403	19.506	12.301	11.872	42	0.118	0.118	0.000	0.000
4	19.403	19.506	10.225	9.869	43	0.118	0.118	0.000	0.000
5	13.850	13.924	2.936	2.834	44	0.118	0.118	0.000	0.000
6	7.740	7.782	0.811	0.783	45	0.223	0.224	0.000	0.000
7	7.050	7.088	31.382	30.290	46	0.223	0.224	0.000	0.000
8	7.050	7.088	0.219	0.212	47	0.223	0.224	0.000	0.000
9	4.018	4.039	0.306	0.295	48	0.223	0.224	0.000	0.000
10	4.018	4.039	0.755	0.729	49	0.230	0.231	0.000	0.000
11	4.018	4.039	0.219	0.212	50	0.230	0.231	0.000	0.000
12	4.018	4.039	0.036	0.034	51	0.230	0.231	0.000	0.000
13	2.274	2.286	0.005	0.005	52	0.230	0.231	0.000	0.000
14	2.274	2.286	−0.036	−0.034	53	0.262	0.263	0.000	0.000
15	2.274	2.286	0.000	0.000	54	0.262	0.263	0.000	0.000
16	2.274	2.286	−0.010	−0.010	55	0.262	0.263	0.000	0.000
17	1.361	1.368	−0.031	−0.030	56	0.262	0.263	0.000	0.000
18	1.361	1.368	0.000	0.000	57	0.197	0.198	0.000	0.000
19	1.361	1.368	0.000	0.000	58	0.197	0.198	0.000	0.000
20	1.361	1.368	−0.010	−0.010	59	0.197	0.198	0.000	0.000
21	0.928	0.933	−0.005	−0.005	60	0.197	0.198	0.000	0.000
22	0.928	0.933	0.020	0.020	61	0.248	0.249	0.000	0.000
23	0.928	0.933	0.000	0.000	62	0.248	0.249	0.000	0.000
24	0.928	0.933	0.000	0.000	63	0.248	0.249	0.000	0.000
25	0.632	0.636	0.000	0.000	64	0.248	0.249	0.000	0.000
26	0.632	0.636	0.000	0.000	65	0.171	0.171	0.000	0.000
27	0.632	0.636	0.000	0.000	66	0.171	0.171	0.000	0.000
28	0.632	0.636	0.000	0.000	67	0.171	0.171	0.000	0.000
29	0.452	0.455	0.000	0.000	68	0.171	0.171	0.000	0.000
30	0.452	0.455	0.000	0.000	69	0.278	0.279	0.000	0.000
31	0.452	0.455	0.000	0.000	70	0.278	0.279	0.000	0.000
32	0.452	0.455	0.000	0.000	71	0.278	0.279	0.000	0.000
33	0.374	0.376	0.000	0.000	72	0.278	0.279	0.000	0.000
34	0.374	0.376	0.000	0.000	73	0.169	0.170	0.000	0.000
35	0.374	0.376	0.000	0.000	74	0.169	0.170	0.000	0.000
					etc.[3]				

[1] General expense, other tax, allocated loss adjustment expense, and unallocated loss adjustment expense flows combined using the weights in Exhibit 9.
[2] Commissions, other acquisition expense and premium tax combined using the weights in Exhibit 9.
[3] Flow continues out to the same quarter as the loss flow.

EXHIBIT 9

PART 1

MASSACHUSETTS WORKERS COMPENSATION CASH FLOW WEIGHTS

	Initial Weights	Final Weights	
Item of Expense Allowance	Prem(%)[1]	Prem(%)	Loss + Exp +Div(%)
Premium (Net of Premium Discounts)	100.0%	100.00%	96.52%
Expected Losses	65.9%	68.64%	66.25%
Total Expenses Plus Dividends	34.1%	34.96%	33.75%
Fixed Expenses:			
(Total Expenses not varying with Premium)	20.8%	21.66%	20.91%
Loss Adjustment Expense[1]	13.9%	14.48%	13.97%
Allocated[2]	7.4%	7.71%	7.44%
Unallocated[2]	6.5%	6.77%	6.53%
General Expenses[3]	6.4%	6.67%	6.43%
Other Tax[3]	0.5%	0.52%	0.50%
Variable Expenses Plus Dividends:			
(Varying with Premium)	13.3%	13.30%	12.84%
Total Acquisition	8.0%	8.00%	7.72%
Commissions[3]	5.1%	5.10%	4.92%
Other Acquisition[3]	2.9%	2.90%	2.80%
Premium Tax	2.3%	2.30%	2.22%
Policyholder Dividends	3.0%	3.00%	2.90%

[1]From Part 2.
[2]The loss adjustment expense split between allocated and unallocated is 53.4% & 46.6% based on a two-year average of Annual Statement data for thirteen major writers in Massachusetts.
[3]Weighted based on calculations underlying other portions of the ratemaking process.

EXHIBIT 9

PART 2

MASSACHUSETTS WORKERS COMPENSATION
DETERMINATION OF INITIAL CASH FLOW WEIGHTS

(1)	Acquisition and Field Supervision (as a Percent of Net Premium)	8.0%
(2)	Premium Taxes (as a Percent of Net Premium)	2.3%
(3)	Policyholder Dividends (as a Percent of Net Premium, Net of Taxes)	3.0%
(4)	Variable Expenses (excluding profit provision) plus Policyholder Dividends	13.3%
(5)	Loss, Loss Adjustment Expense Ratio, and Fixed Expense Ratio	86.7%
(6)	Loss Adjustment Expense as a Percent of Losses	21.0%
(7)	Ratio of Fixed Expense as a Percent of Losses	10.5%
(8)	Loss Ratio to Net of Premium Discount (if there were no loading for profits)	65.9%
(9)	Loss Adjustment Expense as a Percent of Premiums Net of Premium Discount	13.9%
(10)	Fixed Expenses as a Percent of Premiums Net of Premium Discount	6.9%
(11)	Expenses (excluding profit provision) plus Policyholder Dividends	34.1%

(1)	From elsewhere in the ratemaking process.
(2)	From elsewhere in the ratemaking process.
(3)	From elsewhere in the ratemaking process.
(4)	$= (1) + (2) + (3)$
(5)	$= 1 - (4)$
(6)	From elsewhere in the ratemaking process.
(7)	From elsewhere in the ratemaking process.
(8)	$= (5)/[1 + (6) + (7)]$
(9)	$= (6) \times (8)$
(10)	$= (7) \times (8)$
(11)	$= (4) + (9) + (10)$

Values may differ somewhat due to rounding and the desire to have the weights add up to exactly 100% for illustrative purposes.

EXHIBIT 10

Massachusetts Workers Compensation Percentage Distributions of General, Other Acquistion, and Taxes

(1) Time from Eff. Date (Days)	(2) Distribution (%) General Exp.	(3) Distribution (%) Other Acquisition	(4) Distribution (%) Premium Tax	(5) Distribution (%) Other Tax
−359 to −270	1	2	0	1
−269 to −180	1	6	0	2
−179 to −90	15	12	0	14
−89 to 0	23	44	0	29
1 to 90	21	30	100	23
91 to 180	10	2	0	8
181 to 270	9	1	0	7
271 to 360	9	1	0	7
361 to 450	10	2	0	8
451 to 540	1	0	0	1
Total	100	100	100	100

Source: (2) from filing for 1977 Massachusetts workers compensation rates, Exhibit 20.
(3) & (5) from filing for 1977 Massachusetts workers compensation rates, Exhibit 21.

EXHIBIT 11

MASSACHUSETTS WORKERS COMPENSATION COMBINED LOSS FLOW

Quarter	Losses	Quarter	Losses	Quarter	Losses
0	0.000	46	2.096	92	1.590
1	48.524	47	2.096	93	1.590
2	48.524	48	2.096	94	1.590
3	48.524	49	2.159	95	1.590
4	48.524	50	2.159	96	1.590
5	66.200	51	2.159	97	1.590
6	66.200	52	2.159	98	1.590
7	66.200	53	2.457	99	1.590
8	66.200	54	2.457	100	1.590
9	37.726	55	2.457	101	1.590
10	37.726	56	2.457	102	1.590
11	37.726	57	1.853	103	1.590
12	37.726	58	1.853	104	1.590
13	21.349	59	1.853	105	1.590
14	21.349	60	1.853	106	1.590
15	21.349	61	2.324	107	1.590
16	21.349	62	2.324	108	1.590
17	12.779	63	2.324	109	1.590
18	12.779	64	2.324	110	1.590
19	12.779	65	1.601	111	1.590
20	12.779	66	1.601	112	1.590
21	8.713	67	1.601	113	1.590
22	8.713	68	1.601	114	1.590
23	8.713	69	2.610	115	1.590
24	8.713	70	2.610	116	1.590
25	5.936	71	2.610	117	1.228
26	5.936	72	2.610	118	1.228
27	5.936	73	1.590	119	1.228
28	5.936	74	1.590	120	1.228
29	4.248	75	1.590	121	1.190
30	4.248	76	1.590	122	1.190
31	4.248	77	1.590	123	1.190
32	4.248	78	1.590	124	1.190
33	3.512	79	1.590	125	1.190
34	3.512	80	1.590	126	1.190
35	3.512	81	1.590	127	1.190
36	3.512	82	1.590	128	1.190
37	2.500	83	1.590	129	1.190
38	2.500	84	1.590	130	1.190
39	2.500	85	1.590	131	1.190
40	2.500	86	1.590	132	1.190
41	1.104	87	1.590	133	0.024
42	1.104	88	1.590	134	0.024
43	1.104	89	1.590	135	0.024
44	1.104	90	1.590		
45	2.096	91	1.590		

EXHIBIT 12

PART 1

MASSACHUSETTS WORKERS COMPENSATION
ACCIDENT YEAR FINANCIAL AGGREGATE DATA
Paid Medical Losses ($000)

Accident Year	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Report																		
1										53,868	57,773	69,032	73,437	71,349	59,620	56,209	47,474	46,756
2									100,050	125,246	143,539	163,308	168,043	157,921	125,313	111,694	98,415	
3								101,006	120,685	156,030	179,265	202,461	206,221	189,375	144,506	129,386		
4							99,464	111,294	134,064	171,728	198,412	224,423	224,206	202,641	154,817			
5						85,250	103,981	118,337	141,457	181,742	212,212	235,114	233,222	209,992				
6					84,128	87,491	106,993	123,617	146,424	189,738	218,820	241,023	238,891					
7				80,364	85,169	89,279	109,980	126,548	150,553	194,425	223,554	244,963						
8			64,825	81,159	86,736	90,931	111,508	129,785	153,184	197,840	226,442							
9		61,458	65,473	82,235	88,021	92,239	113,482	134,600	155,011	200,696								
10	48,866	62,020	66,200	83,335	88,691	94,155	114,027	135,889	156,469									
11	49,373	62,220	66,408	84,521	90,436	94,869	114,545	135,572										
12	49,986	62,915	66,701	86,405	90,784	96,394	114,737											
13	50,157	63,424	68,101	87,640	91,257	96,521												
14	50,780	64,781	68,370	88,671	92,472													
15	52,900	65,188	68,557	89,697														
16	53,271	65,745	69,034															
17	53,289	66,584																
18	55,017																	
Estimated Ultimate Losses*																		
	59,496	73,415	75,107	105,024	104,280	110,334	131,378	158,061	182,265	241,389	270,238	294,102	291,717	262,854	200,627	179,797	155,381	149,490

*From elsewhere in the ratemaking process.

EXHIBIT 12

PART 2

MASSACHUSETTS WORKERS COMPENSATION
RATIO OF CUMULATIVE PAID LOSSES TO ULTIMATE LOSSES[1]

MEDICAL Accident Year Data																		
Accident Year	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Report																		
1										0.223	0.214	0.235	0.252	0.271	0.297	0.313	0.306	0.313
2									0.549	0.519	0.531	0.555	0.576	0.601	0.625	0.621	0.633	
3								0.639	0.662	0.646	0.663	0.688	0.707	0.720	0.720	0.720		
4							0.757	0.704	0.736	0.711	0.734	0.763	0.769	0.771	0.772			
5						0.773	0.791	0.749	0.776	0.753	0.785	0.799	0.799	0.799				
6					0.807	0.793	0.814	0.782	0.803	0.786	0.810	0.820	0.819					
7				0.765	0.817	0.809	0.837	0.801	0.826	0.805	0.827	0.833						
8			0.863	0.773	0.832	0.824	0.849	0.821	0.840	0.820	0.838							
9		0.837	0.872	0.783	0.844	0.836	0.864	0.852	0.850	0.831								
10	0.821	0.845	0.881	0.793	0.851	0.853	0.868	0.860	0.858									
11	0.830	0.848	0.884	0.805	0.867	0.860	0.872	0.858										
12	0.840	0.857	0.888	0.823	0.871	0.874	0.873											
13	0.843	0.864	0.907	0.834	0.875	0.875												
14	0.853	0.882	0.910	0.844	0.887													
15	0.889	0.888	0.913	0.854														
16	0.895	0.896	0.919															
17	0.896	0.907																
18	0.925																	

[1] Ratio calculated from the data in Exhibit 12, Part 1.

EXHIBIT 12

PART 3

MASSACHUSETTS WORKERS COMPENSATION RATIO OF INCREMENTAL PAID LOSSES TO ULTIMATE LOSSES[1]

MEDICAL
Accident Year Data

Accident Year	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Report																		
1										0.223	0.214	0.235	0.252	0.271	0.297	0.313	0.306	0.313
2										0.296	0.317	0.321	0.324	0.329	0.327	0.309	0.328	
3									0.113	0.128	0.132	0.133	0.131	0.120	0.096	0.098		
4								0.065	0.073	0.065	0.071	0.075	0.062	0.050	0.051			
5							0.034	0.045	0.041	0.041	0.051	0.036	0.031	0.028				
6						0.020	0.023	0.033	0.027	0.033	0.024	0.020	0.019					
7					0.010	0.016	0.023	0.019	0.023	0.019	0.018	0.013						
8				0.008	0.015	0.015	0.012	0.020	0.014	0.014	0.011							
9			0.009	0.010	0.012	0.012	0.015	0.030	0.010	0.012								
10		0.008	0.010	0.010	0.006	0.017	0.004	0.008	0.008									
11	0.009	0.003	0.003	0.011	0.017	0.006	0.004	(0.002)										
12	0.010	0.009	0.004	0.018	0.003	0.014	0.001											
13	0.003	0.007	0.019	0.012	0.005	0.001												
14	0.010	0.018	0.004	0.010	0.012													
15	0.036	0.006	0.002	0.010														
16	0.006	0.008	0.006															
17	0.000	0.011																
18	0.029																	

[1]Increments of the ratios in Exhibit 12, Part 2.

EXHIBIT 12

PART 4

MASSACHUSETTS WORKERS COMPENSATION MEDICAL LOSS FLOW ESTIMATED FROM FINANCIAL AGGREGATE DATA

Annual Flow			Quarterly Flow					
Accident Year Report	Selected % Paid In Year[1]	Cumulative Paid	Quarter	% Paid in Quarter	Quarter	% Paid in Quarter	Quarter	% Paid in Quarter
1	0.310309	0.310309	1	0.077577	46	0.001552	91	0.001250
2	0.321294	0.631603	2	0.077577	47	0.001552	92	0.001250
3	0.104578	0.736181	3	0.077577	48	0.001552	93	0.001250
4	0.054505	0.790686	4	0.077577	49	0.001454	94	0.001250
5	0.031742	0.822428	5	0.080324	50	0.001454	95	0.001250
6	0.021326	0.843754	6	0.080324	51	0.001454	96	0.001250
7	0.016776	0.860530	7	0.080324	52	0.001454	97	0.001250
8	0.013091	0.873621	8	0.080324	53	0.002088	98	0.001250
9	0.017439	0.891060	9	0.026145	54	0.002088	99	0.001250
10	0.006767	0.897827	10	0.026145	55	0.002088	100	0.001250
11	0.002804	0.900631	11	0.026145	56	0.002088	101	0.001250
12	0.006206	0.906837	12	0.026145	57	0.001484	102	0.001250
13	0.005815	0.912652	13	0.013626	58	0.001484	103	0.001250
14	0.008350	0.921002	14	0.013626	59	0.001484	104	0.001250
15	0.005935	0.926937	15	0.013626	60	0.001484	105	0.001250
16	0.006725	0.933662	16	0.013626	61	0.001681	106	0.001250
17	0.005863	0.939525	17	0.007936	62	0.001681	107	0.001250
18	0.005000	0.944525	18	0.007936	63	0.001681	108	0.001250
19	0.005000	0.949525	19	0.007936	64	0.001681	109	0.001250
20	0.005000	0.954525	20	0.007936	65	0.001466	110	0.001250
21	0.005000	0.959525	21	0.005332	66	0.001466	111	0.001250
22	0.005000	0.964525	22	0.005332	67	0.001466	112	0.001250
23	0.005000	0.969525	23	0.005332	68	0.001466	113	0.001250
24	0.005000	0.974525	24	0.005332	69	0.001250	114	0.001250
25	0.005000	0.979525	25	0.004194	70	0.001250	115	0.001250
26	0.005000	0.984525	26	0.004194	71	0.001250	116	0.001250
27	0.005000	0.989525	27	0.004194	72	0.001250	117	0.000119
28	0.005000	0.994525	28	0.004194	73	0.001250	118	0.000119
29	0.005000	0.999525	29	0.003273	74	0.001250	119	0.000119
30	0.000475	1.000000	30	0.003273	75	0.001250	120	0.000119
			31	0.003273	76	0.001250		
			32	0.003273	77	0.001250		
			33	0.004360	78	0.001250		
			34	0.004360	79	0.001250		
			35	0.004360	80	0.001250		
			36	0.004360	81	0.001250		
			37	0.001692	82	0.001250		
			38	0.001692	83	0.001250		
			39	0.001692	84	0.001250		
			40	0.001692	85	0.001250		
			41	0.000701	86	0.001250		
			42	0.000701	87	0.001250		
			43	0.000701	88	0.001250		
			44	0.000701	89	0.001250		
			45	0.001552	90	0.001250		

[1]Latest three-year average of increments in Exhibit 12, Part 3.

EXHIBIT 13

PART 1

MASSACHUSETTS WORKERS COMPENSATION ACCIDENT YEAR FINANCIAL AGGREGATE DATA Paid Indemnity Losses ($000)

Accident Year	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Report																		
1										120,247	137,690	142,992	140,914	117,052	68,573	56,731	48,624	43,578
2									236,187	319,315	381,688	421,680	414,181	324,040	182,154	151,241	134,800	
3								285,961	344,820	469,125	571,781	633,427	617,310	478,981	260,130	223,780		
4							305,843	348,226	433,480	574,344	698,980	758,832	737,862	565,118	305,445			
5						282,023	339,136	395,469	493,370	646,570	774,682	828,605	799,948	623,872				
6					274,255	299,399	365,637	431,819	532,881	698,477	823,743	872,214	847,431					
7				256,162	286,337	314,986	389,072	451,884	560,608	728,175	851,545	900,818						
8			217,492	261,645	298,092	327,759	401,139	464,595	574,907	745,590	870,900							
9		213,574	220,787	267,421	307,369	336,265	409,779	471,651	582,627	758,099								
10	157,572	215,640	225,003	272,338	312,842	340,707	416,787	475,324	591,827									
11	160,492	218,918	227,921	276,273	316,244	344,828	420,620	473,875										
12	163,310	222,244	230,692	278,138	319,978	350,551	422,424											
13	164,222	225,142	232,076	281,285	322,427	355,902												
14	166,056	226,086	234,416	284,195	327,349													
15	167,521	227,993	236,156	287,414														
16	170,118	229,065	239,648															
17	170,660	231,683																
18	173,122																	
Estimated Ultimate Losses*	186,627	251,361	261,737	319,256	364,175	402,259	482,020	542,046	694,626	946,041	1,107,184	1,164,583	1,133,705	890,031	468,719	408,273	357,818	303,942

*From elsewhere in the ratemaking process.

EXHIBIT 13

PART 2

MASSACHUSETTS WORKERS COMPENSATION
RATIO OF CUMULATIVE PAID LOSSES TO ULTIMATE LOSSES[1]

INDEMNITY
Accident Year Data

Accident Year	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Report																		
1										0.127	0.124	0.123	0.124	0.132	0.146	0.139	0.136	0.143
2									0.340	0.338	0.345	0.362	0.365	0.364	0.389	0.370	0.377	
3								0.528	0.496	0.496	0.516	0.544	0.545	0.538	0.555	0.548		
4							0.635	0.642	0.624	0.607	0.631	0.652	0.651	0.635	0.652			
5						0.701	0.704	0.730	0.710	0.683	0.700	0.712	0.706	0.701				
6					0.753	0.744	0.759	0.797	0.767	0.738	0.744	0.749	0.747					
7				0.802	0.786	0.783	0.807	0.834	0.807	0.770	0.769	0.774						
8			0.831	0.820	0.819	0.815	0.832	0.857	0.828	0.788	0.787							
9		0.850	0.844	0.838	0.844	0.836	0.850	0.870	0.839	0.801								
10	0.844	0.858	0.860	0.853	0.859	0.847	0.865	0.877	0.852									
11	0.860	0.871	0.871	0.865	0.868	0.857	0.873	0.874										
12	0.875	0.884	0.881	0.871	0.879	0.871	0.876											
13	0.880	0.896	0.887	0.881	0.885	0.885												
14	0.890	0.899	0.896	0.890	0.899													
15	0.898	0.907	0.902	0.900														
16	0.912	0.911	0.916															
17	0.914	0.922																
18	0.928																	

[1]Ratio calculated from the data in Exhibit 13, Part 1.

EXHIBIT 13

PART 3

MASSACHUSETTS WORKERS COMPENSATION
RATIO OF INCREMENTAL PAID LOSSES TO ULTIMATE LOSSES[1]

INDEMNITY
Accident Year Data

Accident Year	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Report																		
1										0.127	0.124	0.123	0.124	0.132	0.146	0.139	0.136	0.143
2									0.210	0.210	0.220	0.239	0.241	0.233	0.242	0.231	0.241	
3								0.167	0.156	0.158	0.172	0.182	0.179	0.174	0.166	0.178		
4							0.105	0.115	0.128	0.111	0.115	0.108	0.106	0.097	0.097			
5						0.063	0.069	0.087	0.086	0.076	0.068	0.060	0.055	0.066				
6					0.043	0.043	0.055	0.067	0.057	0.055	0.044	0.037	0.042					
7				0.029	0.033	0.039	0.049	0.037	0.040	0.031	0.025	0.025						
8			0.020	0.017	0.032	0.032	0.025	0.023	0.021	0.018	0.017							
9		0.014	0.013	0.018	0.025	0.021	0.018	0.013	0.011	0.013								
10	0.013	0.008	0.016	0.015	0.015	0.011	0.015	0.007	0.013									
11	0.016	0.013	0.011	0.012	0.009	0.010	0.008	−0.003										
12	0.015	0.013	0.011	0.006	0.010	0.014	0.004											
13	0.005	0.012	0.005	0.010	0.007	0.013												
14	0.010	0.004	0.009	0.009	0.014													
15	0.008	0.008	0.007	0.010														
16	0.014	0.004	0.013															
17	0.003	0.010																
18	0.013																	

[1] Increments of the ratios in Exhibit 13, Part 2.

EXHIBIT 13

PART 4

MASSACHUSETTS WORKERS COMPENSATION INDEMNITY LOSS FLOW ESTIMATED FROM FINANCIAL AGGREGATE DATA

Annual Flow			Quarterly Flow					
Accident Year Report	Selected % Paid In Year[1]	Cumulative Paid	Quarter	% Paid in Quarter	Quarter	% Paid in Quarter	Quarter	% Paid in Quarter
1	0.139406	0.139406	1	0.034852	49	0.002490	97	0.001750
2	0.238216	0.377622	2	0.034852	50	0.002490	98	0.001750
3	0.172706	0.550328	3	0.034852	51	0.002490	99	0.001750
4	0.099931	0.650259	4	0.034852	52	0.002490	100	0.001750
5	0.060230	0.710489	5	0.059554	53	0.002631	101	0.001750
6	0.041214	0.751703	6	0.059554	54	0.002631	102	0.001750
7	0.027021	0.778724	7	0.059554	55	0.002631	103	0.001750
8	0.018825	0.797549	8	0.059554	56	0.002631	104	0.001750
9	0.012450	0.809999	9	0.043177	57	0.002027	105	0.001750
10	0.011521	0.821520	10	0.043177	58	0.002027	106	0.001750
11	0.005174	0.826694	11	0.043177	59	0.002027	107	0.001750
12	0.009407	0.836101	12	0.043177	60	0.002027	108	0.001750
13	0.009961	0.846062	13	0.024983	61	0.002627	109	0.001750
14	0.010523	0.856585	14	0.024983	62	0.002627	110	0.001750
15	0.008106	0.864691	15	0.024983	63	0.002627	111	0.001750
16	0.010508	0.875199	16	0.024983	64	0.002627	112	0.001750
17	0.006660	0.881859	17	0.015058	65	0.001665	113	0.001750
18	0.013000	0.894859	18	0.015058	66	0.001665	114	0.001750
19	0.007000	0.901859	19	0.015058	67	0.001665	115	0.001750
20	0.007000	0.908859	20	0.015058	68	0.001665	116	0.001750
21	0.007000	0.915859	21	0.010304	69	0.003250	117	0.001750
22	0.007000	0.922859	22	0.010304	70	0.003250	118	0.001750
23	0.007000	0.929859	23	0.010304	71	0.003250	119	0.001750
24	0.007000	0.936859	24	0.010304	72	0.003250	120	0.001750
25	0.007000	0.943859	25	0.006755	73	0.001750	121	0.001750
26	0.007000	0.950859	26	0.006755	74	0.001750	122	0.001750
27	0.007000	0.957859	27	0.006755	75	0.001750	123	0.001750
28	0.007000	0.964859	28	0.006755	76	0.001750	124	0.001750
29	0.007000	0.971859	29	0.004706	77	0.001750	125	0.001750
30	0.007000	0.978859	30	0.004706	78	0.001750	126	0.001750
31	0.007000	0.985859	31	0.004706	79	0.001750	127	0.001750
32	0.007000	0.992859	32	0.004706	80	0.001750	128	0.001750
33	0.007000	0.999859	33	0.003113	81	0.001750	129	0.001750
34	0.000141	1.000000	34	0.003113	82	0.001750	130	0.001750
			35	0.003113	83	0.001750	131	0.001750
			36	0.003113	84	0.001750	132	0.001750
			37	0.002880	85	0.001750	133	0.000035
			38	0.002880	86	0.001750	134	0.000035
			39	0.002880	87	0.001750	135	0.000035
			40	0.002880	88	0.001750	136	0.000035
			41	0.001294	89	0.001750	137	0.000000
			42	0.001294	90	0.001750	138	0.000000
			43	0.001294	91	0.001750	139	0.000000
			44	0.001294	92	0.001750	140	0.000000
			45	0.002352	93	0.001750	141	0.000000
			46	0.002352	94	0.001750	142	0.000000
			47	0.002352	95	0.001750	143	0.000000
			48	0.002352	96	0.001750	144	0.000000

[1] Latest three-year average of increments in Exhibit 14.

EXHIBIT 14

PART 1

CALCULATION OF RISK-FREE RATE OF RETURN

Duration	Yield*	Weight**
1	5.70%	1× 152.045
2	6.09%	2× 91.034
3	6.25%	3× 66.128
4	6.35%	4× 39.887
5	6.45%	5× 26.394
6	6.52%	6× 18.176
7	6.57%	7× 13.008
8	6.62%	8× 10.752
9	6.66%	9× 7.656
10	6.70%	10× 3.380
11	6.74%	11× 6.416
12	6.78%	12× 6.608
13	6.82%	13× 7.524
14+	6.83%	14× 93.996
Weighted Average	6.60%	

*Yield from Exhibit 14, Part 4.
**Weight is the product of the duration and the corresponding values from Exhibit 14, Part 5.

EXHIBIT 14

PART 2

TREASURY BOND YIELD RATES

Month	1 Year	2 Year	3 Year	5 Year	7 Year	10 Year	30 Year
Jul 96	5.85	6.27	6.45	6.64	6.76	6.87	7.03
Aug 96	5.67	6.03	6.21	6.39	6.52	6.64	6.84
Sep 96	5.83	6.23	6.41	6.60	6.73	6.83	7.03
Oct 96	5.55	5.91	6.08	6.27	6.42	6.53	6.81
Nov 96	5.42	5.70	5.82	5.97	6.10	6.20	6.48
Dec 96	5.47	5.78	5.91	6.07	6.20	6.30	6.55
Jan 97	5.61	6.01	6.16	6.33	6.47	6.58	6.83
Feb 97	5.53	5.90	6.03	6.20	6.32	6.42	6.69
Mar 97	5.80	6.22	6.38	6.54	6.65	6.69	6.93
Apr 97	5.99	6.45	6.61	6.76	6.86	6.89	7.09
May 97	5.87	6.28	6.42	6.57	6.66	6.71	6.94
Jun 97	5.69	6.09	6.24	6.38	6.46	6.49	6.77
Average	5.69	6.07	6.23	6.39	6.51	6.60	6.83

(July 1996–June 1997)
Source: Federal Reserve Board (Statistical Release G-13)

EXHIBIT 14

PART 3

DURATIONS OF TREASURY SECURITIES

Maturity	Yield*	Duration
1 Year	5.69%	0.99
2 Year	6.07%	1.91
3 Year	6.23%	2.79
5 Year	6.39%	4.37
7 Year	6.51%	5.75
10 Year	6.60%	7.51
30 Year	6.83%	13.26

Note: Duration is a weighted average term to maturity, where the years are weighted by the present value of the related cash flow.
For bonds with semiannual coupons, duration in years is:

$$[(1+Y)-(1+Y)\wedge(1-2M)]/2Y$$

where Y is the semi-annual coupon yield = $[(1+\text{yield})\wedge.5]-1$ and M is the maturity.
*From Exhibit 14, Part 2.

EXHIBIT 14

PART 4

INTERPOLATED YIELDS BY DURATION

Duration		Yield	
0.99	*	5.69%	*
1.00		5.70%	**
1.91	*	6.07%	*
2.00		6.09%	**
2.79	*	6.23%	*
3.00		6.25%	**
4.00		6.35%	**
4.37	*	6.39%	*
5.00		6.45%	**
5.75	*	6.51%	*
6.00		6.52%	**
7.00		6.57%	**
7.51	*	6.60%	*
8.00		6.62%	**
9.00		6.66%	**
10.00		6.70%	**
11.00		6.74%	**
12.00		6.78%	**
13.00		6.82%	**
13.26	*	6.83%	*
14.00		6.83%	***

*From Exhibit 14, Part 3.
**Interpolated.
***Taken equal to last observed value.

EXHIBIT 14

PART 5

MASSACHUSETTS WORKERS COMPENSATION CALCULATION OF NET CASH FLOWS BY YEAR

Quarter	Net Cash Flow	Duration Period	Sum for Duration Period	Quarter	Net Cash Flow	Duration Period	Sum for Duration Period
−3	−1.270			30	−3.252	7 Yr	
−2	−2.480			31	−3.252	7 Yr	
−1	−13.780			32	−3.252	7 Yr	13.008
0	−28.930			33	−2.688	8 Yr	
1	135.915			34	−2.688	8 Yr	
2	148.538			35	−2.688	8 Yr	
3	171.820			36	−2.688	8 Yr	10.752
4	133.195			37	−1.914	9 Yr	
5	−14.213	1 Yr		38	−1.914	9 Yr	
6	−36.277	1 Yr		39	−1.914	9 Yr	
7	−54.959	1 Yr		40	−1.914	9 Yr	7.656
8	−46.596	1 Yr	152.045	41	−0.845	10 Yr	
9	−23.186	2 Yr		42	−0.845	10 Yr	
10	−14.834	2 Yr		43	−0.845	10 Yr	
11	−24.799	2 Yr		44	−0.845	10 Yr	3.38
12	−28.215	2 Yr	91.034	45	−1.604	11 Yr	
13	−16.247	3 Yr		46	−1.604	11 Yr	
14	−17.007	3 Yr		47	−1.604	11 Yr	
15	−16.342	3 Yr		48	−1.604	11 Yr	6.416
16	−16.532	3 Yr	66.128	49	−1.652	12 Yr	
17	−10.351	4 Yr		50	−1.652	12 Yr	
18	−9.782	4 Yr		51	−1.652	12 Yr	
19	−9.782	4 Yr		52	−1.652	12 Yr	6.608
20	−9.972	4 Yr	39.887	53	−1.881	13 Yr	
21	−6.764	5 Yr		54	−1.881	13 Yr	
22	−6.290	5 Yr		55	−1.881	13 Yr	
23	−6.670	5 Yr		56	−1.881	13 Yr	7.524
24	−6.670	5 Yr	26.394	57	−1.418	14 Yr	
25	−4.544	6 Yr		58	−1.418	14 Yr	
26	−4.544	6 Yr		59	−1.418	14 Yr	
27	−4.544	6 Yr		60	−1.418	14 Yr	5.672
28	−4.544	6 Yr	18.176	61–400	−88.324	15+ Yr	88.324
29	−3.252	7 Yr					

Note: Net Cash Flow = Premium − Total Losses & Expenses (including dividends).

EXHIBIT 15

CALCULATION OF THE RISK-ADJUSTED RATE OF RETURN

(1)	Risk-Free Rate of Return	6.60%
(2)	Beta of Liabilities	–0.21
(3)	Market Risk Premium	8.9%
(4)	Risk-Adjusted Rate of Return = (1) + [(2) × (3)]	4.73%

(1) From Exhibit 14.
(2) The Beta of Liabilities is the same as used by the Massachusetts Commissioner of Insurance in the past to set private passenger automobile rates.
(3) From Exhibit 16.

EXHIBIT 16

MARKET RISK PREMIUM

	Total Return		
Year	Large Company Stocks	U.S. Treasury Bills	Difference
1926	11.62	3.27	8.35
1927	37.49	3.12	34.37
1928	43.61	3.56	40.05
1929	−8.42	4.75	−13.17
1930	−24.90	2.41	−27.31
1931	−43.34	1.07	−44.41
1932	−8.19	0.96	−9.15
1933	53.99	0.30	53.69
1934	−1.44	0.16	−1.60
1935	47.67	0.17	47.50
1936	33.92	0.18	33.74
1937	−35.03	0.31	−35.34
1938	31.12	−0.02	31.14
1939	−0.41	0.02	−0.43
1940	−9.78	0.00	−9.78
1941	−11.59	0.06	−11.65
1942	20.34	0.27	20.07
1943	25.90	0.35	25.55
1944	19.75	0.33	19.42
1945	36.44	0.33	36.11
1946	−8.07	0.35	−8.42
1947	5.71	0.50	5.21
1948	5.50	0.81	4.69
1949	18.79	1.10	17.69
1950	31.71	1.20	30.51
1951	24.02	1.49	22.53
1952	18.37	1.66	16.71
1953	−0.99	1.82	−2.81
1954	52.62	0.86	51.76
1955	31.56	1.57	29.99
1956	6.56	2.46	4.10
1957	−10.78	3.14	−13.92
1958	43.36	1.54	41.82
1959	11.96	2.95	9.01
1960	0.47	2.66	−2.19
1961	26.89	2.13	24.76
1962	−8.73	2.73	−11.46
1963	22.80	3.12	19.68
1964	16.48	3.54	12.94
1965	12.45	3.93	8.52

EXHIBIT 16

MARKET RISK PREMIUM
(Continued)

	Total Return		
Year	Large Company Stocks	U.S. Treasury Bills	Difference
1966	−10.06	4.76	−14.82
1967	23.98	4.21	19.77
1968	11.06	5.21	5.85
1969	−8.50	6.58	−15.08
1970	4.01	6.52	−2.51
1971	14.31	4.39	9.92
1972	18.98	3.84	15.14
1973	−14.66	6.93	−21.59
1974	−26.47	8.00	−34.47
1975	37.20	5.80	31.40
1976	23.84	5.08	18.76
1977	−7.18	5.12	−12.30
1978	6.56	7.18	−0.62
1979	18.44	10.38	8.06
1980	32.42	11.24	21.18
1981	−4.91	14.71	−19.62
1982	21.41	10.54	10.87
1983	22.51	8.80	13.71
1984	6.27	9.85	−3.58
1985	32.16	7.72	24.44
1986	18.47	6.16	12.31
1987	5.23	5.47	−0.24
1988	16.81	6.35	10.46
1989	31.49	8.37	23.12
1990	−3.17	7.81	−10.98
1991	30.55	5.60	24.95
1992	7.67	3.51	4.16
1993	9.99	2.90	7.09
1994	1.31	3.90	−2.59
1995	37.43	5.60	31.83
1996	23.07	5.21	17.86
Average	12.67	3.79	8.88

Selected Market Risk Premium is 8.9.
Source: SBBI, 1997 Year Book from Ibbotson Associates, Table 2-5.

EXHIBIT 17

SURPLUS FLOW
(Computed Using Final Weights)

Quarter	Proportion of Loss + Expense and Dividends Remaining to be Paid	Surplus[1]
0	0.954041	238.510
1	0.851465	425.733
2	0.788122	394.061
3	0.724595	362.298
4	0.663072	331.536
5	0.602455	301.227
6	0.550032	275.016
7	0.468795	234.397
8	0.417636	208.818
9	0.388307	194.154
10	0.358545	179.272
50	0.105393	52.697
100	0.034422	17.211

Note: Quarters 11, 12, etc. have not been displayed solely in the interests of space.

[1]Equal to the premium times the proportion of loss, expenses, and dividends remaining to be paid, divided by the premium-to-surplus ratio. For example, in Quarter 50, $(1000) \times (.105393)/2 = 52.697$. The premium-to-surplus ratio has been selected as 2 for all quarters. In Quarter 0, only one-half of the calculated surplus is included to represent the surplus flow starting at policy inception, which occurs at the end of Quarter 0.

EXHIBIT 18

PART 1

INVESTMENT BALANCE FOR TAX FLOW

Quarter	Using Initial Weights	Using Final Weights
−3	0.000	0.000
−2	−1.270	−1.254
−1	−3.750	−3.677
0	−17.530	−17.391
1	191.926	192.547
2	514.335	516.894
3	631.142	633.879
4	771.122	774.089
5	873.515	876.604
6	829.096	831.878
7	766.730	769.144
8	670.742	674.388
9	598.699	601.950
10	560.920	563.957
50	159.725	160.578
100	53.181	53.465

Note: Quarters 11, 12, etc. have not been displayed solely in the interests of space.
The Investment Balance for Taxes is the Investment Balance advanced one quarter.
The Investment Balance is the sum of the Surplus Flow (Exhibit 17) and the Cumulative Premiums minus Losses, Expenses, and Dividends (Exhibit 18, Part 2).

EXHIBIT 18

PART 2

CUMULATIVE PREMIUM MINUS LOSSES, EXPENSES, AND DIVIDENDS

Quarter	Using Initial Weights	Using Final Weights
−3	−1.270	−1.254
−2	−3.750	−3.677
−1	−17.530	−17.391
0	−46.460	−45.963
1	89.455	91.161
2	237.994	239.818
3	409.813	411.791
4	543.009	545.068
5	528.796	530.651
6	492.519	494.128
7	437.560	439.991
8	390.964	393.132
9	367.779	369.803
10	352.944	354.841
50	104.830	105.389
100	34.236	34.418

Note: Quarters 11, 12, etc. have not been displayed solely in the interests of space.

EXHIBIT 19

PART 1

UNDERWRITING TAX FLOWS

Contribution to the Underwriting Tax Flow of:			
		Losses and Expenses (plus Dividends)*	
Quarter	Premiums	Final Weights	Initial Weights
−3	0.00	1.254	1.270
−2	0.00	2.423	2.480
−1	0.00	13.714	13.780
0	0.00	28.572	28.930
1	250.00	231.876	232.398
2	250.00	192.643	192.075
3	250.00	192.826	192.294
4	250.00	190.823	190.218
5	0.00	14.936	14.974
6	0.00	6.743	6.739
7	0.00	35.556	36.620
8	0.00	5.478	5.458
9	0.00	3.712	3.704

*Loss and LAE contribution from Exhibit 19, Part 3, converted to a quarterly flow. (Exhibit 19, Part 3 only displays the result for the initial weights.) Dividends plus Expenses Other than LAE from Exhibit 19, Part 2. For example, for the initial weights for Quarter 6, $(20.953/4) + 1.501 = 6.739$. Quarters 10, 11, etc. have not been displayed solely in the interests of space.

EXHIBIT 19

PART 2

UNDERWRITING TAX FLOW FOR EXPENSES (INCLUDING DIVIDENDS) OTHER THAN LAE

Quarter	Final Weights	Initial Weights
−3	1.254	1.270
−2	2.423	2.480
−1	13.714	13.780
0	28.572	28.930
1	57.065	58.515
2	17.832	18.192
3	18.015	18.411
4	16.012	16.335
5	9.670	9.736
6	1.476	1.501
7	30.290	31.382
8	0.212	0.219
9	0.295	0.306
10	0.729	0.755
11	0.212	0.219
12	0.034	0.036
13	0.005	0.005
14	−0.034	−0.036
15	0.000	0.000
16	−0.010	−0.010
17	−0.030	−0.031

Note: Quarters 18, 19, etc. have not been displayed solely in the interests of space.

EXHIBIT 19

PART 3

CONTRIBUTION TO THE UNDERWRITING TAX FLOW OF LOSS AND LOSS ADJUSTMENT EXPENSE–INITIAL WEIGHTS

(1) Year	(2) Reserve Discount Factors[1]	(3) Difference in Reserve Discount Factors	(4) Loss + LAE Paid During Year[2]	(5) Loss + LAE Paid Subsequent to the Year	(6)[3]	(7) Change in Discounted Reserves[4]	(8) Loss + LAE Contribution to Underwriting Tax Flow
1	0.0000	0.8339	181.079	616.924	181.079	514.453	695.533
2	0.8339	−0.0307	202.706	414.219	33.669	−12.717	20.953
3	0.8032	−0.0306	115.518	298.701	22.734	−9.140	13.594
4	0.7726	−0.0188	65.369	233.331	14.865	−4.387	10.478
5	0.7538	−0.0104	39.128	194.203	9.633	−2.020	7.614
6	0.7434	−0.0146	26.678	167.525	6.846	−2.446	4.400
7	0.7288	0.0014	18.175	149.350	4.929	0.209	5.138
8	0.7302	−0.0051	13.006	136.344	3.509	−0.695	2.814
9	0.7251	0.0335	10.753	125.591	2.956	4.207	7.163
10	0.7586	0.0263	7.655	117.936	1.848	3.102	4.950
11	0.7849	0.0287	3.380	114.556	0.727	3.288	4.015
12	0.8136	0.0316	6.417	108.138	1.196	3.417	4.613
13	0.8452	0.0354	6.610	101.529	1.023	3.594	4.617
14	0.8806	0.0407	7.524	94.005	0.898	3.826	4.724
15	0.9213	0.0486	5.674	88.332	0.447	4.293	4.739
16	0.9699	0.0000	7.117	81.215	0.214	0.000	0.214
17	0.9699	0.0000	4.903	76.311	0.148	0.000	0.148
18	0.9699	0.0000	7.992	68.319	0.241	0.000	0.241

[1]Exhibit 20.
[2]Sum of quarterly paid losses from Exhibit 11 plus paid LAE.
[3]Losses paid in the year minus previously held discounted reserve for those losses.
[4]On losses for subsequent year.

(6) = [1 − (2)] × (4)
(7) = (3) × (5)
(8) = (6) + (7)

Note: Years beyond 18 are not displayed solely in the interest of space. The contribution to the underwriting tax flow declines slowly to zero.

EXHIBIT 20

PART 1

SUMMARY OF DISCOUNT RESERVE FACTORS

Year	Discount Reserve Factor
1	0.8339
2	0.8032
3	0.7726
4	0.7538
5	0.7434
6	0.7288
7	0.7302
8	0.7251
9	0.7586
10	0.7849
11	0.8136
12	0.8452
13	0.8806
14	0.9213
15	0.9699
16	0.9699

Calculated using the reserve flow from Exhibit 20, Part 3 and the interest rate (average mid-term AFR) from Exhibit 20, Part 4. The calculation of the values for the first two years are shown on Exhibit 20, Part 2; the remaining values are calculated similarly.

EXHIBIT 20

PART 2

CALCULATION OF COUNTRYWIDE LIABILITY RESERVE DISCOUNT FACTORS

Year	Reserve Flow*	Discount Factors**	Discounted Reserve Flow
1	28.3575	0.9699	27.5043
2	15.4945	0.9124	14.1377
3	8.2342	0.8584	7.0679
4	5.1434	0.8075	4.1532
5	4.1564	0.7596	3.1573
6	2.4089	0.7146	1.7214
7	2.3136	0.6723	1.5553
8	0.5173	0.6324	0.3271
9	0.9641	0.5949	0.5736
10	0.9641	0.5597	0.5396
11	0.9641	0.5265	0.5076
12	0.9641	0.4953	0.4775
13	0.9641	0.4659	0.4492
14	0.9641	0.4383	0.4226
15	5.2530	0.4124	2.1661
16	0.0000	0.3879	0.0000
Total	77.6634		64.7605
Total Discounted Reserve/Total Reserve =			0.8339

Year	Reserve Flow*	Discount Factors**	Discounted Reserve Flow
1	15.4945	0.9699	15.0283
2	8.2342	0.9124	7.5131
3	5.1434	0.8584	4.4149
4	4.1564	0.8075	3.3562
5	2.4089	0.7596	1.8299
6	2.3136	0.7146	1.6533
7	0.5173	0.6723	0.3478
8	0.9641	0.6324	0.6097
9	0.9641	0.5949	0.5736
10	0.9641	0.5597	0.5396
11	0.9641	0.5265	0.5076
12	0.9641	0.4953	0.4775
13	0.9641	0.4659	0.4492
14	5.2530	0.4383	2.3025
15	0.0000	0.4124	0.0000
Total	49.3059		39.6032
Total Discounted Reserve/Total Reserve =			0.8032

*From Exhibit 20, Part 3.
**Based on the average mid-term AFR (see Exhibit 20, Part 4) of 6.30%.

EXHIBIT 20

PART 3

WORKERS COMPENSATION COUNTRYWIDE RESERVE FLOW

Year	Annual Liability Loss Flow
1	22.3366
2	28.3575
3	15.4945
4	8.2342
5	5.1434
6	4.1564
7	2.4089
8	2.3136
9	0.5173
10	0.9641
11	0.9641
12	0.9641
13	0.9641
14	0.9641
15	0.9641
16	5.2530

Source: Revenue Procedure 92-47 (Tables of Discount Factors).

EXHIBIT 20

PART 4

CALCULATION OF INTEREST RATE FOR RESERVE DISCOUNT FACTORS

Month	Midterm AFR*	Month	Midterm AFR*
Jun. 1992	7.04%	Jun. 1995	6.83%
Jul. 1992	6.85%	Jul. 1995	6.28%
Aug. 1992	6.49%	Aug. 1995	6.04%
Sep. 1992	5.98%	Sep. 1995	6.38%
Oct. 1992	5.78%	Oct. 1995	6.31%
Nov. 1992	5.68%	Nov. 1995	6.11%
Dec. 1992	6.15%	Dec. 1995	5.91%
Jan. 1993	6.34%	Jan. 1996	5.73%
Feb. 1993	6.22%	Feb. 1996	5.61%
Mar. 1993	5.88%	Mar. 1996	5.45%
Apr. 1993	5.45%	Apr. 1996	5.88%
May 1993	5.46%	May 1996	6.36%
12 Month Average	**6.11%**	**48 Month Average**	**6.24%**
Jun. 1993	5.33%	Jun. 1996	6.58%
Jul. 1993	5.54%	Jul. 1996	6.74%
Aug. 1993	5.32%	Aug. 1996	6.84%
Sep. 1993	5.35%	Sep. 1996	6.64%
Oct. 1993	5.00%	Oct. 1996	6.72%
Nov. 1993	4.92%	Nov. 1996	6.60%
Dec. 1993	5.07%	Dec. 1996	6.31%
Jan. 1994	5.32%	Jan. 1997	6.10%
Feb. 1994	5.34%	Feb. 1997	6.38%
Mar. 1994	5.36%	Mar. 1997	6.42%
Apr. 1994	5.88%	Apr. 1997	6.49%
May 1994	6.43%	May 1997	6.85%
24 Month Average	**5.76%**	**60 Month Average**	**6.30%**
Jun. 1994	6.92%		
Jul. 1994	6.83%		
Aug. 1994	7.05%		
Sep. 1994	7.05%		
Oct. 1994	7.10%		
Nov. 1994	7.45%		
Dec. 1994	7.74%		
Jan. 1995	7.92%		
Feb. 1995	7.96%		
Mar. 1995	7.75%		
Apr. 1995	7.34%		
May 1995	7.12%		
36 Month Average	**6.29%**		

*Midterm "Applicable Federal Rate" published monthly by the Internal Revenue Sevice.

EXHIBIT 21

PART 1

VALUES OF KAPPAS

	Initial Weights	Final Weights
κ_1 = Risk-adjusted discounted loss, expense and dividend factor	.8573	.8567
κ_2 = Risk-free discounted premiums	.9622	.9622
κ_3 = Risk-free discounted investment value tax	14.4878	14.5589
κ_4 = Risk-free discounted underwriting profit tax factor (contribution of premiums)	.9610	.9610
κ_5 = Risk-adjusted discounted underwriting profit tax factor (contribution of losses, expenses, and dividends)	.9496	.9495
κ_6 = Risk-free discounted revenue offset tax factor	.9674	.9674

EXHIBIT 21

PART 2

VALUES USED SOLELY TO COMPUTE THE RISK PREMIUM

	Initial Weights	Final Weights
Risk-Free κ_1	.8195	.8187
Risk-Free κ_5	.9331	.9330

EXHIBIT 21

PART 3

CALCULATION OF THE RISK PREMIUM

(1)	Premium calculated using a risk-adjusted discount rate	965
(2)	Premium calculated using a risk-free discount rate (Beta = 0)	906
(3)	Risk Load $1-(2)/(1)$	6.1%

EXHIBIT 21

PART 4

CALCULATION OF KAPPAS

	Flow Discounted	Discount Rate	Discounted to Time Zero From Middle or End of Quarter
κ_1	Losses, Expenses, and Dividends (Exhibits 10 and 11)	Risk-Adjusted	Middle
κ_2	Premiums (Exhibit 6)	Risk-Free	Middle
κ_3	Investment Balance for Taxes (Exhibit 18)	Risk-Free	Middle
κ_4	Premium Contribution to U/W Tax Flow (Exhibit 19)	Risk-Free	End
κ_5	Loss, Expense, and Dividends Contribution to U/W Tax Flow (Exhibit 19)	Risk-Adjusted	End
κ_6	Unearned Premium Reserve Contribution to Revenue Offset Tax Provision (Exhibit 22)	Risk-Free	End

EXHIBIT 22

PART 1

MASSACHUSETTS WORKERS COMPENSATION CALCULATION OF ALPHA— THE REVENUE OFFSET TAX FACTOR

(1)	Unearned Premium Reserve/Premium (Exhibit 22, Part 2)	0.120
(2)	Risk-Free Rate (See Exhibit 14)	6.60%
(3)	Quarterly Risk-Free Rate = $[1+(2)]^{0.25}-1$	1.61%
(4)	Proportion of Unearned Premium Reserve change brought into income (TRA 1986)	20%
(5)	Alpha = $4\times(1)\times(3)\times(4)$	0.00155

EXHIBIT 22

PART 2

MASSACHUSETTS WORKERS COMPENSATION CALCULATION OF UNEARNED PREMIUM RESERVE RATIO

(1)	Countrywide Net Written Premium—1995	26,188,620
(2)	Unearned Premium (Prior Year—1994)	3,323,798
(3)	Unearned Premium (Current Year—1995)	3,506,306
(4)	Average Unearned Premium = $[(2)+(3)]/2$	3,415,052
(5)	Ratio Unearned/Written Premium (Prior Year) = $(2)/(1)$	0.127
(6)	Ratio Unearned/Written Premium (Current Year) = $(3)/(1)$	0.134
(7)	Average Ratio = $(4)/(1)$	0.130
(8)	Ratio Underlying Current Rates	0.110
(9)	Selected Unearned Premium Reserve Ratio	0.120

Source: "1996 Best's Aggregates & Averages" ($000)
Annual Statement & Insurance Expense Exhibit
"Underwriting & Investment Exhibit, Part 2—Premium Earned".

EXHIBIT 23

MASSACHUSETTS WORKERS COMPENSATION RISK-FREE DISCOUNTED UNEARNED PREMIUM TAX FACTOR

(1) Quarter	(2) Unearned Premium Reserve	(3) Unearned Premium Reserve Lagged One Quarter
0	180	0
1	140	180
2	100	140
3	60	100
4	0	60
Total	480	480

(4)	Annual Risk-Free Rate (Exhibit 14)	6.60%
(5)	Present value of Column (3) at interest rate in (4)	464.3483
(6)	κ_6 = (5)/Sum of (3)	0.967392

(2) = Selected Relative Values (see Text).

EXHIBIT 24

SENSITIVITY ANALYSIS BASED ON PRACTICAL EXAMPLE IN SECTION 4

Risk-Free Rate	Model Profit Provision	Difference
12.6%	−11.5%	−7.9%
10.6%	−9.2%	−5.6%
8.6%	−6.6%	−3.0%
6.6%	−3.6%	Base
4.6%	−0.1%	+3.5%
Beta of Liabilities		
−.11	−6.9%	−3.3%
−.21	−3.6%	Base
−.31	−0.2%	+3.4%
Investment Income Tax Rate		
25%	−8.2%	−4.6%
30%	−5.9%	−2.3%
35%	−3.6%	Base
40%	−1.4%	+2.2%
Underwriting Income Tax Rate[1]		
25%	−3.3%	+0.3%
30%	−3.4%	+0.2%
35%	−3.6%	Base
40%	−3.8%	−0.2%
(Initial) Premium-to-Surplus Ratio		
3	−5.7%	−2.1%
2	−3.6%	Base
1	2.5%	+6.1%

[1]The sensitivity exhibited here is not typical. This type of sensitivity will be present when a small negative underwriting profit provision has been calculated. The magnitude and direction of sensitivity to the underwriting income tax rate depends on whether there is an indicated underwriting loss or gain and the magnitude of that loss or gain.

EXHIBIT 24

Sensitivity Analysis
Based on Practical Example in Section 4
(Continued)

Market Risk Premium		
8%	−4.3%	−0.7%
8.9%	−3.6%	Base
10%	−2.7%	+0.9%
Policyholder Dividends[2]		
0	−3.9%	−0.3%
3%	−3.6%	Base
5%	−3.4%	+0.2%
10%	−3.0%	+0.6%
Reserves for Tax Purposes		
No Discounting	−5.2%	−1.6%
Discounting as per TRA 1986	−3.6%	Base
Revenue Offset Feature[3]		
None	−3.7%	−0.1%
As per TRA 1986	−3.6%	Base
Timing of Loss Payments[4]		
Two Quarters Later	−4.4%	−0.8%
One Quarter Later	−4.0%	−0.4%
As per Exhibit 9	−3.6%	Base
One Quarter Earlier	−3.3%	+0.3%

[2]The observed sensitivity is due to the profit provision taking into account the effect of policyholder dividends on investment income. It does not include any change in rates due to any loading of a provision for dividends themselves.
[3]The impact would be greater for lines of insurance with a larger ratio of unearned premium reserves to premium. Also the impact is greater the higher the risk-free rate.
[4]Includes the impact of the corresponding changes in the LAE flows. The impact is greater with a higher risk-free rate. (A higher risk-free rate enhances the impact of time on the value of money.)

APPENDIX

Section 4 contains a practical application of the Myers–Cohn model to Massachusetts workers compensation insurance. Input values were selected to be reasonable at the time this calculation was first prepared in 1997. Most of the inputs will change over time and thus should be updated on a regular basis. While the particular input values shown will not be up to date, the means of getting these values should still be applicable.

In many cases, inputs have been taken from elsewhere in the ratemaking procedure. The calculations that produced those inputs are beyond the scope of this paper. However, in general it is important to choose a set of consistent inputs to any underwriting profit model. The set of inputs should be consistent both internally and with other parts of the ratemaking process.

In this application of the Myers–Cohn model, time has been divided into quarters of a year. While this has been found to be a very useful choice in practical applications, there is no reason why some other choice could not be made.[66] Claim payments in workers compensation insurance can extend for 70 years or more from the date of accident. Therefore, in the rate filing the loss flows extend out about 300 quarters.[67]

Certain complications present in recent rate filings have been removed to aid in exposition. Enough complications have been left to illustrate some of the difficulties that arise in practical situations. However, every application can have its own peculiar details that require special treatment. Many of those that have arisen in Massachusetts workers compensation are beyond the scope of this paper.

[66] In that case the risk-free and risk-adjusted rates used in the Myers–Cohn formula should be adjusted to be appropriate for the selected periods of time.

[67] The detailed behavior in the extreme tail of the loss flow has little impact on the profit provision. The fact that the loss flow is very long does have a significant impact.

For completeness, the changes that were made from the filing for 1/1/98 rates to get the practical application shown here are:

1. Massachusetts imposes a 1% tax on the investment income of domestic insurers. The final tax rate for investment income was 0.2% higher in the rate filing to reflect the pro-rated impact of this tax after federal income taxes.

2. In the rate filing at the suggestion of the Insurance Department, the risk-adjusted rate increases linearly to the risk-free rate from Quarter 5 to the end of the loss and expense flow. Equivalently, the absolute value of beta decreases linearly to zero. Consistent with the change in risk-adjusted rate, the surplus/liabilities ratio used in the rate filing decreases linearly to zero from Quarter 5 to the end of the loss and expense flow. No adjustment was made in the surplus ratio or the risk-adjustment by quarter in the practical application presented here.

3. In the rate filing at the suggestion of the Insurance Department, the expected compensation to shareholders[68] contained in the investment balance is reduced such that only 25% of expected shareholder compensation remains in the investment balance after Quarter 5. No such adjustment was made in the practical application presented here.

4. Massachusetts has had two major reform laws within the last fifteen years. Chapter 572, effective 10/1/86 introduced escalation of benefits and increased the maximum durations of benefits, among other changes. This lengthened the indemnity loss flow considerably. Chapter 398

[68]This expected compensation to shareholders for the risk of writing insurance can be calculated by comparing the profit provision with a beta of zero, i.e. with the risk-adjusted rate equal to the risk-free rate, to that calculated with the selected beta. In recent Massachusetts workers compensation rate filings, the expected compensation to shareholders has been about 5% or 6%.

effective 12/23/91 cuts back on the escalation of benefits and the maximum durations of benefits, among other changes. Recent rate filings have included these impacts on the indemnity loss flows. However, for simplicity, neither impact is presented here. More generally, estimates of the loss flows in particular applications could include estimates of the effects of changes in the law or other changes in payment patterns.

5. Recent rate filings have contained no provisions for policyholder dividends, due to changes in the law governing rate filings in Massachusetts. As calculated herein, we have assumed a policyholder dividend provision has been included in the proposed rates.[69] Dividends have been included in the calculation of the profit provision both here and in the rate filing in order to show the impact on the cash flows. It should be noted that as calculated herein, the profit provision takes into account the loss of opportunity to earn investment income but not the money paid out in dividends itself. One could add the dividend provision to the calculated profit provision to get a "profit and dividends provision." However, to the extent dividend payments have been explicitly allowed for elsewhere in the ratemaking process, one would only need to reflect the loss of opportunity to earn investment income in the calculation of a profit provision, as is done here.

[69]The loading for policyholder dividends is assumed to be 3% of net premiums. As with all inputs, this should be viewed as illustrative only. In those circumstances in which policyholder dividends should not be considered, the weight to the policyholder dividend flow can be set equal to zero.