TOTAL RETURN PRICING IN PROPERTY-CASUALTY INSURANCE: THE MASSACHUSETTS SYSTEM

By Jeffrey Brown

INTRODUCTION

The insurance industry recognizes the need to develop improved ways of measuring the profitability of a given line of insurance. The traditional profit measure -- underwriting profit -- ignores investment income, which today is the property-casualty industry's major source of net income. Better profit measures would improve companies' ability to: (1) set fair and equitable rates, and (2) to manage -- i.e., to plan, monitor and measure performance.

Many different methods of including investment income in profitability measures have been proposed. Some procedures calculate total profitability of a line (as a percent of earned premiums) by adding investment income to underwriting margins for each line of insurance. Methods of allocating investment income to lines of insurance range from estimating investment income attributable to unearned premium reserves only, to allocating a firm's total investment income to its lines of insurance. Other methods of total return pricing do not measure profitability as a percent of earned premiums. Plotkin[1], for example, measures profitability by total returns on assets -- defined as total net income divided by total assets.

[1] For explanation of system see Plotkin (June 1969).

More recent studies have focused on the return on equity as the most appropriate profit measure.[2] The appeal of return on equity (ROE) lies partly in the ability to apply modern finance theory to determine a "fair" ROE by comparison of the returns achieved in other enterprises.

Return on equity has been used as a profitability measure in other regulated industries -- electric and telephone utilities and, more recently, trucking. The current legal standard for judging the equity of rates-of-return in regulated industries was put forth in the United States Supreme Court ruling in the Hope Natural Gas case. In the Hope case, the Court stated:

> ...the return to the equity owner should be commensurate with returns on investments in other enterprises having corresponding risks. (Federal Power v. Hope Natural Gas Co., 320 U.S. 591, 603(1944))

THE MASSACHUSETTS METHOD OF TOTAL RETURN PRICING

In December 1976, the Massachusetts State Rating Bureau, as part of its advistory filing,[3] proposed a new system for determining profit provisions based on the criteria in the Hope case. The proposed system calculates ROE for each line of insurance by examining both the company's underwriting profits and its investment income on cash flow for that line. The theoretical framework for the system drew heavily on the concepts of modern portfolio theory, in particular, the Capital Asset Pricing Model (CAPM).

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[2] An excellent discussion of various profitability measures is contained in the NAIC report of June 1970 entitled "Measurement of Profitability and Treatment of Investment Income in Property-Casualty Liability Insurance".

[3] The original system can be found in Massachusetts Division of Insurance (December 20, 1976).

In response to numerous criticisms, including those of the Massachusetts Attorney General, Dr. William Fairley[4] in 1978, presented a revised version of the Massachusetts system. The new system contains the same basic framework as the 1976 system, but differs in its treatment of the CAPM. It is the revised system proposed by Fairley for determining profit margins that this paper will examine.

According to the Massachusetts rate-of-return standard, each property-liability company should anticipate a rate-of-return equal to a "target" rate based on the returns for unregulated industries having corresponding risks. The failure to provide an adequate rate-of-return results in losses to the current equity owners and an inability to attract adequate equity capital to the company. And, as different lines of insurance have different risk levels, the associated "target" returns will vary by line.

The total anticipated returns for an insurer equals its underwriting profit plus its returns on investment of the cash flow and of the company's capital. This can be expressed by the relationship:

$$(1)\quad \begin{matrix}\text{Anticipated}\\ \text{Returns}\end{matrix} = \begin{matrix}\text{Underwriting}\\ \text{Profit}\end{matrix} + \begin{matrix}\text{Underwriting Investment}\\ \text{Return on Cash Flow}\end{matrix} + \begin{matrix}\text{Investment Return}\\ \text{on Capital}\end{matrix}$$

This relationship can be expressed using a fairly standard financial model:

$$(2)\quad r_E = (1-t)\,(ps + r_A ks + r_A)$$

where r_E = expected total after-tax rate-of-return on equity (ROE)
r_A = expected before-tax rate-of-return on assets
t = effective tax rate
k = proportionality constant
s = premium-to-equity ratio
p = expected profit provision

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[4] Dr. Fairley is an Economist and Statistician for the Massachusetts State Rating Bureau; his system can be found in Fairley (1978).

The proportionality constant of the model, k, can be interpreted as the average number of years that assets corresponding to insurance reserves are held for investment.

Equation (2) can also be transformed to related a "target" or "allowable" ROE to a "target" or "allowable" underwriting profit provision.

The "target" ROE for the system r_E is set using the Capital Asset Pricing Model. The CAPM states that a company's risk-adjusted after tax "target" rate-of-return, r_E^*, is equal to the yield on a risk-free security, r_f, plus a risk-premium equal to the company's beta coefficient, B_E, times the average market risk-premium rate, $r_m - r_f$:

$$(3) \quad r_E^* = r_f + B_E(r_m - r_f)$$

The beta coefficient, B_E, is a measure of the systematic risk of the company and is, by definition:

$$(4) \quad B_E = \text{Cov}(r_m, r_E)/\text{Var}(r_m)$$

where r_E = rate-of-return on equity of the company
r_m = rate-of-return to the overall stock market

Therefore, the beta coefficient for returns on a company's assets would be:

$$(5) \quad B_A = \text{Cov}(r_m, r_A)/\text{Var}(r_m)$$

For a monoline company, a "fair" underwriting profit margin can be determined by equating the company's target rate-of-return with that of the anticipated rate-of-return. The result is an expression for the required profit margin:

(6) $p = -kr_f + B_p (r_m - r_f) + (t/(1-t)s)r_f$

where k = proportionality constant
r_f = yield on a risk-free security
$r_m - r_f$ = average market risk-premium rate
t = effective tax rate
s = premium-to-equity ratio
B_p = beta coefficient for profits

The derived profit margin, p, is earned or accrued to the benefit of the company or its shareholders over the length of the policy. To calculate the value of the total profit as of a given point in time, p must be adjusted with a discount factor computed in the cash flow portion of the model.

For a multiline company, profit margins for the Nth line of insurance, p_N, can be determined by slightly modifying the expression used for monoline companies. The anticipated return on equity for an individual line N, can be computed by substituting the line's proportionality constant, k_N, for the company's overall constant, k, in Equation (2). The target rate for the line would be calculated by replacing B_E with the line's beta coefficient in Equation (3). Thus, the profit margin for a single line of insurance within a multiline company would be:

(7) $P_N = -k_n r_f + B_{p,N}(r_m - r_f) + (t/(1-t)s)r_f$

Actual estimates of the profit margins for each line will depend on the values assigned to the model's parameters (k_N; r_f; $r_m - r_f$; t; s; $B_{p,N}$) during the rate hearings. The values Fairley employs for k_N, t, and s are the average values over the period 1971-75 for a Value Line Investment Survey of nine stock insurance companies.[5] For the average risk-premium

[5]For a discussion of the Value Line sample and estimates from it see Massachusetts Division of Insurance (1978).

rate he utilizes an estimate calculated over the period 1926-74[6] and for the risk-free rate fairly choses an "illustrative" value.

Estimating the beta coefficient, $B_{p,N}$ presents more of a problem. One method is to calculate it from the beta coefficient for liabilities; the other method utilizes the relationship between $B_{p,N}$ and the company's beta coefficient for equity, its beta coefficient for assets, and several other parameters. However, the two methods are interrelated since the beta coefficient for liabilities can be expressed in terms of the other beta coefficients. After obtaining the estimates for the parameters in Equation (6), the required profit margins can be computed.

CRITIQUE OF THE MASSACHUSETTS SYSTEM

There are two classes of problems with the Massachusetts system for total return pricing: (1) problems related to the theoretical assumptions or techniques used in the system, and (2) problems related to calculating the parameter values required in the system.

Theoretical Problems

The first theoretical problem is a failure to clearly distinguish between before-tax and after-tax returns in the deriviation of the system. Although return on equity is taken as an after-tax return, the other returns in the model are treated as before-tax returns. The result is an incorrect derivation of the "fair" profit margin for each line.

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[6]For discussion of estimate see Ibbotson and Sinquefield (1976).

The problem occurs when the CAPM is incorrectly applied in two places: (1) to obtain an expression for the rate-of-return on assets, and (2) to express the beta coefficient for equity in terms of the other beta coefficients. The return on assets is a before-tax return . Likewise profits are treated as before-tax, yet the CAPM is still applied. Therefore the substitutions made for r_A and B_E in the derivation of the profit margin expression are incorrect.

To obtain an accurate expression for the required profit margin, the after-tax return on assets, r_A^*, must first be expressed in terms of the before-tax returns:

$$(8) \quad r_A^* = (1-t)r_A$$

Correctly applying the CAPM then yields:

$$(9) \quad r_A^* = r_f + B_A(r_m - r_f)$$

Second, Equation (3) must be changed to a form with only after-tax returns:

$$(10) \quad r_E = r_A^* (ks + 1) + p^*s$$

where r_A^* = after-tax rate-of-return on assets
p^* = after-tax profit margin

From this, the correct expression for the beta coefficient of equity, B_E, can be obtained:

$$(11) \quad B_E = B_A(ks + 1) + B_p s$$

Using these revisions gives the new expression for the required profit margin:

$$(12) \quad p = \frac{-kr_f}{(1-t)} \quad \frac{B_p(r_m - r_f)}{(1-t)}$$

where p = required profit margin
k = proportionality constant
r_f = yield on a risk-free security
$r_m - r_f$ = risk-premium rate
B_p = beta coefficient for profits
t = effective tax rate

The error created by the incorrect expression for the required profit margins can be seen in Table I. Using Fairley's parameter estimates, the old margins, pN, and new margins, pN*, can be compared:

Line	kN	$B_{p,N}$	r_f	$r_m - r_f$	t	pN	pN*
Auto Bodily	1.60	.34	6.0	8.8	.2	-5.5	-8.69
Auto Property	.31	.07	6.0	8.8	.2	-0.1	-1.55
Homeowners	.35	.07	6.0	8.8	.2	-0.3	-1.85
Workers' Compensation	1.60	.34	6.0	8.8	.2	-5.5	-8.69
Medical Malpractice	3.74	.79	6.0	8.8	.2	-14.4	-19.36

A second conceptual problem is the lack of a uniform time horizon for the model's parameters. For example, the profit margin used is an undiscounted margin for the end of the first policy year. However, the company's associated capital is committed at the beginning of the policy year. In order to maintain a time horizon consistent with the timing of the commitment of capital, the system should use the beginning of the policy year.

Problems in Application

While the remaining theoretical problems are relatively insignificant, the data problems involved when applying the system are not because:

1. The allowable underwriting profit margins are extremely sensitive to the parameter estimates used in the calculation, and
2. Values for these parameters cannot be determined with any reasonable degree of precision.

To use the model, estimates of the following parameters are required:

B_p = beta coefficient for profits
r_f = risk-free rate
$r_m - r_f$ = risk-premium rate
t = effective tax rate
k = proportionality rate

For an estimate of r_p the risk-free rate, Fairley suggests using the prevailing rate of interest on a risk-free security. This implies that insurance rates would have to be refiled whenever interest rates change. For an estimate of the risk-premium rate he advocates using the long-term average, and for the remaining parameters, an average value for a five-year period is calculated using a selected set of property-casualty companies.

Beta Coefficients

One advantage of the revised system, according to Fairley, is that the profit margins do not depend on the estimated beta coefficient of the company. Examining the final expression for the profit margin in Equation (6) one would tend to agree. However, looking beyond that equation, we see that B_p depends directly on B_E. In fact, Fairley derives a relationship between B_p and B_E which is used to calculate B_p. Even using B_L, the beta coefficient for liabilities, to calculate B_p indirectly involves B_E, due to the "balance sheet" relationship between B_E, B_L and B_A. Changes in B_E will thereby directly effect the values of B_p and subsequently, the established profit margins. However research has indicated that short-term beta coefficients for a firm vary widely from year to year.[7] Only when calculated over a longer span of time do

[7] See Levy (1971).

beta coefficients exhibit a degree of stability. Since the system involves four beta coefficients (B_p,B_E,B_L.B_A) their stability is important if consistent profit margins are to be obtained. If wide variations occur in the beta coefficients, significant disparities could arise between the true profit margins and the estimated margins.

When estimating B_p for the various lines of insurance, the system assumes that the beta coefficients for liabilities, $B_{L,N}$ are constant across all lines. The only justification or rationale given for this assumption is that no a priori reason exists for believing that size differentials between lines should effect the systematic risk of the liabilities. However, as recent studies have shown that factors such as asset size effect the beta coefficients for assets,[8] we might be led to wonder if these results also generalize to liabilities.

Using numerical estimates for the parameters, it can be shown that the B_L's are far from constant across lines. In the course of the system's derivation, the following equations were obtained:

$$(13) \quad B_{E,N} = (1-t)\,(B_A\,(K_N s + 1) + B_{P,N} s) \qquad B_{P,N} = -k_N B_{L,N}$$

Substituting and solving, we can express $B_{L,N}$ in terms of the other parameters:

$$(14) \quad B_{L,N} = \left[(1-t)\,B_A\,(k_N s + 1) - B_{E,N}\right] / (1-t) k_N s$$

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[8] See Beaver et. al. (1970).

Let us consider two lines of insurance: auto bodily injury and auto property damage. Since the parameter estimates for t, B_A, s, and the k_N's are provided (by Fairley),[9] all that remains is to calculate the beta coefficient of equity, $B_{E,N}$ for both lines. Using a technique presented in the 1976 Massachusetts system for adjusting a company's overall beta, we obtain corrected line betas, $B_{E,N}$ of 1.03 and .89 for bodily injury and property damage,[10] respectively.

The beta coefficients for liabilities of each line can be computed from these parameters. If the assumption that B_L is constant across all lines holds true, then the values for the $B_{L,N}$'s should be approximately -.21. Evaluating yields:

B_L for bodily injury = .32
B_L for property damage = -2.65

Therefore, it appears that the assumption does not hold true. The importance of this result rests in the fact that even small changes in B_L will result in significant changes in the required profit margins.

The effect on allowable underwriting profit of changes in B_L can be seen in Table II which utilizes the corrected estimates for the individual B_L's:

Line	B_L^*	B_P^*	k	r_f	r_m-r_f	t	s	pN	pN^*
Auto Bodily	.32	-.51	1.60	6.0	8.8	.2	1.3	-5.5	-13.00
Auto Property	-2.65	.82	.31	6.0	8.8	.2	1.3	-0.1	6.50

[9] Estimates are: t = .2; B = .5; s = 1.3; k for bodily injury = 1.60; k for property damage = .31.

[10] Using a B of 1.00 (as estimated by Fairley) and the adjustments calculated in Massachusetts Division of Insurance (1976).

Estimation of Risk-Free and Risk-Premium Rates

Another major stumbling block to using the system to determine profit margins for a line results from the inability precisely to estimate r_f and $r_m - r_f$. Without acceptable estimates of these two parameters, the new system is no more equitable than the traditional fixed underwriting margin.

Due to the structure of the profit margin determination, margins are sensitive to fluctuations in the risk-free rate, r_f. The margins for longer lines are more sensitive to changes in r_f than the shorter lines because the average number of years that assets corresponding to that line, k_N, is greater for longer lines. In expression (2) ROE is proportional to k_N times r_f. Despite the importance of correctly estimating r_f, nowhere in the system is it explained how r_f will be estimated. Will the estimate be a historical value, a forecasted value for the coming year, or the prevailing rate at the time of filing? The difficulty arises from the fact that interest rates fluctuate a great deal, often changing 1.0 - 1.5% within a single year. Such fluctuations could result in profit margins which vary substantially from those estimated at the time of filing. Are insurers expected to refile rates whenever interest rates change?

Other Problems

Several other problems surface when using this system to determine profit margins. One of the major assumptions of the system is that, in the long run, the control system of the property-liability industry will maintain the required profit margins. Fairley emphasizes that the allowances computed under the new system are close to the historical margins actually earned by the industry.

That result itself provides a major reason for not adopting the new system. Fairley's results indicate that property-liability insurers have traditionally undershot the target profit margins. Therefore the assumption that the industry maintains the required profit margins obviously does not hold.

Finally, the most importantly, in an attempt to obtain viable estimators of the model's parameters, the system treats the entire industry as a single unit. However, individual companies file for rates, not industries or groups of companies. Each company has its own unique risks, risks that vary widely, even between property-liability companies.[11] The revision was to develop a system that met the criteria established in the Hope case, that of equal returns for companies youth corresponding risks. If the system does not consider each company's unique risks, it fails to meet the Hope criteria and, thereby, its own objectives.

[11]Value Line Investment Survey, June 25, 1976.

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