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Article abstract

In an attempt to curb the inappropiate investment practices of the past, the National Association of Insurance Commissioners (NAIC) have proposed the Model Investment Law. Although the most recent draft of the Model Investment Law is less complex and offers increased flexibility in certain investment areas, it continues to receive criticism since it uses a "pigeon hole" approach with asset limitations based on definitional classifications that apply to all companies. This paper proposes a methodology for establishing a strategic asset allocation for the property-liability insurer while recognizing the confounding influences of capital structure and product line mix. The methodology is developed in accordance with mean-variance efficiency on an after-tax basis.

FINANCIAL DECISION MODEL FOR THE PROPERTY-LIABILITY INSURER: AN ALTERNATIVE TO THE NAIC MODEL INVESTMENT LAW

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RÉSUMÉ

L'organisme américain désigné sous le nom *National Association of Insurance Commissioners* ou NAIC a mis au point un modèle de placement conçu dans le but de réglementer le placement des fonds des compagnies d'assurances provenant de leurs portefeuilles de risques «vie», «dommages» et «responsabilité». Devant les critiques engendrées par ce projet législatif, les auteurs suggèrent une approche alternative en vue d'établir et de contrôler l'allocation optimale de l'actif, la détermination appropriée du capital et l'évaluation du modèle proposé par NAIC.

ABSTRACT

In an attempt to curb the inappropiate investment practices of the past, the National Association of Insurance Commissioners (NAIC) have proposed the Model Investment Law. Although the most recent draft of the Model Investment Law is less complex and offers increased flexibility in certain investment areas, it continues to receive criticism since it uses a "pigeon hole" approach with asset limitations based on definitional classifications that apply to all companies. This paper proposes a methodology for establishing a strategic asset allocation for the property-liability insurer while recognizing the confounding influences of capital structure and product line mix. The methodology is developed in accordance with mean-variance efficiency on an after-tax basis.

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I. INTRODUCTION

Managers of property-liability insurance companies are faced with difficult and interrelated decisions regarding asset allocation, capital structure and product line mix. That is, the optimal asset portfolio allocation reflects the insurer's liabilities and capital structure. Likewise, effective capital standards must recognize the insurer's assets' and liabilities' composition. *Given the wide differences in the financial structure and product mix across insurers, merely applying uniform standards on investment and capital decisions will be ineffective.*

The National Association of Insurance Commissioners has proposed the NAIC Model Investment Law (MIL), a law designed to regulate the investment portfolios of domestic life and property-liability insurers.[1] This proposed law continues to receive criticism since it uses a "pigeon hole" approach with asset limitations based on definitional classifications that apply to all companies. Babbel (1994) and Lamm-Tennant (1995) demonstrate that any attempt to prescribe a uniform "broad brush" investment strategy given the industry's diverse capital structures and liability characteristics should be suspect. Instead, the methodology should reflect the unique interdependencies of individual companies' product line mix, capital structure and targeted solvency standard.[2]

The purpose of this paper is to propose an alternate approach for establishing and monitoring optimal asset allocation, determining capital adequacy (risk-based capital) and assessing the impact of the NAIC Model Investment Law. The proposed strategic asset allocation model is intended for the individual property-liability insurer and will recognize the company's specific capital and liability structure. The approach is developed in accordance with mean-variance efficiency on an after-tax basis. Using the proposed methodology, optimal asset allocations are determined for a "typical" insurer while recognizing the limitations imposed by the Model Investment Law. Using the proposed methodology, a sensitivity analysis is performed across various asset limitations, capital structures and product line mix to analyze the implications of the Model Investment Law.

II. METHODOLOGY

Although the methodology set forth in this paper targets the asset allocation decision; the capital structure decision or the product line mix decision could also be targeted. The methodology is developed in accordance with Modern Portfolio Theory (Markowitz, 1959) which has had important implications in prior applications to the management of pension funds and mutual funds. Past uses of Modern Portfolio Theory (MPT) as a foundation for modeling the insurer's financial decisions has been limited for four reasons: (1) the objective function is to maximize the expected return on assets yet the insurer is a bundle of both assets and liabilities whose interdependence needs to be managed; (2) it focuses on before-tax expected return on assets yet the insurance industry is largely taxable; (3) it fails to directly recognize the insurer's need for maintaining solvency; and (4) it typically produces an asset allocation solution inconsistent with regulatory guidelines. Although previous applications of MPT within the insurance industry have been limited, Bachman (1978), Bachman and Lang (1976) and Cummins and Nye (1981) utilize the principles of MPT for modeling the insurer's optimal product line mix.

The proposed methodology for determining and monitoring the insurer's asset allocation decisions relies on MPT as a foundation yet overcomes some of the previously identified limitations by recognizing the insurer's capital structure, product line mix, taxation and regulation. (See Meehan, Yoo and Fong (1993) for an after-tax optimization on nuclear decommissioning funds.) Product line mix is particularly important because of differing underwriting and total return margins by line. Also, the underwriting margin can be on either a gross or net basis reflecting the incidence and quality of reinsurance, a subject of considerable interest in Risk Based Capital discussions. By maximizing the after-tax return on equity (ROE) in accordance with MPT we consider not only the assets but also the insurer's specific product line mix, capital structure and taxes. (Recognition of regulation is discussed in a following section.) We can demonstrate this point by reviewing Equation 1, the statement for after-tax ROE.

$$ROE^{AT} = \left(\frac{P}{S} * \sum_i w_i ROU_i^{AT}\right) + \left(\frac{R}{S} * \sum_j w_j ROI_j^{AT}\right) + \left(\sum_j w_j ROI_j^{AT}\right) \quad (1)$$

where

ROE^{AT} = after-tax return on equity

P/S = insurance leverage = premium-to-surplus ratio

w_i = percent of business in line I

ROU^{AT} = after-tax return on underwriting

R/S = financial leverage = reserves-to-surplus

w_j = percent of assets invested in asset class j

ROI^{AT} = after-tax return-on-investments.

On an after-tax basis ROE is the sum of three terms: (1) the levered after-tax return on underwriting; (2) the levered after-tax return on funds provided by insurance reserves; and (3) the after-tax return on surplus. The product line mix is recognized in the first term since the return on underwriting (ROU) is the weighted average of the by-line ROU. Capital structure is recognized in both the first and second term. In the first term, ROU is multiplied by insurance leverage (premium-to-surplus) to derive a levered ROU. In the second term, return on investments ROI is multiplied by financial leverage (reserves-to-surplus) to derive a levered return on reserves.

In accordance with MPT, a quadratic programming model is developed whereby the optimal asset allocation maximizes the insurer's after-tax return on equity for each solvency target (ie. probability of surplus decline). In addition, constraints reflecting asset class limitations imposed by insurance regulation and capital market limitations are recognized within the modeling process.[3] The following quadratic programming objective illustrates the intuition of the process:

Maximize: After-tax Return on Equity

Subject to:

(1) the company's tolerance for risk (ie. minimal acceptable standard deviation or probability of 50% surplus decline)

(2) the allocation to equities (internationals, growth, value, domestic index) must not exceed 25%

(3) the allocation to mortgage-backed securities must not exceed 25%

(4) the allocation to preferred securities must not exceed 15%

(5) the allocation to international securities must not exceed 20%

(6) the allocation to low grade fixed-income must not exceed 10%

(7) the allocation to convertible securities must not exceed 5%

(8) the allocation to international equities must not exceed 8%

(9) the sum of all the asset allocations equal 100% and no allocation is negative.

The intent is to solve the allocation decision for incrementally increasing levels of risk as measured by either the standard deviation in after-tax ROE or the probability of surplus decline. We target the eventual probability of a 50% decline in surplus as our risk proxy, although any level of surplus decline may be modeled. Also we specify the time period as infinite, yet an interim time period may be specified. In essence, a range of efficient portfolio allocations is identified - one efficient portfolio allocation for each level of risk. Constraints 2 through 6 are motivated by the Model Investment Law. Constraint 7 is justified based on the size of the convertible security market relative to amount of investable assets.[4] Constraint 8 is based on evidence indicating that the allocation to international equities should not exceed one-third of the allocation to domestic equities.[5] Since equities are capped at 25%, then a subconstraint is placed on international equities at 8% or approximately one-third the equity allocation. The final constraint assures that all assets are invested and no short sales are allowed. There are no constraints upon fixed income securities beyond those above.

For the purposes of this article a "typical" insurer is hypothesized. The insurer's a product line mix and capital structure is characterized by the industry's results accumulated by A. M. Best. Although this approach is acceptable for demonstrative purposes, the advantage of the methodology rests in its ability to specify optimal asset portfolios given specific company financial/product line characteristics and operating results.[6]

III. DATA

Asset Data

Time series return data on capital market assets was attained on twenty-one capital market asset classes and styles. Asset styles were simulated for both the equity and fixed-income asset classes. For example, as opposed to simulating domestic equities as one asset class, the various management styles are recognized. Consequently three domestic equity asset classes are modeled, namely, value, growth and indexed. Likewise, the international fixed income class is modeled as unhedged world fixed-income, hedged world fixed-income, unhedged foreign fixed-income,

TABLE 1
CAPITAL MARKET ASSET CLASS RETURN PROXY

ASSET CLASS	PROXY
Fixed Income Securities:	
US Treasury Bill	Salomon Brothers Treasury Index
Intermediate Treas. Note	Shearson Lehman Intermediate Treasury Index
Long Term Treas. Bond	Shearson Lehman Long Treasury Index
30-Year Treas. Bond	Ryan Labs 30-Year Treasury Index
Intermediate Municipal Bond	Equal Weight of: Dreyfus Intermediate Municipal Bond, Scudder Medium-Term Tax-Free and Vanguard Municipal Intermed. Term
Long Term Municipal Bond	Equal Weight of: T. Rowe Price Tax-Free Income, SAFECO Municipal Bond and Scudder Managed Muni Bonds
Intermediate Corporate Bond	Shearson Lehman Intermediate Corporate Index
Long Term Corporate Bond	Shearson Lehman Long Corporate Index
Mortgage Backed Security	Lehman Brother Mortgage Backed Securities Index
High Yield Bond	CS First Boston High Yield Bond Index
Hybrid Securities:	
Convertible Security	CS First Boston Convertible Securities Index
Preferred Stock	S&P Preferred Stock Index
Structured Security:	
Laddered Treasury	Cash Flow Match Against Treasury Securities
Equity Securities:	
Domestic Equity Passive	S&P500 Index
Growth	Equal Weight of: Janus, Scudder Capital Growth and Twentieth Century Ultra Investors
Value	Equal Weight of: Fidelity Equity Income, T.Rowe Price Equity Income and Washington Mutual Investors
International Securities:	
International Equity	EAFE Index
World Fixed Income - Hedged	Salomon World Government Bond Index - Hedged
World Fixed Income - Unhedged	Salomon World Government Bond Index - Unhedged
Foreign Fixed Income - Hedged	Salomon WGBI - Excluding US and Hedged
Foreign Fixed Income - Unhedged	Salomon WGBI - Excluding US and Unhedged

hedged foreign fixed income.[7] A "Laddered" asset class was simulated by staggering the coupons and maturities on treasury securities such that they form a cash flow match with consolidated insurance liability payouts.[8] Table 1 displays the twenty-one asset classes/styles and the index selected as the proxy.

For each capital market asset class, total return time series data, and the capital gain and income components of the total return were obtained using a generally accepted asset class index. For example, monthly time series data is from February 1973 to January 1995 representing four complete market cycles.[9] The component return data is necessary to support the tax adjustment in deriving after-tax returns. Also a typical turnover rate as well as tax rates on capital gains and income were assumed to support the after-tax return calculation. Investment management styles, such as growth equities or value equities, are simulated using performance data on mutual funds professing adherence to the style. In the case of municipal bonds, mutual fund data was used to attain the breakout of total return into its components - capital gain and income.

☐ Liability Data

The approach taken in this paper relies on statutory accounting data. For each line of business, underwriting return data is provided on a before-tax basis by A. M. Bests. Given by-line, before-tax underwriting returns from 1973 through 1993, after-tax underwriting returns were proxied by applying industry wide tax rates uniformly across lines for each year. Although this becomes a proxy, at best, it is acceptable for demonstration purposes. When applying the process to a specific insurer, the accuracy of estimating after-tax underwriting returns across time is improved since their specific tax structure can be applied.

☐ Capital Structure Data

As stated in Equation 2, the insurer's by-line financial leverage (reserves-to-surplus) is the product of insurance leverage (premiums-to-surplus) times the reserve-to-premium ratio.

$$\frac{Reserves}{Surplus} = \frac{Premium}{Surplus} * \frac{Reserves}{Premium} \qquad (2)$$

The total financial leverage for the insurer becomes a weighted average of the by-line financial leverage whereby the percent of premiums to total serve as the weights.

In order to proxy the "typical" insurer's by-line financial leverage, we must derive estimates of (1) insurance leverage and (2) the reserve-to-premium ratio. Insurance leverage was measured as 1.40 based on the industry wide premium-to-surplus ratio reported by A. M. Best. The by-line reserve-to-premium ratio was proxied through simulation based upon product line mix.

Table 2 below illustrates the simulation of the reserve-to-premium ratio for two lines of business - automobile liability and automobile collision. For automobile liability, with an average loss ratio of 0.764, Table 2 indicates that as of midyear in the first year, 65.69% of the initial reserve is still outstanding. Per $1 of premium, $0.502 (.6569 * .764) of the initial loss reserve remains outstanding. Similarly, in the fifth year, the midyear percent outstanding is 0.047 of the initial reserve. If a company were underwriting automobile liability at a constant amount of premium for several years, then, according to Table 2 at any point in time after 14 years it would have $1.134 of outstanding reserves per $1 of premium. In the case of automobile collision, there would be $0.12 of outstanding

TABLE 2
DEVELOPMENT OF THE RESERVE-TO-PREMIUM RATIO

	AUTO - PRIVATE- LIABILITY Avg. Loss Ratio: 0.764			AUTO - PRIVATE- COLLISION Avg. Loss Ratio: 0.644		
End of Year	Percent Paid Out	Percent of Reserve Remaining	$ Amount of Reserve Remaining	Percent Paid Out	Percent of Reserve Remaining	$ Amount of Reserve Remaining
Initial		1.00	0.764		1.00	0.644
1	34.31	65.69	0.502	83.11	16.89	0.109
2	30.88	34.81	0.266	15.78	1.11	0.007
3	15.03	19.78	0.151	0.54	0.57	0.004
4	8.82	10.96	0.084	0.57		
5	4.76	6.20	0.047			
6	2.73	3.47	0.027			
7	1.24	2.23	0.017			
8	0.63	1.60	0.012			
9	0.23	1.37	0.010			
10	0.31	1.06	0.008			
11	0.31	0.75	0.006			
12	0.31	0.44	0.003			
13	0.31	0.13	0.001			
14	0.13					
15						
	Reserve to Premium Ratio: 1.134			Reserve to Premium Ratio: 0.120		

reserve per $1 of premium. Hence the reserve-to-premium ratio of automobile liability equals 1.134 and 0.12 for automobile collision. If the business mix were equally weighted, then the company reserve-to-premium ratio would be 0.627.

IV. RESULTS

Computation of Input Estimates

The necessary inputs for the objective statement are proxies for the after-tax expected return for each insurance line of business and for each capital market asset class. For individual asset classes or lines of business, the mean-variance model utilizes the arithmetic average of historic after-tax returns as the proxy for the next period after-tax expected return. The objective statement is constrained by the company's risk tolerance (or, alternately, the company's targeted solvency margin). Risk is measured by the standard deviation in the after-tax ROE. Using the standard deviation and the after-tax expected ROE we derive an alternate risk proxy, the probability of a 50% surplus decline. Hence, the inputs needed for our risk proxy include (1) the standard deviation of each asset class/style returns across time, (2) the standard deviation of each product line returns across time, and (3) the covariance or correlation between all paired combinations of after-tax returns generated by asset/style classes and insurance lines of business.

More recent application of mean-variance model blend forward-looking simulations of the term structure of interest rates with traditional concepts from equity management when deriving the asset class expected returns. Although the approach taken here within is based on traditional MPT, these recent developments may be easily incorporated into the analysis.

Simulation of Current Industry Benchmarks

Table 3 below displays the current condition for the "typical" property-liability insurer to establish benchmark values for the expected after-tax return on equity and probability of surplus decline given the insurer's current asset allocation, business diversification and capital structure. As reported in Table 3, the insurance leverage (premium-to-surplus) for the insurer is currently 1.40 and the financial leverage (reserves-to-surplus) is 1.66. The business diversification is measured as the percent of by-line premiums

TABLE 3
BENCHMARK VALUES

INPUTS

***Premium to Surplus:* 1.40**

Liability Classes	Mix (%)
Allied/Fire	3.9
Auto - Comm. - Liability	6.0
Auto - Comm - Collision	2.1
Auto - Private - Liability	29.3
Auto - Private - Collision	16.9
Burglary/Theft/Glass	0.1
Fidelity/Surety	2.1
General Liability	8.8
Inland Marine	2.3
Ocean Marine	0.7
Medical Malpractice	2.2
Home - Multiple Peril	10.7
Workers Compensation	15.0
Totals:	100.0

Asset Classes	Mix (%)
Int'l Equity	
Growth Equity	
Equity	17.0
Value Equity	
Treas - 30 Year	
Intl Fix Inc (XU)*	
Convertibles	
Treas - Long	
Muni - Long	
Prefereds	2.3
Corp - Long	
Mortgage Back	2.7
High Yield	
Muni - Inter	36.0
Intl Fix Inc (IU)*	1.0
Corp-Inter	19.0
Treas-Inter	22.0
Intl Fix Inc (IH)*	
Intl Fix Inc (XH)*	
T-Bills	
Totals:	100.0

RESULTS

***Financial Leverage:* 1.66**

Returns:	**(%)**
Underwriting	(7.70)
Reserves	12.07
Surplus (ROA)	7.28
Capital Gain Return	1.35
Income Return	5.70
Total Ret. on Equity:	11.65
Risk:	**(%)**
Std Dev	9.63
Variance	0.0093
Ruin Probability:	**(%)**
100% Surplus Reduction:	1.3E-11
50% Surplus Reduction:	3.5E-06

* There are four World Gov't Bond International Fixed Income Indices

IU includes the U.S. gov't bonds, Unhedged.
XU excludes the U.S. gov't bonds, Unhedged.
IH includes the U.S. gov't bonds, Hedged.
XH Excludes the U.S. gov't bonds, Hedged.

written to total and range from 29.3% in private passenger automobile liability to 0.1% in burglary and glass. The percent of assets allocated by-asset class is proxied by the industry's 1993 asset allocation and range from 36% in intermediate municipal bonds to 1% in global fixed income securities. Given the insurer's asset allocation, product line mix and capital structure, as well as standard assumptions regarding tax rates and turnover, the expected after-tax return on equity is targeted at a 11.65%, a rather low rate in today's capital markets making it difficult to compete effectively. Of this 11.65% after-tax return on equity, -7.70% is attributed to the levered after-tax loss on underwriting, 12.07% is attributed to the levered after-tax return on reserves and 7.28% is attributed to the unlevered after-tax return on surplus. The unlevered after-tax return on surplus is equivalent to the after-tax return on assets and is comprised of a capital gain of 1.35% plus an income gain or yield of 5.70%. The standard deviation in the asset portfolio is 9.63% and the probability of 50% surplus decline is less than 5 in 1 million.

☐ Asset Allocation Optimization with Model Investment Law Constraints

As previously shown, the results reported in Table 3 provide benchmark values for the property-liability insurance industry's expected return on equity and probability of surplus decline. These results suggest that the current asset allocation is not optimal relative to the insurer's product line mix and capital structure. Alternatively, Table 4 provides for a mean-variance optimization of the asset allocation decision given the "typical" insurer's product line mix, capital structure, tax status and regulatory/capital market constraints.[10] MPT provides for the optimal asset allocation at various positions along the efficient frontier with each position representing incrementally increasing levels of targeted after-tax expected return on equity.

By comparing the benchmark asset allocation shown in Table 3 with the optimal constrained asset allocations displayed in Table 4 below, alternative asset allocations exist that provide either the same expected after-tax return on equity and a lower probability of surplus decline (Portfolio A).

Although portfolio with an equivalent probability of surplus decline as currently experienced by the industry is indeterminable, a near substitute with a higher after-tax expected return on equity is indicted as Portfolio C. The Portfolio C is of similar risk as the "typical" industry insurer, yet it provides a 430 basis point

TABLE 4
INDUSTRY ASSET ALLOCATION - CONSTRAINED

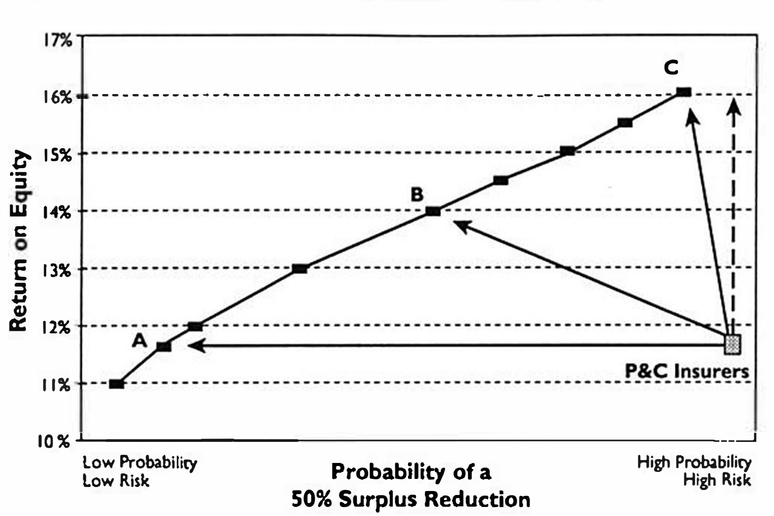
Premium to Surplus: 1.4

ASSET	PORTFOLIO			
	A (%)	B (%)	C (%)	P&C (%)
ROE	11.7	14.0	16.0	11.7
Std Dev	5.0	6.7	9.5	9.6
P(S)	9.0E-21	2.2E-14	1.9E-08	3.5E-06
Total ROA	7.3	8.2	8.9	7.3
Cap Gains ROA	1.3	2.0	3.0	1.4
Income ROA	5.8	5.7	5.4	5.7
Int'l Equity	2.0	4.4	7.2	
Growth Equity				
Equity	5.6	8.5	15.6	17.0
Treas-30Yr				
Convertible			5.0	
Muni-Long				
Preferred	5.6	14.9	15.0	2.3
Mortgage Back	18.7	20.0	20.0	2.7
High Yld				
Int'l Fix Inc*	12.1	15.6	12.8	1.0
Muni-Inter	23.3	24.0	24.4	36.0
Corp-Inter	2.9			19.0
Treas-Inter				22.0
T-Bills				
Treas Ladd	29.8	12.6		
Total	100	100	100	100.0

* Int'l Fixed excludes US securities and are unhedged.

improvement in expected after-tax ROE. Also, some asset allocation exists that provides both a higher after-tax return on equity and lower probability of surplus decline (Portfolio B). For example, Portfolio B provides and after-tax expected return on equity of 14.0% versus 11.65% for the "typical" insurer allocation, a 235 basis point improvement. Also, Portfolio B provides for less risk than the current "typical' insurer asset allocation. The precise asset allocation underlying Portfolio B on the efficient frontier is as follows: 12.6% in the treasury ladder asset, 24.0% in intermediate municipal bonds, 15.6% in international fixed income securities (excluding U.S. securities and unhedged), 20.0% in mortgaged-backed securities, 14.9% in preferred securities, 8.5% in domestic

FIGURE 1
INDUSTRY ASSET ALLOCATION – CONSTRAINED



equities (indexed) and 4.4% in international equities. Figure 1 below graphically displays the improved expected return and reduced risk resulting from the model-derived optimal portfolio allocations.

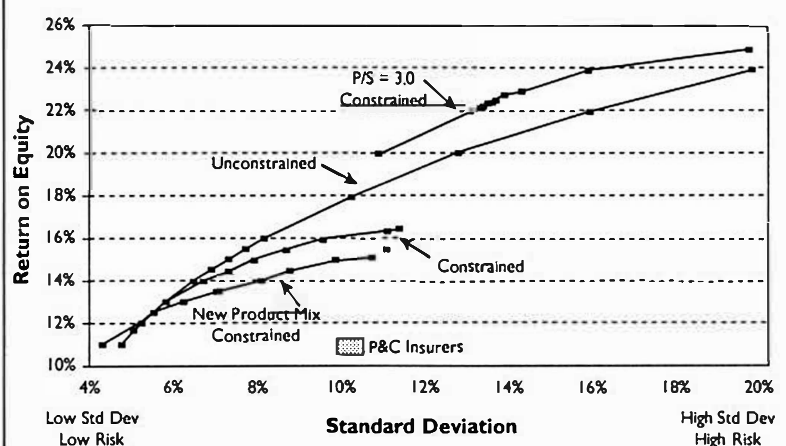
With regards to the analysis of various management style choices, it appears that on an after-tax basis, an indexed exposure to domestic equities always dominates an actively managed growth or value style. Due to the high turnover associated with active managed equities, the after-tax risk-adjusted returns associated with active managed equities are lower than the after-tax risk-adjusted returns on the index. Also with regards to the international fixed income allocation, an unhedged exposure excluding U.S. securities always dominated the hedged style as well as the world approach. Although the unhedged exposure excluding U.S. securities has high total risk, must of the total risk eliminated through diversification. Finally, at low levels of risk the laddered asset class which structures the asset returns according to the liability payouts using default free securities dominates, as would be expected.

When simulating the "typical" industry insurer, the asset constraints imposed by the Model Investment Law prevent solutions with expected after-tax ROE in excess of 16.0%. Furthermore risk (probability of 50% surplus decline or standard deviation in expected ROE) is held unnecessarily low. Consequently, in pursuit of containing risk, the MIL may prevent the insurance company from competing effectively in today's markets by holding targeted ROE at 16.0% or less. In a following section we demonstrate that by increasing leverage the insurer may target an after-tax ROE in excess of 16%, although increasing leverage causes the risk level to exceed those associated with alternate asset allocations. In other words, given the MIL an insurer may be incentivized to increase leverage in an attempt to raise the targeted ROE; yet increasing leverage may add more risk that relaxing the asset constraints. It appears that the proposed NAIC asset constraints are economically inefficient.

☐ Sensitivity Analysis Product Line and Leverage

Figure 2 illustrates the relationship between risk and after-tax return on equity given (1) a change in the product line mix and then given (2) a change in the level of insurance leverage. Each of these two scenarios are plotted against the efficient frontier with and without the MIL asset allocation constraints. When comparing the efficient frontier with the MIL asset allocation constraints against the unconstrained efficient frontier, a cost or trade-off is attributed to the imposition of the MIL constraints. That is, at a 14% targeted return on equity the optimal asset allocation results in a standard deviation of 6.5% under the traditionally constrained solution versus 6.7% under the solution constrained by the Model Investment Law. Although this difference may seem insignificant, Figure 2 illustrates that the cost or trade-off attributed to regulation will increase as the targeted after-tax return on equity rises.

FIGURE 2
SENSITIVITY ANALYSIS

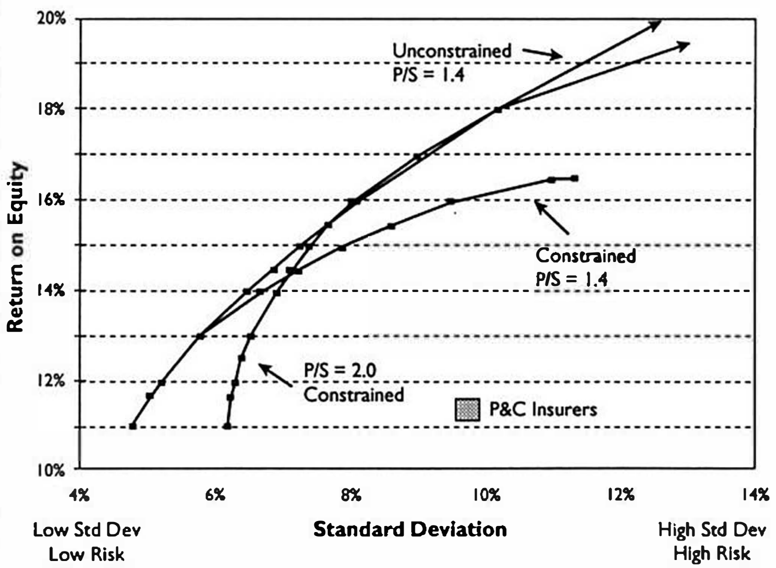


We then increased insurance leverage from 1.4 to 3.0 and recalculated the efficient frontier. When comparing the constrained efficient frontier with P/S = 3.0 efficient frontier, Figure 2 indicates that an increase in insurance leverage will result in an efficient set well beyond that provided for by the constrained scenario. Stated differently, even with the MIL asset constraints imposed, an increase in insurance leverage will result in high risk levels. In fact, an increase in leverage prevents solutions within the previously targeted low risk range.

We then altered the product line mix by increasing workers compensation and decreasing the property lines. The specific adjustment increased the business allocation for workers compensation 32.6% and eliminated inland marine, ocean marine, allied fire and homeowners. When comparing the constrained efficient frontier with the new product mix efficient frontier, Figure 2 illustrates that the new product mix results in a higher level of risk for any targeted return on equity. Thus for any targeted after-tax ROE, asset constraints alone will not contain risk.

Figure 3 provides a closer look at the underlying incentives attributed to the MIL. As previously discussed, given the "typical" industry insurer, the MIL limits the targeted expected after-tax ROE

FIGURE 3
LEVERAGE VS. ASSET CONSTRAINTS

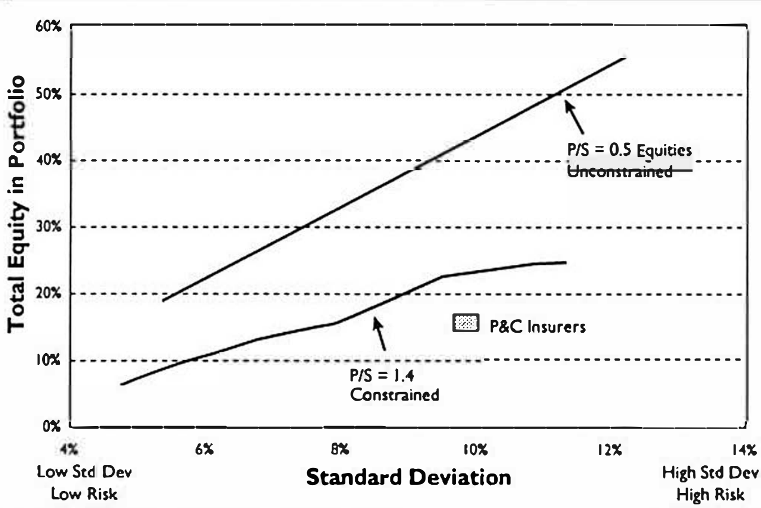


to 16.0%. Consequently an insurer may be incentivized to increase leverage so as to increase the expected ROE. For example, Figure 3 illustrates the expected return/risk opportunities under three conditions: (1) P\S = 1.4 with MIL asset constraints, (2) P\S = 1.4 without MIL asset constraints, and (3) P/S - 2.0 with MIL asset constraints. By comparing the unconstrained/1.4 leverage opportunity set against the constrained/2.0 leverage opportunity set, we see that for most risk levels the unconstrained\1.4 leverage opportunities dominate the alternatives. That is, when constrained by the MIL insurers will be incentivized to increase leverage so at to achieve higher targeted levels of ROE, yet for most targeted levels of ROE the risk resulting from increasing leverage exceeds the risk resulting from relaxing the asset constraints. We have demonstrated that under certain circumstances, the MIL asset constraints provide for inefficient incentives. These inefficient incentives are clearly attributed to the MIL's failure to consider the interdependencies between capital structure, asset allocation and product line mix.

☐ Sensitivity Analysis Across Equity Constraints

A final sensitivity analysis is performed by lowering insurance leverage from 1.4 to 0.5 and relaxing the constraint on the equity allocation. Figure 3 plots the percent of assets allocated to equities relative to risk under two scenarios - with the MIL equity constraints and insurance leverage equal to 1.4 versus without equity

FIGURE 4
LEVERAGE AND EQUITY ALLOCATION



limitations and insurance leverage equal to 0.5. For any targeted level of risk, higher allocations to equities are permitted by lowering insurance leverage. In fact, given insurance leverage equal to 0.5, the equity allocation can increase to 50% yet maintain risk levels permitted within the MIL asset constrained scenario.

V. CONCLUSION

In summary, optimizing the financial decisions of the property-liability insurance company requires recognition of the relationships among asset allocation, business diversification and capital structure. In this paper, a process for establishing a strategic asset allocation for the property-liability insurer while recognizing the interdependent influence of capital structure and product line mix is developed in accordance with MPT on an after-tax basis. Although the decision process targets the asset allocation decision, it could be empirically implemented with either product line mix or capital structure as the targeted decision element.

Using the proposed framework for establishing an insurer specific asset allocation, an evaluation of the risk/return trade-offs imposed by the Model Investment Law is performed. The mean-variance efficient solution is first derived while recognizing the asset class limitations imposed by the Model Investment Law. Then a sensitivity analysis is performed across varying levels of leverage, product line mix and asset constraints.

The following conclusions are evident. First, after-tax ROE can be improved by as much as 435 basis points from a modest expected 11.65% without increasing risk, given industry leverage and product line mix. Second, the NAIC asset allocation constraints produce either lower returns or increased risk when compared to the unconstrained situation. That is, for any target expected return on equity, the imposition of the Model Investment Law will impose a higher risk portfolio as measured by the probability of surplus decline or the standard deviation in ROE. Third, the Model Investment Law will needlessly suppress expected ROE making it difficult for the insurance industry to compete in today's marketplace. Fourth, the risk/return trade-off is sensitive to product line mix and leverage. Therefore, should the NAIC impose asset constraints, the individual insurer may either alter its product line mix or its leverage to increase targeted after-tax ROE and in so doing may increase risk beyond acceptable levels. In essence the MIL will not be effective in preventing insolvencies. At the same time, the imposition of asset constraints specific by the MIL will force well-managed, well-capitalized insurers to increase risk for any targeted level ROE. Fifth, solvency regulation, which limits the investment activities, should be firm specific. The imposition of industry wide standards on the asset allocation without considering the company's leverage and product line mix may not result in acceptable levels of risk.

Endnotes

1. Although prior drafts were circulated, in September 1994 a full revised draft was made available upon request to the Model Investment Law Working Group of the Valuation of Securities Task Force of the NAIC in Kansas City. The earlier versions of the model law were deemed complex, burdensome and received extensive criticism from the industry.

2. See Lamm-Tennant, Starks and Stokes (1995) for a discussion of solvency standards and cost considerations when regulating solvency; and Cummins, Harrington and Klein (1994) for a review of insolvency experience and corrective actions

3. The precise variables definitions as well as a full model specification appear in a working paper titled "The NAIC Model Investment Law: Implications for Optimal Capital Allocation Decisions" and can be attained from the author upon request.

4. The U.S. insurance industry represents approximately $3 trillion of investable assets. Given the size of the convertible securities market, an allocation limitation is necessary to maintain liquidity in this asset class.

5. In 1991, SEI Capital Resources issued a position paper titled "International Equity Investing" which summarizes their research regarding the appropriate blend of international equities within a domestic equity portoflio.

6. This model has been used to derive the asset allocation decision for multi-line insurers writing various types of property-liability insurance. Across all levels of risk, a very different allocation decision is identified as being optimal when compared to the optimal asset allocation for the "typical" insurer. Herein lies the precise advantage of the methodology. That is, optimal asset allocations are firm specific. The Model can identify optimal asset allocations, product line mix and capital structure for any individual company by relying upon the company's line of business, operating results and stated level of risk tolerance.

7. A foreign asset class excludes U.S. holdings whereas a world asset class includes U.S. holdings.

8. Although the Laddered asset class was simulated by structuring a cash flow match against consolidated insurance lines on business, a preferred methodology would be to structure a Laddered asset class for each insurance line of business such that near perfect negative correlations would be attained between the Laddered asset class and the insurance line of business.

9. Exceptions are noted when the data was unavailable. For example, return data on mortgage backed securities begins in February 1979 due to the newness of the asset class. Also, 30-year Treasuries and high yield fixed income returns data is quarterly as opposed to monthly.

10.An Appendix is available upon request detailing the optimal asset allocation for nine positions on the efficient frontier ranging from an expected after-tax return on equity of 11.0% to 16.0%, although any intermediate targeted return on equity can be derived.

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