FOUNDATIONS OF CASUALTY ACTUARIAL SCIENCE

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Chapter 8 - Special Issues

Part 1 - Investment Issues in Property-Liability Insurance

Section A - Investment Income

The property-liability insurance industry has traditionally segregated operating divisions and returns into two components, underwriting and investments. The concentration of most insurance textbooks, allocation of personnel and management attention has been on the underwriting side of operations. In many cases this emphasis on underwriting has led to neglect of investment operations. Until recently investment income was generally not considered in ratemaking. This neglect has tended to produce an investment strategy for insurers that is often inefficient and uncoordinated with underwriting performance. In insurance companies investment departments tend to be understaffed and investment managers undercompensated relative to other investment organizations such as stockbrokers and pension fund managers.

One reason for the relative neglect of the investment side of property-liability insurance operations was the comparative stability of underwriting profitability and net investment income, the value commonly used by insurers to describe investment performance. Figure 8-1-A-1 illustrates the underwriting profit or loss and net investment income for the period 1926 through 1986 for stock property-liability insurers. As is easily seen, the net investment income is much less volatile than the underwriting profit or loss value. The variability of underwriting profitability led to an emphasis on this aspect of insurance operations as insurance managers concluded, perhaps erroneously, that close attention to the underwriting aspect of operations could minimize the adverse results and increase the likelihood of favorable results. The rapid growth of investment income during the 1970s, resulting from both higher rates of return and longer loss payout patterns, prevented the industry from neglecting investment income any longer. Concurrently with the rapid growth in investment income, some regulatory authorities mandated the inclusion of investment income in the ratemaking methodology. By the mid 1980s investment income has become recognized, by necessity, as an equally important component of insurance operating results as underwriting income. The purpose of this section is to describe the typical investments of property-liability insurers, define investment terminology and discuss the role of investment income in pricing property-liability insurance.

As of the end of 1986, the property-liability insurance industry had a total of $374 billion in admitted assets. Admitted assets are those recognized by statutory accounting conventions which tend to be conservative in valuing assets. Invested assets at the end of 1986 comprised approximately $314 billion. The allocation of admitted assets among investment alternatives and other categories is displayed in Figure 8-1-A-2.

Bonds

Bonds, including U.S. government, municipal (state and local government

units) and industrial issues, represent the primary investment medium for the property-liability insurance industry. Bond investments have several characteristic attributes. Bonds typically consist of principal, which is the amount paid to the bondholder at the maturity date, and coupons, which are the periodic interest payments to the bondholder. However, bonds that have no maturity date (perpetuities) exist as do bonds that pay no current interest (zero coupon bonds). In most cases, the principal and coupon rate are fixed. However, a very few bonds determine the redemption value of the bond by reference to changes in the value of gold or prices in general. Variable interest rate bonds are available in which the coupon rate changes in line with current interest rates.

If an investor purchases a bond at issuance, the price is usually close to the principal value. The coupon rate produces an income stream that approximates the current interest rate on investments with similar risk and maturity. Any difference between the coupon rate and market interest rates is reflected in a price differential between the cost and principal. After issuance, changes in interest rates affect the market value of the bond. If interest rates were to rise, an investment yielding the prior, lower rate of interest would not be worth as much as it was previously. Thus, the market value of the bond would decline. Conversely, the market value of outstanding bonds rises as interest rates fall. The market value of any fixed income investment can be determined from the present value formula:

$$(1) \quad PV = \sum_t CF_t/(1+r)^t$$

where PV = present value
CF = cash flow from investment (coupon or principal)
r = current rate of return
t = time until cash flow is received

Insurance accounting uses an amortized value for fixed income investments rather than market value accounting. The amortized value is determined by equation (1) with the rate of return applicable at the time the asset was purchased used instead of the current interest rate. Theoretically, equation (1) with the current rate of return used as the interest rate would yield the current market value. The amortized value gradually adjusts the value of the bond from the purchase price to the principal over the maturity of the bond. The justification used for this treatment is that it prevents the value of insurers' assets, and therefore surplus, from fluctuating with changes in interest rates. The major drawback of the use of amortized values is that they do not reflect the current price in the market. If an insurer sold bonds, the market value would determine the proceeds. Although insurers frequently hold bonds until maturity, when an insolvency arises and bonds have to be sold, the market value reflects the proceeds that will be received.

The interest received on corporate and U. S. government bonds is fully taxable under federal income tax regulations. Prior to the Tax Reform Act of 1986 (TRA), interest received on municipal bonds was exempt from federal income taxation. The revised tax law subjects 15 percent of municipal bond interest on bonds purchased after August 7, 1986, to regular income taxation. The Alternative Minimum Tax (discussed later) increases the taxable portion of municipal bond interest, depending on the interaction of underwriting gains or losses, taxable investment income, tax preference items and municipal bond interest. Traditionally, property-liability insurers invested heavily in tax exempt securities, although during the mid 1980s insurers' investment

portfolios shifted more heavily to taxable issues as statutory underwriting losses served as a tax shield for otherwise taxable investment income. The ratio of state and municipal bond investments to total admitted assets for 1986 was 8.7 percent, and the ratio of special revenue bonds, many of which also enjoyed tax exempt status prior to TRA, to admitted assets was 20.9 percent. These percentages are likely to decline as a result of TRA.

In addition to interest income on bonds, investors may also incur gains or losses on the value of the bond itself. Realized gains or losses on fixed income investments, which are the difference between the selling price and the purchase price, are fully taxable for all types of bonds in the year the bond is sold or redeemed. This provision provides for tax deferral on changes in the market values of bonds. The market value of bonds moves inversely to interest rate changes. Thus, depending on recent directions on interest rates, insurers may have a substantial amount on unrealized gains or losses that can be sold as part of a tax minimization strategy. These sales need to be coordinated with expected underwriting results to achieve this objective.

Investors in fixed income securities are accepting investment risk and, as such, require a return commensurate with the level of risk. Investments in low risk debtors, such as the U. S. government, generate lower yields than those in more risky debtors. Corporate bonds yield more than U. S. government bonds, and corporations with a low credit rating pay higher interest rates than more solvent firms. Similarly, the length of time until the debt will be redeemed also reflects different levels of risk. Thus, bonds of the same issuer with different maturities will provide different yields. The plot of yields versus time to maturity is known as the yield curve.

Normally, the yield curve is upward sloping, meaning that longer term securities have higher yields than shorter term ones. However, occasionally the yield curve is inverted, with shorter term debt yielding more than longer term securities. This inverted yield curve usually results from an upward spurt in the rate of inflation that investors expect to subside in the long run or from short term capital shortages from an expanding economy.

In order to take advantage of the usual higher yields on longer term issues, the property-liability insurance industry is normally heavily invested in long term debt. The maturity distribution of bond investments for the industry is shown in Figure 8-1-A-3. The advantage of a long term investment portfolio is that it locks in current interest rates making investment income less volatile and usually higher than the short term securities yield. The major disadvantages are that it locks insurers into historic rates of return when interest rates rise, and that the market values of long term bonds are more volatile than shorter term securities.

The long term fixed income investment strategy highlights one problem with the lack of coordination between underwriting and investments. An unexpected increase in inflation adversely affects underwriting performance by increasing loss costs above the levels anticipated when rates were set. The market values of long term bonds are reduced by an unexpected increase in inflation, which tends to push interest rates up. Thus, both underwriting and investments are adversely affected by increases in inflation. Conversely, both areas are favorably affected by declines in inflation. An investment strategy that hedged the impact of inflation on underwriting could be implemented, which would reduce the total risk of the insurer. Consideration of such a coordinated strategy by increasing actuaries' awareness of investment

operations is one objective of this chapter.

Equities

The second largest component of insurance company investments is in common and preferred stocks, commonly termed equities. Shares of stock represent ownership interests in the firms, as opposed to the debtor/creditor relationship generated by bonds. Common stock is the primary ownership interest in the firm; preferred stock is a hybrid between a direct ownership interest and a fixed income investment. Preferred stock pays a predetermined dividend rate. The dividend can be omitted or reduced, but, generally, dividends to common stockholders cannot be paid until the preferred stockholders have been paid in full for any back dividends. Some preferred stock is convertible to common stock at a predetermined ratio. Without the convertibility feature, the prices of preferred stock fluctuate in line with bond prices rather than with stock prices. Preferred stock is an outgrowth of tax regulations that exempt a portion of stock dividends from corporate income taxation. Prior to TRA this tax-exempt portion was 85 percent; TRA reduced this value to 80 percent. Dividends on common stocks are subject to more volatility than those of preferred stocks. These dividends can be raised or lowered, or omitted without any obligation to restore prior levels or pay omitted values. The total return on common stocks consists of the dividends, if any, and price changes. In general, the common stock investor expects price appreciation to supplement the dividend income to produce a rate of return in excess of bond yields, as common stocks are more risky investments than fixed income securities. The actual rate of return on common stock investments has been both higher and more volatile than on fixed income securities. The average rates of return and standard deviations for common stocks and bonds by type are displayed in Figure 8-1-A-4 for the period 1926 through 1981.

Although bonds are stated at amortized value for statutory accounting purposes, stocks are stated at market value. Thus, changes in stock prices flow directly into surplus. However, unrealized gains or losses have not been subjected to taxation. Thus, if an insurer were to sell appreciated stock and incur taxes, the actual surplus would be less than the statutory value just prior to the realization of the gains.

Real Estate

Although insurance companies are allowed considerable leeway in real estate investments, several statutory provisions limit the usefulness of this form of investment. Statutory requirements that vary by state establish upper limits on the amount of real estate holdings that are allowed as admitted assets. Any excess real estate investments are non-admitted, and thus are not included in surplus. Also, real estate investments are valued at the lower of net book value (cost less depreciation) or market value. These restrictions explain the rather low level of real estate investments by the property-liability insurance industry.

Real estate has traditionally been viewed as an inflation hedge for investors. As insurers are adversely impacted by inflation on underwriting operations, real estate investments may serve to reduce overall corporate risk. However, the severe valuation and investment restrictions discourage such investments. Under current regulations, the potential benefits from real estate investments must be weighed against the statutory drawbacks.

Regulations that tend to reduce the desirability of holding a fully diversified portfolio reduce investment flexibility and may prevent the use of optimal portfolio choices. More enlightened regulation may be enacted in the future that allows full utilization of all investment possibilities for insurers to manage risk optimally.

Other Investments

A small portion of property-liability insurers' assets are invested in mortgage loans, collateral loans, cash and miscellaneous assets, including oil and gas production payments, transportation equipment, timber deeds, mineral rights and motor vehicle trust certificates. Insurers are now allowed to invest in options and futures based on regulations in some states. Options represent the right, but not the obligation, to buy or sell a financial asset at a predetermined exercise price within a given time period. Financial futures are obligated transactions that will be consummated at a later date. Although the prices of options and futures are extremely volatile by themselves, investment strategies utilizing options and futures can reduce overall investment risk. Insurers are now beginning to adopt some of these approaches.

Investment Income

The total investment income of the insurance industry is segregated into several categories and reported separately in financial reports. The net investment income earned category is reported in the Underwriting and Investment Exhibit Part 1 of the Annual Statement. This value consists of all interest, dividend and real estate income earned during the year (adjusting for unpaid accruals) less all investment expenses incurred and less any depreciation on real estate.

Net realized capital gains and losses consists of any difference between the net sale price and the net purchase price of bonds, stocks or any other investment assets and is determined in Part 1A of the Underwriting and Investment Exhibit of the Annual Statement. These gains or losses can be realized as a result of a sale of an asset or upon the maturity of a bond. Net investment gain or loss is the sum of the net investment income earned and the net realized capital gains or losses. This total is displayed in the Annual Statement on line 9A of the Statement of Income on page 4 of the Annual Statement.

Net unrealized capital gains and losses are also determined on Part 1A. These consist of adjustments in book value resulting from market value changes (for equities) or amortized value changes (for bonds) and any gain or loss from changes in the difference between book value and admitted value. Thus, this value is a combination of actual price changes on equities, amortization on bonds and statutory accounting conventions. The entire net unrealized gain or loss flows directly into the surplus determination as listed on line 23 of the Statement of Income in the Annual Statement. The future tax consequences of the eventual realization of these gains or losses is not taken into account.

When investment income is considered in insurance ratemaking, either formally in the regulatory process or informally in company deliberations, the determination of the rate of return on investments must be established. Generally, one of two measures of investment income is used, the portfolio rate or the new money rate. The portfolio rate of return is determined by dividing

the net investment income earned by the statutory value of investable assets, usually determined by averaging the beginning and ending values. This measure ignores capital gains, either realized or unrealized. As statutory, rather than market, values are used for investable assets, this becomes a weighted average of past fixed income investments. If market values were used to determine the portfolio rate of return, the value of the investable assets would change in line with changes in interest rates, so the portfolio rate of return would approximate the new money rate.

New money rates of return reflect the current rate of return only, ignoring historic returns that the insurer may have locked in. The new money rate reflects current market conditions and indicates the rate of return the insurer is likely to obtain on any funds generated for investment purposes by writing policies. This rate of return is for fixed income securities, and does not apply to equity investments.

Impact of Investment Income on Pricing

From the promulgation of the 1921 standard profit formula until the mid 1960s, investment income was virtually ignored in insurance ratemaking. In establishing the 5 percent underwriting profit benchmark, the majority report of the Fire Insurance Committee of the National Convention of Insurance Commissioners concluded that "no part of the so-called banking profit (or loss) should be considered in arriving at the underwriting profit (or loss)." The model bill for state rate regulation approved by the National Association of Insurance Commissioners in 1946, in the wake of the McCarran-Ferguson Act's affirmation of the rights of states to regulate insurance, included the provision that "due consideration shall be given ... to a reasonable margin for underwriting profit and contingencies..." All but eight states adopted the model bill including this provision. The other eight states excluded the word "underwriting." Despite the different statutory language, by the early 1960s a 5 percent underwriting profit margin was the normal loading for all lines except workers' compensation.

During the 1960s, Florida, Maryland and Virginia began to require the consideration of investment income in ratemaking. A 1969 New Jersey Supreme Court decision ruled that investment income could not be ignored in setting insurance rates and remanded the case to reconsideration by the insurance commissioner. That ruling led to the New Jersey Remand Decision of 1972 which established a fair rate of return for an insurer and reduced that value by the policyholders' share of investment earnings. The policyholders' share of investment earnings is measured by multiplying the insurer's portfolio rate of return by the unearned premium and loss reserves less deductions for prepaid expenses. Considerable controversy has ranged in New Jersey over both the determination of the fair rate of return for insurers and the application of the specific formula for arriving at the target underwriting profit provision.

Beginning in 1975 rate regulatory hearings in Massachusetts began to require the inclusion of investment income. Protracted hearings led to the introduction of the Capital Asset Pricing Model (CAPM) into insurance ratemaking. The basic formula of the CAPM is:

$$E(r_A) = r_F + \beta\,(E(r_M) - r_F)$$

where r_A = return on an asset
r_F = risk free rate of return
r_M = return on the market portfolio
β = systematic risk of asset
E = expectation operator

Applying the CAPM to insurance pricing leads to the following (for the specific derivation see the Fairley paper included in Cummins and Harrington):

$$E(r_U) = -k(1-x)r_F + \beta_u (E(r_M) - r_F)$$

where r_U = underwriting profit margin
k = investable funds per dollar of written premium
x = expense ratio
β_u = systematic underwriting risk

The theory behind the CAPM is that the equity markets are controlled by well diversified investors that are not concerned about the total risk (volatility of price) of an individual asset any more than an insurer is concerned about the risk of an individual policy. The law of large numbers assures that independent volatility will be of no consequence in the total risk of a portfolio of either individual investments or policies. The factor that does concern investors is the systematic risk, or that risk that cannot be diversified away. Based on the assumption that insurers are owned by such diversified investors (which may not hold for mutual insurers), this theory leads to the conclusion that only systematic underwriting risk needs to be considered in pricing insurance products.

A number of problems arise in applying the CAPM to insurance pricing. Market values of beta cannot be determined for individual lines since no single line insurer is publicly traded. Instead, accounting data is used to generate an assumed beta by measuring the fluctuations in reported underwriting profitability in line with stock market movements. No proof exists that accounting data can be used to determine betas for use in the CAPM. In addition to this problem, the betas calculated from accounting data are not stable over time, so use of a beta determined from historical data is unlikely to be valid for the ratemaking horizon.

Other methods for including investment income in ratemaking have also arisen as alternatives to the New Jersey Remand methodology and the CAPM. One method commonly used by insurers is termed the total rate of return model. The common application of this technique is to select a target rate of return for a given line of insurance either after analyzing its volatility or by use of a company wide standard. The contribution of investment income toward this total return is then projected, usually by multiplying the portfolio rate of return by the expected holding period for premium income, and subtracted from the target total return. The remainder of the target needs to be obtained from underwriting, providing a target underwriting profit margin. The major weaknesses of this approach are determining the proper target return and the use of portfolio rates of return to determine the investment income contribution.

Another approach that has been proposed in regulatory hearings is termed discounted cash flow analysis. Under this technique all of the cash flows

emanating from writing a policy are projected, period by period. The cash flows include premium income, expenses, taxes and loss payments. All cash flows are discounted to the beginning of the policy term by the appropriate discount rate. The primary drawback of this technique is the determination of the appropriate discount rate. One advocate of this technique proposed discounting losses and expenses by the CAPM determined discount rate ($E(r_A)$) and taxes by the risk free rate.

The Florida Insurance Department adopted a ratemaking methodology in 1987 that combines investment income in the determination of the allowable underwriting profit margin by discounting premium income and loss payment patterns. Under this procedure an insurer calculates the investment income opportunities for all sublines and sets the target underwriting profit margin for the subline with the smallest value at a level no larger than 5 percent. The investment income opportunities are determined by multiplying the estimated portfolio rate of return for the insurer by the average length of time the funds will be held before losses are paid. The allowable underwriting profit margin for each subline other than the one with the smallest investment income opportunity is determined by subtracting the investment income differential from the initial target underwriting profit margin.

The various methodologies for including investment income in the determination of an allowable underwriting profit margin have the advantage of producing specific indications which can be used to establish rates. However, each method is subject to criticism for ignoring certain circumstances or requiring a value to be estimated that is difficult or impossible to obtain. An alternative school argues that investment income should be given indirect consideration, rather than be attempted to be included directly in the ratemaking process. The arguments in favor of this position are:

1. no formula approach is recognized as producing the correct results in all situations
2. the effect of competition on insurance prices is ignored in ratemaking formulae, but is crucial to the ability of an insurer to charge a particular rate level
3. if rates in a particular market are producing an excessive rate of return for insurers in total then new entry will drive the price down to the proper level
4. if rate levels are inadequate to produce an acceptable rate of return in total then insurers will exit from the market until price levels increase to the acceptable level
5. analysis of the difference in rate levels in prior approval and open competition states indicates that there are no significant differences in profitability over any extended time

The conclusion of these observations is that financial and insurance markets will work to produce the proper total rate of return for insurers, without the need for complicated formula adjustments. Although this may be true in the long run, the notorious underwriting cycle (the consistent pattern of fluctuation between profitability and losses for underwriting results as depicted in Figure 8-1-A-1) indicates that severe market distortions are caused as the market moves toward equilibrium. Exits and entry take time to affect prices. Thus, the slowness of market adjustments needs to be weighed against the inaccuracies of any rigid formula approach to insurance pricing problems.

Having a valid model is not necessary for the insurance industry to

function, just as stocks were traded for a long time before the CAPM arose to explain security returns. Tests of the validity of the CAPM for pricing financial assets are based on how well it explains historical returns for securities. Similarly, the validity of any insurance pricing model depends on how well it explains the prices actually charged. Using the model to determine regulated prices should be redundant if competitive forces are at play. If the model is correct, then why would it be necessary to force insurers to charge that price? This action is similar to requiring investors to buy and sell securities at prices determined by a theoretical model and not allowing the market to establish prices independently. The model rests on being able to explain prices, and not on prices being set by the model.

However, having an accurate insurance pricing model would be a substantial benefit. Although prices should move toward equilibrium in the long run, a valid model would allow insurers to price accurately in the short run as well. This increase in pricing accuracy would not prevent insurers from periodically undercharging or overcharging the equilibrium price, and thus would not eliminate the underwriting cycle. Nevertheless, a valid pricing model would allow insurers to determine the appropriate price level and might reduce the degree of fluctuations in results.

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Figure 8-1-A-1
Underwriting Profit or Loss and Net Investment Income
Stock Property-Liability Insurers
1926-1986

Figure 8-1-A-2
Distribution of Admitted Assets-1986

Bonds	
U. S. Government	15.7%
State, Municipal, etc.	8.7
Special Revenue	20.9
Industrials	8.9
Other	3.0
Subtotal-Bonds	57.3
Stocks	
Industrials	7.3
Affiliated Companies	4.2
Other	2.7
Preferred	2.1
Subtotal-Stocks	16.3
Mortgage Loans	1.2
Real Estate	1.0
Cash	1.5
Short Term Investments	6.0
Other Invested Assets	0.6
Premium Balances	8.0
Other Assets	8.1
Total	100.0

Figure 8-1-A-3
Maturity Distribution of Bond Investments-1986

Maturity	Allocation
1 Year or Less	3.6%
1 to 3 Years	11.4
3 to 5 Years	12.2
5 to 10 Years	24.7
10 to 15 Years	15.6
15 to 20 Years	13.1
Over 20 Years	19.4

Figure 8-1-A-4
Total Annual Rates of Return: 1926-1981

	Geometric Mean	Arithmetic Mean	Standard Deviation
Common Stocks	9.1	11.4	21.9
Long Term Corporate Bonds	3.6	3.7	5.6
Long Term Government Bonds	3.0	3.1	5.7
U. S. Treasury Bills	3.0	3.1	3.1

Part 1 - Section B
Investment and Tax Strategies

In a typical property-liability insurance company, the underwriting and investment operations are run separately. Each area attempts to maximize returns independently of the other. Although the two areas are inextricably linked operationally - the underwriting area provides the cash flow for investment and generates the need for cash to pay expenses and claims and the investment area generates investment income from the funds in the interim - prior to the mid 1980s, few insurers actively coordinated the two activities. In this section, several strategies that link underwriting and investment operations will be discussed.

Asset-Liability Matching

The investment strategy behind asset-liability matching is to invest funds for exactly as long as they will be held. If a certain amount of funds will be needed in six years to pay claims, then investments would be made that would generate that amount in six years. If longer term bonds were held, then the insurer would have to sell the bonds when the funds are needed, creating the possibility of a gain or loss on the sale depending on interest rate fluctuations. A shorter term investment would be readily available when the funds are needed, but prior to that time the funds would have been continually reinvested at the then available interest rates, exposing the insurer to interest rate risk during the interim. By locking in the current rate of return for the applicable holding period, the insurer eliminates interest rate risk.

Financial institutions such as banks and life insurers utilize asset-liability matching more heavily than property-liability insurers. By matching assets and liabilities banks, for example, avoid the problem of investing long term (fixed rate mortgages), while borrowing short term (passbook savings accounts and short term certificates of deposit). If assets and liabilities were not matched, banks would be exposed to interest rate risk where a rise in interest rates would increase the cost of funds but does not increase the investment income.

If a property-liability insurer were to adopt asset-liability matching, the payout pattern on existing liabilities would be matched by an investment portfolio that produced the cash flow as needed. Changes in interest rates would not affect the availability of cash as the desired flow would be locked in.

Two arguments are raised against the need for property-liability insurers to adopt asset-liability matching. First, in most situations the cash inflow in a given period from new and renewal policies is adequate to pay all losses and expenses. Even if premium receipts were not enough to pay all losses and expenses, they are predictable enough to avoid the need to generate all cash needs from investments. A small margin of liquid assets could prevent an insurer from incurring losses on premature sale of assets.

The second argument against asset-liability matching revolves around the predictability of payout patterns for property-liability insurers. For banks the values of liabilities are fixed and the maturity dates of savings accounts are known. For insurers, the loss costs and payout dates are not certain, but must be estimated. Future inflation rates could affect the value of losses. An investment strategy that generates a predetermined amount of cash at a set

time may not match the need for cash as the loss payouts develop. Since a rise in the rate of inflation would most likely increase the cost of losses while, at the same time, increasing interest rates, a more appropriate hedging strategy for a property-liability insurer might be to invest in maturities shorter than the indicated need for cash in order to reinvest at interest rates that more closely approximate the underlying rate of inflation that affects loss costs.

Duration

The commonly used measure of maturity for fixed income investments is inappropriate for analyses of interest rate risk because it focuses on the time when the principal will be repaid. However, during the time until maturity, the asset will be generating interest income which is either used by the asset holder or reinvested at the then current interest rates. The effective yields based on market valuation on two bonds with the same maturity dates but different coupon rates would be the same under stable interest rates but would differ in volatile interest rate times.

The duration of a security is the weighted average of the length of time until payments will be received by the holder. Duration is calculated as follows:

$$D = \frac{\sum_{t} C_t(t)/(1+r)^t}{\sum_{t} C_t/(1+r)^t}$$

Where C_t = interest or principal payment at time t
(t) = length of time to payment
n = length of time until maturity
r = yield to maturity

The denominator of the equation is the present value of the fixed income investment. The numerator is the present value of the payments weighted by the length of time until they are paid. The higher the duration, the longer into the future the payments will, on average, be received.

To illustrate the concept of duration, two $1000 face value bonds, each with a remaining maturity of five years and annual coupon payments, will be used. The first bond has a coupon rate of 6 percent and the second 12 percent. Each has a yield to maturity of 9 percent, reflecting current interest rates on five year bonds. The duration of the first bond is calculated by:

$$D_1 = \frac{\frac{(60)(1)}{1.09} + \frac{(60)(2)}{(1.09)^2} + \frac{(60)(3)}{(1.09)^3} + \frac{(60)(4)}{(1.09)^4} + \frac{(1060)(5)}{(1.09)^5}}{\frac{60}{1.09} + \frac{60}{(1.09)^2} + \frac{60}{(1.09)^3} + \frac{60}{(1.09)^4} + \frac{1060}{(1.09)_5}}$$

$D_1 = 3909.70/883.32 = 4.426$

The duration of the second bond is calculated similarly, except the coupon is 12 percent, or 120 per year, rather than 60 per year.

$$D_2 = \frac{\frac{(120)(1)}{(1.09)} + \frac{(120)(2)}{(1.09)^2} + \frac{(120)(3)}{(1.09)^3} + \frac{(120)(4)}{(1.09)^4} + \frac{(1120)(5)}{(1.09)^5}}{\frac{120}{1.09} + \frac{120}{(1.09)^2} + \frac{120}{(1.09)^3} + \frac{120}{(1.09)^4} + \frac{1120}{(1.09)^5}}$$

$D_2 = 4569.74/1116.68 = 4.092$

The duration of the second bond is less than the duration of the first bond because the interim payments are larger. The weighted average of the date of the receipt of cash from the second bond is sooner than that of the first bond.

Duration is commonly calculated on fixed income assets in which the coupon payments and principal are known. For property-liability insurers, the duration of liabilities, particularly loss reserves, can also be determined, although not with certainty. In this context the duration of liabilities would simply be the weighted average of the length of time until the payments will be made.

Immunization

Immunization of a portfolio is any strategy that eliminates price risk and coupon reinvestment risk on a fixed income portfolio. Asset-liability matching is one method of immunization, but it requires an exact balancing of income from investments against cash needs. A less restrictive method of immunization is for the duration of the investment portfolio to equal the duration of the cash flow needs, or the duration of the assets to equal the duration of the liabilities.

On an immunized portfolio interest rate changes affect the two investment risks in offsetting ways. A rise in interest rates lowers the market price of outstanding bonds, but allows reinvestment of income to be made at a higher rate, preventing a change in eventual cash flow. A drop in interest rates raises the price of outstanding bonds but reduces the reinvestment rate. Thus, the predicted amount of cash can be available when needed.

The immunization strategy can be thwarted if the yield curve changes shape. If short term interest rates fall proportionately more than long term rates, the reinvestment rate will drop more than the price of outstanding issues will increase. Theoretically, the investment portfolio can be adjusted continually to minimize such distortions, but this increases the cost of this strategy. Also, the liabilities of property-liability insurers can differ from the original forecast, making even an immunized portfolio inadequate to meet the new cash flow needs.

Taxation

The Tax Reform Act of 1986 (TRA) dramatically changed the income tax regulations for the property-liability insurance industry. The overall effect of this new law is still uncertain and many of the interpretations of statutory language are in the process of being clarified. The major provisions of TRA will be discussed here, but the reader is urged to refer to more complete and timely sources for a full explanation of this watershed tax legislation.

The stated goal of TRA is to raise $7.5 billion in tax revenue from the property-liability insurance industry over the five year period 1987-1991. One provision of TRA is the delegation of a study to determine if that revenue goal

is being met and to recommend any necessary changes in the tax law to achieve this target figure. One reason for the concentration on tax revenue is the federal budget deficit, currently running in the $150-200 billion level annually. The property-liability insurance industry was the target of such a significant change in tax regulations as a result of the failure of the prior tax code to produce any significant revenue from the industry. In fact, during the five year period 1982-1986, the property-liability insurance industry in aggregate recouped $6.2 billion in taxes previously paid. The sudden shift from recouping an average of $1.2 billion in taxes per year to paying $1.5 billion per year is bound to cause severe distortions and market tightening, as well as require price increases industry wide.

In addition to the aggregate negative tax position of the property-liability insurance industry, several other situations called attention to the industry during the 1986 version of tax legislation. Retroactive insurance was becoming a feasible product, fueled in part by tax subsidies and the differential tax treatment of property-liability insurers. After MGM Grand Hotel suffered a major fire loss, it purchased additional coverage for less than the expected losses. The insurers expected that they could profit from this below cost pricing by immediately establishing loss reserves at the expected loss level and reporting an underwriting loss for tax purposes. This loss generated tax savings which, in addition to the net premium, could be invested until the loss were paid. Thus, the tax code was subsidizing insurers in pricing coverage to the extent that known losses could be covered by insurance more inexpensively than if the non-insurance corporation paid the loss itself. The tax regulations for non-insurance firms allow the tax deduction for losses only when the loss is paid, not when it is incurred. In addition to generating a market for retroactive insurance, this differential contributed to the growth in captive insurance companies as they attempted, unsuccessfully it turned out, to qualify for classification as insurers, that would have allowed the firms to utilize the more favorable rules of deducting losses when incurred rather than when paid.

Another aspect of the insurance industry that focussed the tax reformers' attention on the property-liability insurance industry was the growing practice of loss reserve transfers. Insurers were using this strategy to optimize the use of taxable income and tax loss carrybacks. Under this approach an insurer with an excess of tax losses would sell loss reserves to another insurer in a tax paying position through the use of reinsurance. The first insurer would transfer loss reserves to the second insurer and, at the same time, pay the second insurer a premium that was less than the statutory value of the losses, but more than the present value of those losses. The first insurer would immediately book an underwriting gain equal to the difference between the premium and the statutory loss reserve value. The second insurer would book an underwriting loss, which could be used to offset other taxable income.

The primary provision in insurance tax regulations that generated negative tax payments for the prior five years and promoted retroactive insurance, the growth of captives and loss reserve transfers, was the ability of insurers to deduct the total future value of loss and loss adjustment expense payments on incurred losses as opposed to the economic worth, or present value. Discounting loss reserves at an appropriate rate would alleviate this problem. Although discounting of loss reserves was included in TRA, the mandated discount rate is not necessarily the appropriate rate, and several other far more onerous provisions were included in TRA.

The primary provisions of TRA for property-liability insurers are to:

1. Tax previously tax exempt interest and dividends
2. Include a portion of the unearned premium reserve as taxable income
3. Discount loss reserves for tax purposes
4. Eliminate the Protection Against Loss (PAL) account
5. Apply a strict Alternative Minimum Tax (AMT)

Tax Exempt Interest and Dividends

Municipal bonds have traditionally been exempt from federal income taxation as a subsidy to state and local government units in raising revenue. The property-liability insurance industry has been a heavy investor in such issues. A common investment strategy has been to invest in taxable bond issues to the extent of offsetting any underwriting losses with the remainder of the investment portfolio invested in municipal bonds. This strategy led to the low effective tax rates on property-liability insurers during the past decade.

Common and preferred stock dividends from domestic corporations have also received favorable tax treatment. In order to avoid double taxation of dividends for corporate investors, an income tax deduction of 85 percent of the dividends received was allowed prior to TRA. Under TRA this deduction is reduced to 80 percent of dividends received.

Thus, all municipal bond income and 80 percent of dividend income is exempt from taxation for corporate investors. However, TRA reduces the loss reserve deduction by 15 percent of this otherwise tax free income on any investment acquired after August 7, 1986, in essence taxing 15 percent of this income.

Unearned Premium Reserve

The unearned premium reserve is the prorata portion of premiums that reflect unexpired coverage. As expenses tend to be paid at the beginning of the exposure period and losses generated proportionally over the coverage period, the unearned premium reserve includes a well recognized redundancy to the extent that the reserve reflects previously paid expenses. This redundancy is commonly termed the "equity in the unearned premium reserve." This "equity" varies depending on the individual insurer's expense ratio and expected loss ratio. Accordingly it would be highest for lines of business and insurers with high expense ratios and lowest for lines and insurers with low expense ratios. This distinction is not recognized under the revised tax regulations. Under TRA 20 percent of the change in the unearned premium reserve will be included in taxable income. In addition, 20 percent of the unearned premium reserve as of December 31, 1986, will be included in taxable income ratably over the six year period beginning in 1987. Thus, for 1987 taxable income will include 20 percent of the change in unearned premium reserve from 12/31/86 to 12/31/87 plus 3.33 percent (one-sixth of 20 percent) of the 12/31/86 unearned premium reserve.

Loss Reserves

Prior to TRA, statutory loss and loss adjustment expense reserves were used to calculate taxable income. These statutory values are intended to be the total undiscounted value of all loss and loss adjustment expense payments to be made in the future for losses that have occurred prior to the evaluation date. By not adjusting for the present value of these payments, a payout to be

made in ten years is valued equally with an imminent payout.

TRA requires discounting of loss and loss adjustment expense reserves for determining taxable income. The interest rate to be used for discounting is the five year moving average of the Applicable Federal Rate on three to nine year securities, but months prior to August, 1986, are not included in the calculation. For 1987 the average rate for the months August, 1986, through December, 1986, is to be used. This rate is 7.20 percent. For 1988, the average rate for August, 1986, through December, 1987, will be used.

The payment pattern for loss and loss adjustment expense reserves can be either the pattern promulgated by the Treasury Department, based on industry experience through 1985 as reported by A. M. Best, or a company's individual experience. Whichever choice an insurer makes for determining 1987 taxable income will be binding for five years. The payment pattern determined by the Treasury Department will not be updated during that five year period. An insurer selecting to use its own payout pattern must update the values each year, but only with respect to the new accident year. Payout patterns on prior years cannot be changed, even if the loss development pattern differs from the original projection.

A fresh start approach is applied to discounting loss reserves. For 1987 the discounted loss and loss adjustment expense reserves for both beginning and ending reserves will be calculated and the difference included in the taxable income determination. Without the fresh start approach, ending reserves would have been discounted but not beginning reserves, which would have substantially increased taxable income for 1987.

Protection Against Loss (PAL) Account

Prior to the TRA, mutual property-liability insurers were allowed a tax deduction for contributions to a fund that could be drawn upon as needed in times of unprofitability. This fund, termed the Protection Against Loss (PAL) fund, was justified based on the inability of mutual insurers to raise capital by issuing equity, as stock insurers could do if additional funding were required. Maximum contributions were related to premiums written. The deduction for PAL accounts is repealed starting in 1987. Amounts in existing PAL accounts can continue to be treated as provided by pre-TRA provisions: 1) the accounts are accumulated until offset by taxable losses, 2) amounts not absorbed by the fifth year are included in taxable income except for one-half of 25 percent of underwriting gains, 3) any continuing amount is included in taxable income when the insurer ceases to qualify as a mutual insurer.

Alternative Minimum Tax (AMT)

The more stringent provisions of the Alternative Minimum Tax regulations will entail most property-liability insurers' calculating two sets of taxes and paying the higher. The regular tax is calculated on the regular taxable income; the AMT is calculated from the alternative minimum taxable income (AMTI). The AMTI is determined by adding tax preference items to the regular taxable income. These preference items include:

1) book income versus taxable income
2) certain tax exempt income
3) accelerated depreciation

Book income will normally be the annual statement income after dividends to policyholders but before income taxes. However, if GAAP statements are filed with the Securities and Exchange Commission or audited financial

statements used for other purposes, these income values take precedence over annual statement data. The tax preference item for the years 1987 through 1989 is 50 percent of the difference between the book income and the AMTI excluding this item. After 1989 the preference item will be 75 percent of the difference between adjusted current earnings and AMTI before this adjustment. The definition of adjusted current earnings is not clear at the time this is being written (early 1988).

Tax exempt interest on certain private activity bonds (e.g., industrial development bonds) issued after August 7, 1986, is included as a tax preference item. Also, any depreciation taken in excess of the 150 percent declining balance method for tangible personal property or over 40 year straight-line depreciation for real property will be included as a preference item.

Tax and Investment Strategies

An entirely new operating strategy for property-liability insurers emerges as a result of TRA. Insurers will pay the larger of the regular tax or the AMT. Net after tax income is maximized when the two taxes are equal. Thus, insurers should manage their investment portfolios by shifting assets between taxable and tax exempt investments depending on the relative yields and the company's tax calculations. Projected underwriting losses, based on discounted loss reserves and including part of the unearned premium reserve as income, will indicate the optimal investment mix. The need for coordination between underwriting and investment operations will be increased. Actuaries will most likely be involved in developing this strategy as underwriting results must be forecasted and loss reserves discounted. This new role for actuaries increases the need for actuaries to master investment and tax issues.

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Part 1 - Section C
Rate of Return Measures

In order to quantify the profitability of the property-liability insurance industry, users of financial data have developed a number of measures that are relied upon to provide some insight into current and past operating results. Some of these measures are easy to calculate, and others are more complex. Some measures are widely used, whereas others are applied only in the more complex rate regulatory hearings and in sophisticated company analyses. This section will describe several of these measures, discuss the meaning of the values and analyze the strengths and weaknesses of the measures.

Combined Ratio

The combined ratio is determined in two different ways. It can be calculated as the sum of the loss ratio and the expense ratio or as this sum less the policyholders' dividends ratio. The loss ratio is determined by dividing the incurred losses, including loss adjustment expenses, by the earned premium. The expense ratio is calculated by dividing expenses by the written premium. The policyholders' dividend ratio is determined by dividing dividends by earned premium. The combined ratio is thus involves combining ratios with different denominators, in a sense a mixture of apples and oranges.

The combined ratio is calculated in the foregoing manner to make an adjustment for the different rates at which losses and expenses tend to be incurred for property-liability insurers. Losses tend to be incurred evenly over the coverage period for most lines of business. If a policy is for an annual term, then, except for slight seasonal patterns, losses are likely to occur evenly over the year. One-twelfth of the losses are expected to occur in the first month the policy is in force, one-half by the middle of the exposure period, and so forth. Therefore, losses that have been incurred are divided by the earned premium to determine the portion of the premium expended on losses to date.

Conversely, expenses for such items as commissions, premium taxes, policy coding costs and overhead, tend to be incurred as soon as the policy is written. These expenditures are not recurring over the policy term. Thus, the expenses are divided by the premium written to determine the portion of premiums that are used to cover expenses.

For an insurer that is writing a constant premium volume, eventually the written and earned premiums will be equal. Thus, the use of the different denominators in the combined ratio will not have any effect. However, most insurers do not write a constant level of premiums. During inflationary periods, even an insurer not writing any increase in exposures will be experiencing an increase in written premium. In general, the written premium exceeds the earned premium unless an insurer is scaling back operations either in a given state or nationally. The combined ratio adjusts the expenditure pattern to reflect the different rates of payouts for losses and expenses for this normal difference.

The combined ratio is easy to calculate and widely used within companies and in public discussion of insurance profitability. Figure 8-1-C-1 shows the

combined ratio including dividends to policyholders for the period 1939 through 1986 for all stock property-liability insurers. This graph show that the combined ratio fluctuates considerably and the levels during the mid 1980s were unusually high. Many industry publications concentrate on the combined ratio as a measure of financial health of the insurance industry. Levels below 100 indicate that an insurer, or the industry, is paying out less in losses, expenses and dividends than it is taking in as premium, and therefore is profitable. Levels in excess of 100 indicate that expenditures exceed premium income. Interpretation of the meaning of such values is difficult and often leads to unsupported statements.

The advantage of the combined ratio as a measure of insurance performance is its simplicity. However, this also leads to its major problem. The combined ratio does not include any provision for investment income in the calculation. As insurers generally pay losses after premium is received, they earn investment income prior to payment of claims. If the delay between receipt of premium and payment of losses were stable among lines and over time, and the interest rate on invested funds were constant, then the contribution of investment income to insurer profitability would be consistent and an easy adjustment to the combined ratio could be made. Unfortunately loss payout patterns vary among lines of business and over time and interest rates have been volatile, especially over the past two decades. Thus, a combined ratio of, for example 110, could be acceptable if the loss payout pattern is slow, as in liability lines, and interest rates high. Conversely if the loss payout pattern is rapid, as in a property line, and/or interest rates at the low end of the cycle over the period, then the same 110 combined ratio could indicate a pricing problem.

Underwriting Profit Margin

The underwriting profit margin is calculated by subtracting the combined ratio from 100. Conversely, the expected loss ratio is often determined by subtracting the sum of the target underwriting profit margin and the expense ratio from 100. This value suffers from the same basic problem as the combined ratio since the underwriting profit margin is calculated from the same data: investment income is not included. Thus, determining the appropriate underwriting profit margin is difficult.

Historically, the property-liability insurance industry sought to achieve standard underwriting profit margins. The industry standard was 2.5 percent for workers' compensation and 5 percent for all other lines. These standards were derived from the 1920 era of insurance regulation and had no mathematical or economic support. By achieving a 5 percent underwriting profit margin, an insurer was, in the long run, retaining 5 percent of sales, which was argued as being a reasonable proportion. This measure was not equated to a return on equity measure. As investment income was not included, it did not reflect total insurance profitability. Also, as different insurers operated at different premium to surplus ratios, total return on equity would vary among insurers with the same underwriting profit margins.

Fluctuations in the underwriting profit margin occur normally as a result of catastrophic losses and other unpredicted developments. The gradual increasing trend of the combined ratio shown in Figure 8-1-C-1 (and therefore the decreasing trend of the underwriting profit margin) is the result of competitive pressures as longer payout patterns and higher interest rates

developed. Negative underwriting profit margins occurred in almost each year since 1973, which some industry spokespersons claimed indicated inadequate rates. Although the statement about inadequate rates may have been true, negative underwriting profit margins do not, by themselves, lead to this conclusion.

Operating Ratio

The failure of the combined ratio and the underwriting profit margin to include the effect of investment income has led to the emphasis on the operating ratio as a profitability measure. The operating ratio is calculated by subtracting the ratio of investment income divided by the earned premium from the combined ratio. Thus, investment income is "included" in the profitability measure.

A number of serious problems still exist in the use of the operating ratio as a measure of profitability. The first problem is the definition of investment income. Some users of financial data include only net investment income earned which consists of interest and dividends received. Other users apply the net investment gain or loss value which includes net realized capital gains and losses as well as the investment income earned. A third possible definition of investment income includes net unrealized capital gains and losses in addition to the other components. Thus, three possible operating ratios can be calculated, leading to considerable confusion.

Regardless of which definition of the investment income is used, potential problems result. The most commonly used definition of investment income is net investment income earned. This is not a realistic measure of investment income for any investment other than very short term debt instruments. Longer term bonds pay interest and also experience fluctuations in value as interest rates and credit conditions change. Thus, the actual rate of return differs from simply the interest received. For investments in equities, the dividend income is generally only a small portion of the total investment income expected. Capital gains are expected to occur to provide the required rate of return commensurate with the investment risk accepted. Similarly, investments in real estate are also expected to produce capital gains.

An insurer could intentionally generate zero dollars of net investment income earned by investing in zero coupon bonds and common stock in firms that do not pay dividends. Such an investment strategy would produce a high operating ratio that would not reflect the investment income potential of the insurer. Thus, some reflection of capital gains is necessary to produce a reasonable measure of investment income. Therefore, the second combined ratio measure includes net realized capital gains and losses with net investment income, the total of which is termed the net investment gain or loss.

The problem with using realized gains and losses to measure investment income is the timing factor involved in this determination. Realized gains and losses occur when an asset is sold, and reflect all the change in value that has occurred since the asset was purchased. If an insurer does not sell any capital assets, then, regardless of the change in values of investments, no capital gains or losses would be recorded. When an asset is sold, though, all of the change in value is reflected in that year, even though all or most of

the change may have occurred in prior years. Thus, unless an insurer is experiencing a constant portfolio turnover and consistent appreciation is asset values, the net realized capital gains and losses value will fluctuate considerably and will not necessarily reflect current investment earnings.

The third measure of investment income includes the change in unrealized capital gains and losses in addition to the net investment gain or loss. By including unrealized gains and losses, all investment performance is reflected in this profitability measure. By adding or subtracting the change in unrealized gains and losses to the net realized gains and losses, only the investment gains experienced during the current year are reflected. Changes in asset values that occurred in prior years would not distort the results.

Several problems still exist with this measure of the operating ratio. One problem is the degree of fluctuation that will occur as a result of changes in equity values. A rapidly increasing stock market will inflate the investment income measure and reduce the operating ratio. A falling stock market will reduce the investment income value. This increased volatility is a cost of fully reflecting investment income in the operating results of insurance companies.

Another problem is that insurance accounting conventions value bonds at amortized values rather than market values. Thus, unrealized capital gains and losses for bonds are not representative of market values but are based on the values when the assets were purchased and the time left until maturity. In this regard the investment income value based on reported unrealized capital gains and losses is not a true market measure.

Another major problem with this third combined ratio measure is the mismatch in the asset base that generated the investment income used in this measure and the earned premium that is used as the denominator in the calculation. To a large extent, the investable assets currently generating the investment income were produced by premium writings in prior years. The loss reserve outstanding comes from both current and prior years' writings. However, all the investment income is being credited against the current year's experience. This distortion will most significantly affect rapidly growing or declining insurers. However, even stable insurers will not have the same loss payout pattern occur in the future as has in the past.

The operating ratios for the insurance industry for the period 1983 through 1986 (the only years that the necessary information is available) based on the net investment income earned, net investment gain or loss and the net investment gain or loss including unrealized capital gains or losses, are shown in Figure 8-1-C-2. These values are calculated from the consolidated industry Annual Statement data published by A. M. Best Company.

Combined Ratio Based on Discounted Losses

The Tax Reform Act of 1986 instituted discounting property-liability loss reserves for tax purposes. Also in 1986 the NAIC created a Working Group on Discounting Loss Reserves to consider changing statutory accounting provisions. The effect of discounting loss reserves is to reflect the time value of money in the reserving process. Undiscounted reserves value loss payments in future years equally with current loss payments. Statutory reserving requirements currently prohibit discounting loss reserves except for periodic payments for Workers' Compensation, which are in essence annuity type claims. The stated rationale for using undiscounted loss reserves is to instill a level of

conservatism into the reported financial position of insurers.

The level of conservatism included by not discounting property-liability loss reserves depends on the loss payout pattern of the line of business and on the general level of interest rates. As the concentration of the industry moved from primarily property to predominately liability insurance, the loss payout patterns lengthened. Also, over the last several decades the general level of interest rates has increased. Thus, the degree of conservatism engendered by not discounting statutory loss reserves has increased. As taxable income was traditionally based on statutory accounting conventions, the federal government's tax receipts from the property-liability insurance industry eroded. Over the decade 1976 through 1986, the industry as a whole did not pay any federal income taxes. The revenue needs of the federal government led to the adoption of discounting for tax purposes.

Discounting loss reserves at an appropriate rate of interest for the calculation of incurred losses would present the relevant economic value of losses instead of simply the sum of the stream of payments ignoring the time value of money. The primary problem is the determination of the appropriate discount rate. Rates that have been proposed include: the current risk free rate as measured by the return on short term U. S. Treasury bonds, the rate of return earned by the industry over a particular recent time interval, the rate of return achieved by the specific insurer over a particular recent time interval or a selected interest rate based on a specific index over a particular time interval. No general consensus exists as to the proper discount rate.

Basic finance theory suggests that the appropriate discount rate should reflect the relevant risk of the loss payment pattern. The Capital Asset Pricing Model would determine this rate based on the systematic risk of loss payout patterns. The Arbitrage Pricing Model would base the rate on the results of a factor analysis of historical experience.

The sparsity of market value information of loss reserves makes the determination of a market driven discount rate difficult. As insurance prices are affected by current, rather than historical, interest rates, the interest rate achievable by the insurer when the policies are written would be a superior measure than the proposals to use moving averages of past interest rates, either general or company specific. Thus, the most valid proposal made to date is to use the current risk free interest rate to discount loss reserves.

Use of the current short term U. S. Treasury bond interest rate to discount the loss payout pattern in the calculation of the incurred loss ratio will have the effect of including the time value of money in the combined ratio. Thus, investment income does not have to be factored in separately, as currently introduced in the operating ratio. The loss payout pattern expected to apply to the current book of business is used. Also, the current market conditions on risk free investments are applied. This measure avoids the distortions caused in the investment income measures when equity and other risky assets experience marked price movements in a given year.

Return on Equity

Corporate financial analysis commonly uses a value termed the return on equity (ROE) to measure profitability. This value is calculated by dividing the net profit after taxes available to common stockholders (after deducting preferred dividends) by the value of the common equity in the firm. The value of common equity is traditionally a book value either at the beginning of the year or the average of the beginning and ending values. The common equity values are not based on market value, although this may be a more appropriate measure.

Return on equity values can similarly be derived for property-liability insurers, but several adjustments are needed. Initially a determination of net profit must be made. This value can be either on a statutory or GAAP basis. Neither profit figure includes unrealized capital gains or losses incurred during the period. For an insurer with significant values in this category, the ROE value would be distorted. However, if unrealized gains or losses were to be included, they cannot simply be added (or subtracted) from the net profit value. The present value of future taxes associated with realization of these gains or losses must be accounted for before an adjustment to the net profit figure is made.

The primary advantage of a return on equity measure is that it allows a comparison of insurance profitability with other industries. All prior profitability measures discussed are specific to insurance companies. Return on equity measures for other industries are readily available for comparison purposes. However, the comparison of return on equity values must be done with care. Many industries have recognized distortions either in the net profit figure or the book values. For example, loan loss reserves for banks are often well below the level needed to absorb problem loans. Also, natural resource firms often carry assets at purchase price rather than market price. For the property-liability insurance industry, the distortions in net profits and book value must be recognized in order to interpret the ROE results meaningfully. Among the problems with insurance financial statements are:

1) the equity in the unearned premium reserve is not recognized
2) bonds are valued at amortized rather than market value
3) loss and loss adjustment expense reserves are carried at the sum of estimated future payments rather than the present value, and the estimates may be inadequate or redundant
4) many assets are not included in statutory surplus, such as nonadmitted reinsurance

Internal Rate of Return

The internal rate of return of an investment is the mathematically determined discount rate that sets the present value of the total cash flow equal to zero. When discounted at the internal rate of return, the present value of the cash inflows equals the present value of the cash outflows. For standard investment decisions, the initial investment outlay is the cash outflow and the subsequent receipts are the cash inflows. The situation is reversed when the internal rate of return is calculated from the insurer's point of view on an insurance policy. The standard treatment of this transaction is that the insurer receives a cash inflow when the policy is written, pays some expenses immediately and others in future periods, and pays

losses in the future as well. In order for a positive internal rate of return to result, expenses and losses must exceed premium. (This would result in a combined ratio in excess of 100.)

A more realistic description of the cash flows involved for insurance policies would have some expenses incurred prior to writing the policy. These prepaid expenses would include policy development costs and training expenditures. Other expenses would be paid when the policy is actually written. Premium income would be received several months after the policy is written, representing lags in collecting premiums from agents or insureds. Additional expenses and the losses would be paid subsequent to the receipt of premium. Following loss payments, salvage, subrogation and reinsurance payments might be received.

This more representative cash flow model would thus entail cash outflows preceding and following the cash inflow, with the potential for more cash inflows at the end of the sequence. Solving the discount rate that sets the present value of the cash flows to zero may yield multiple values. Mathematically, the number of discount rates that solve the equation equals the number of sign reversals in the cash flow. Selecting the proper internal rate of return from competing values is occasionally a complex endeavor.

Competitive Insurance Company
Income Statement

Underwriting Income	
Net Written Premium	$100,000,000
Net Earned Premium	95,000,000
Incurred Losses	68,000,000
Loss Adjustment Expense Incurred	10,000,000
Other Underwriting Expenses	28,000,000
Net Underwriting Gain or Loss	-11,000,000
Investment Income	
Net Investment Income Earned	14,000,000
Net Realized Capital Gains or Losses	2,000,000
Net Investment Gain or Loss	16,000,000
Net Income Determination	
Net Income Before Dividends to Policyholders and Income Taxes	5,000,000
Dividends to Policyholders	2,500,000
Federal and Foreign Income Taxes Incurred	-1,500,000
Net Income	4,000,000
Capital and Surplus Account	
Beginning Surplus	57,000,000
Gains and Losses in Surplus	
Net Income	4,000,000
Net Unrealized Capital Gains or Losses	1,000,000
Ending Surplus	62,000,000
Average Statutory Surplus	59,500,000

Rate Of Return Measures

Combined Ratio	
Loss and Loss Adjustment Expense Ratio	82.1%
Expense Ratio	28.0
Combined Ratio	110.1
Underwriting Profit Margin	
Underwriting Profit Margin	-10.1
Operating Ratio	
A) Net Investment Income Earned/Earned Premium	14.7
B) Net Investment Gain or Loss/Earned Premium	16.8
C) Net Investment Gain or Loss Including Unrealized Capital Gains or Losses/Earned Premium	17.9
Operating Ratio Based on A	95.4
Operating Ratio Based on B	93.3
Operating Ratio Based on C	92.2

Discounting

Accident Year Y Experience

Paid Loss and Loss Adjustment Expenses	35,000,000
Undiscounted Loss and LAE Reserves	45,000,000*
Discounted Loss and LAE Reserves	36,000,000
Loss and LAE Ratio - Undiscounted	84.2%
Accident Year Combined Ratio	112.2
Loss and LAE Ratio - Discounted	74.7
Accident Year Combined Ratio - Discounted	102.7

Return on Equity Measures

Net Income/Average Statutory Surplus	6.7
Net Income plus Unrealized Capital Gains or Losses/Average Statutory Surplus	8.4

*Note that the calendar year incurred loss and loss adjustment expenses total $78 million but the accident year loss and LAE equal $80 million. This would result if favorable development were experienced on prior years' loss and LAE reserves.

Figure 8-1-C-2
Industry Operating Ratios

	1983	1984	1985	1986
Combined Ratio After Dividends	112.0	118.0	116.3	108.0
Net Investment Income/EP	14.9	15.4	14.6	13.2
Operating Ratio I	97.1	102.6	101.7	94.8
Net Investment Gain/EP	16.9	18.0	18.7	17.3
Operating Ratio II	95.1	100.0	97.6	90.7
Net Investment Gain Including Unrealized Gains and Losses/EP	18.1	15.5	22.7	18.5
Operating Ratio III	93.9	102.5	93.6	89.5

Part 1 - Section D
Measurement, Allocation and Uses of Surplus

The surplus of an insurer is the difference between statutory assets and liabilities. This surplus consists of a number of different categories including capital paid up, gross paid in and contributed surplus, unassigned funds and any special surplus funds. Surplus represents the owners' (stockholders for a stock insurer, policyholders for a mutual or reciprocal) interest in the company and the cushion on which the insurer can rely in adverse situations. An insurer would be considered bankrupt if surplus were negative or zero. Great reliance is placed on the surplus for regulatory purposes. Licensing requirements establish minimum levels of surplus for writing certain lines of business. Premium to surplus ratios are often monitored as an indication of insurer solvency. A well known rule of thumb, termed the Kenney rule, restricts net written premium to no more than twice the surplus. Other regulatory tests establish a level of three to one as acceptable. These levels are applied on a company basis. Industry wide levels of premium to surplus ratios also fluctuate markedly as equity values and market conditions vary. Figure 8-D-1 illustrates the stock property-liability insurance industry aggregate values of the premium to surplus ratio for the period 1926 through 1986. These values are not consolidated to eliminate double counting of some assets for corporate groups. Consolidated figures have been determined only recently.

The degree of reliance placed on the surplus measure is remarkable given the widely recognized distortions in the statutory surplus value. The unearned premium reserve is universally recognized as being redundant as it is calculated based on the entire written premium and most expenses are incurred at the inception of the policy term. The Tax Reform Act of 1986, with the discounting of loss reserve provision, is contributing to the increasing awareness that the statutory loss and loss adjustment expense reserve may be excessive on a true economic valuation. Loss reserves are set at the undiscounted value of future payments ignoring the time value of money. The strongest arguments in favor of overlooking these distortions is that statutory insurance accounting is meant to be conservative and these conventions impart a safety margin to regulatory considerations. However, a safety margin could be included directly if one were needed without reliance on inaccurate measurements. The current procedure imposes a safety margin that decreases from one valuation period to another as loss ratios increase and is a function of interest rates (the time value of money).

Two additional inaccuracies in the measurement of surplus do not have the value of being conservative. The tax liability of an insurer on unrealized gains in equities is ignored in the surplus measure. The market value of equities is included in surplus. However, any difference in the current market price and the purchase price of equities will be taxable when the gain (or loss) is realized. Although the tax liability is inexact, as prices may continue to fluctuate prior to the realization of the gain (or loss), and the timing of the tax liability is unknown, failure to consider this liability distorts the statutory surplus measure and in rising equity markets, overstates surplus.

The final distortion in statutory surplus is the amalgamation of differences between book value of assets and their actual market value, as

discussed in Section A. The largest impact is the treatment of bonds, which are valued at amortized value in the determination of statutory surplus. The amortized value of bonds is the initial purchase price plus or minus the amortization of any discount or premium at the time of the purchase. The amortization occurs over the period between the purchase date and the maturity date of the issue. A bond purchased at par value would continue to be listed at that value as long as the bond is held regardless of fluctuations in interest rates. A bond purchased at a discount from the maturity value would increase in book value each year at the maturity date approached. Market values of bonds move inversely with interest rates. As interest rates rise, the common occurrence from the 1950s through the mid 1970s, outstanding bonds decline in value. These declines were not recognized by statutory accounting conventions as long as the insurer did not sell the bonds. This distortion led to the unintended situation that GEICO, in the early 1970s, could not sell municipal bonds to reinvest in taxable issues, despite the higher after tax income that this would produce, because the use of overstated amortized values on its bonds was providing a level of surplus that would have disappeared if the bonds were sold.

The use of amortized rather than market values for bonds can either increase or decrease surplus depending on the movement of interest rates. Other statutory book value conventions tend to reduce statutory surplus. Reinsurance with nonadmitted reinsurers is excluded from book values. Real estate is valued at the original purchase price less depreciation unless market value is lower. Agents balances over three months due are not admitted. Equipment, furniture and supplies (other than electronic computers) is also not admitted as an asset for statutory purposes. Salvage and subrogation recoveries that are expected but not yet received, are not included as an asset. Any asset that is not specifically allowed by regulatory authorities is considered a non-admitted asset and, as such, excluded from the statutory book value determination.

In addition to the distortions in the value of surplus generated by statutory accounting, other anomalies exist with use of premium to surplus ratios as regulatory tools. A company with a lower expense ratio will have a lower premium to surplus ratio than a similar insurer with a higher expense ratio writing the same volume of expected losses supported by the same surplus. If an insurer raises rates and writes the same number of policies at the new rates, the premium to surplus ratio increases; this insurer is considered more risky even though rate levels are now higher. A potential solution to both of these problems is to substitute incurred losses for written premium when determining allowable levels of insurance writings. However, incurred losses are affected by loss reserve adequacy, which varies among insurers.

Allocation of Surplus

The surplus calculation described above determines the total surplus for an insurer. Some ratemaking techniques require surplus to be allocated to individual lines or coverages, whereas other techniques require the investment income earned by an insurer to be allocated to individual lines of business and to the surplus. No consensus exists about the proper allocation of either item.

The Insurance Expense Exhibit includes an allocation of investment income to each line of business and to surplus. Only the net investment income earned is allocated, and this value excludes capital gains whether realized or not.

The net investment income earned on all investments except equities is allocated to individual lines of business based on the share of investable assets generated by the line of business. Investable assets generated by each line are the mean unearned premium reserves reduced by prepaid expenses and the mean loss and loss adjustment expense reserves. All net investment income earned not allocated to individual lines of business, including the dividend income from equities, is assigned to surplus.

The discounted cash flow analysis includes surplus as a cash flow, first being invested by the insurer and later flowing back to the insurer. In order to accomplish this calculation, the surplus contribution must be determined and the length of time it must be invested must be calculated. The amount of surplus required can be determined by use of a rule of thumb about premium to surplus ratios, it can be a prorata allocation of the insurer's surplus to all lines of insurance equally or it can be based on a study of surplus needs by line based on volatility. Surplus needs based on volatility or riskiness will be less for the company as a whole that the sum of the surplus needs for the individual lines of business, as aggregate volatility is lower than the sum of individual lines' volatility as long as the lines are not perfectly correlated.

The timing of the surplus flows back to the insurer also presents a choice. Traditional uses of the premium to surplus ratio imply that once the premium is written or the losses incurred, the surplus is no longer needed to be allocated to that line. However, if the surplus is viewed as a margin of safety for underpricing or underreserving, then some surplus should be allocated to the line of business until all losses are paid. One alternative discounted cash flow model maintains a constant loss reserve to surplus ratio until all losses are settled.

Another alternative surplus allocation is proportional to the total marginal profit of a particular line of business. This allocation approach is based on classical micro-economic theory. Another alternative allocation of surplus is determined by subjectively equating the riskiness of individual lines of business to each other by varying the premium to surplus ratios to equate the less volatile lines with the more volatile lines.

Paul Kneuer has analyzed the methods and considerations in allocating surplus to individual dimensions of insurer operations. The dimensions include type of risk or peril, branch office or producer, and geographic or temporal characteristics. Based on the practical considerations raised in an allocation of surplus, none of the current allocation methods completely achieve the goals of surplus allocation.

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Part 2 - Section A
Financial Solvency Tests

One of the primary concerns of insurance regulation is to assure the solvency of insurers. The future nature of the financial commitment made by the insurer in exchange for the policy premium creates a concern on the part of the insured that the insurer remain solvent in order to fulfill its part of the obligation. By reducing the likelihood of insurer insolvencies, insurance regulation could increase the demand for insurance.

In 1973 the National Association of Insurance Commissioners (NAIC) developed an Early Warning Test program designed to detect solvency problems soon enough to prevent insolvency or at least to mitigate the damages caused by the insolvency. A series of eleven tests were performed on the annual statement data of insurers. Acceptable ranges for the results of each test were determined and companies whose results were outside the normal range were indicated as failing a particular test. Any insurer failing four or more tests was indicated to be a priority company and regulators were encouraged to give special attention to this insurer. The objective of the program was to assist regulators in selecting and rank ordering those insurers which require further analysis by drawing attention to the approximately 15 percent of those insurers with the greatest financial problems.

The eleven tests included in the program are listed on Table 8-2-A along with the initial acceptable ranges for the results. Each year the acceptable ranges can be adjusted to reflect current conditions in the insurance and investment markets.

Table 8-2-A
NAIC Early Warning Tests

Number	Test	Acceptable Range
1	Premium To Surplus	Less than 300%
2	Change in Writings	Between + and - 33%
3	Surplus Aid to Surplus	Less than 25%
4	Two Year Operating Ratio*	Less than 100%
5	Investment Yield	Greater than 5.0%
6	Change in Surplus	Between -10 and +50%
7	Liabilities to Liquid Assets	Less than 105%
8	Agents' Balances to Surplus	Less than 40%
9	One Year Reserve Development To Surplus	Less than 25%
10	Two Year Reserve Development to Surplus	Less than 25%
11	Estimated Current Reserve Deficiency to Surplus	Less than 25%

*This test has shifted from a five year operating ratio to a two year adjusted underwriting ratio (including dividends) and then to a two year operating ratio.

The NAIC Early Warning Tests were first applied to the 1972 Annual

Statement data. The results were provided to the state insurance commissioners approximately six months after the end of the year. In addition to the time lag in compiling results, several other problems exist. Except in a few states, participation in the program is voluntary. Insurers that do not submit their Annual Statements to the NAIC for analysis are not rated. Insurers that realize they will be classified as priority companies can avoid that position by failing to submit data. Also, the analysis is performed on unaudited figures. Unintentional errors in Annual Statement data, as will as intentional misrepresentations, distort the results of the tests. The most crucial problem with the system is the documented failure to provide a valid early warning of potential insolvencies. A study by Thornton and Meador [ ] of eleven insolvencies of Texas insurers subsequent to the development of the NAIC Early Warning system found that only 20 percent of the insolvent insurers would have been classified as priority companies five years prior to insolvency, as opposed to an expected early warning classification rate of 82 percent. Three years prior to insolvency 55 percent of the companies would have been given priority ratings, as opposed to an expected 82 percent. The Annual Statement data of the year prior to the insolvency did classify 91 percent of the insolvent companies as priority companies, but this information would not have been provided to the state insurance commissioners until six months into the year of insolvency, providing little if any time for corrective actions.

After implementing the Early Warning system, the NAIC combined the statistical analysis with an analytical phase conducted by financial examiners and termed the approach Insurance Regulatory Information System (IRIS). This two phase system is considered more discriminating than the initial statistical only program. Financial examiners can quickly determine if the priority rating assigned by the statistical phase is unjustified due to special circumstances. This review helps focus regulatory attention on those insurers in more dire financial condition.

The NAIC has resisted all attempts to make the results of the IRIS system public. In particular, insurance agents have requested access to the priority ratings in order to avoid placing business with insurers most at risk for insolvency. The NAIC fears that public disclosure of priority companies would hamper any attempts to work out the financial difficulties of these insurers. The NAIC has agreed to provide raw statistical data to organizations, but to keep the results of the rating system confidential.

Discriminant Analysis

The statistical tests of the IRIS system are termed univariate as they focus on one variable at a time in classifying an insurer. An insurer is classified as either passing or failing each test. The degree with which an insurer passed or failed a given test is not considered. An alternative classification system, termed multiple discriminant analysis, has been found to perform much better at predicting insolvency than a univariate model based on similar data. Multiple discriminant analysis considers the results of financial ratio calculations in combination with each other so that a slightly excessive ratio for one variable can be offset by very favorable results for another ratio. In a sense, the difference between univariate analysis and multiple discriminant analysis is akin to the difference between multiple choice and essay examinations. In two studies by Pinches and Trieschmann [and] multiple discriminant analysis was used to predict insurer insolvency.

The six variables found most useful in this type of analysis were:

1. Agents' Balances/Total Assets
2. Stocks Cost/Stocks Market Value
3. Bonds Cost/Bonds Market Value
4. Loss Adjustment and Underwriting Expenses Paid/Net Written Premium
5. Loss and LAE Incurred/Earned Premium
6. Direct Written Premium/Surplus

Results of this analysis were to classify 49 of 52 sample insurers, of which 26 were known to become insolvent, correctly. Although further tests of such a system would be necessary, current indications are that multiple discriminant analysis would be an improvement over the current IRIS system.

Other Rating Systems

Although the NAIC IRIS system does not make its results public, the insurance consumer does have access to several insurance rating systems. A. M. Best Company has reported on the financial condition of property-liability insurers since 1900. Standard and Poor's, Conning and Company and Consumers Union also provide ratings of insurers. The Best's ratings are widely cited and will be discussed in some detail.

The objective of Best's rating system is to evaluate each insurer's financial position relative to the rest of the industry and to predict its ability to fulfill its financial obligations. The ratings are based on quantitative and qualitative factors. The quantitative factors, which are published with the individual company reports, include profitability, leverage and liquidity tests. The eight quantitative tests are:

1. Combined Ratio
2. Net Operating Income/Net Earned Premium
3. Return/Prior Year's Surplus
4. Net Written Premium/Surplus
5. Net Leverage
6. Gross Leverage
7. Current Liquidity
8. Investment Leverage

In addition to the financial tests, Best's provides a set of adjusted results that reflect the equity in the unearned premium reserve, present value of loss reserves, market values of bonds, preferred stock and mortgages and a review of conditional reserves. These adjustments in total currently tend to produce an adjusted surplus in excess of the statutory surplus, reducing the return on surplus and leverage ratios.

In addition to the quantitative analysis, Best's also considers several qualitative factors in arriving at the final rating of an insurer. The qualitative analysis, which is not published, covers the reinsurance program of the insurer, to determine the extent of the company's reliance on reinsurance and the soundness of the reinsurers, the adequacy of unearned premium and loss reserves and the competence, experience and integrity of management. The ratings awarded to insurers after consideration of the above factors range from A+ (Superior) to C (Uncertain), or any one of ten reasons for a rating not being assigned.

The Best's ratings are a useful tool for insurance purchasers in evaluating the financial strength of a particular insurer. The public disclosure of these ratings and the significance attached to the ratings serves as a control on insurance management. The ratings do not provide information about some important aspects of an insurance operation for the insurance consumer. For example, the competitiveness of rate levels, the promptness of claim payments and the willingness of the company to resolve customer disputes are all important to the insurance consumer but not included in the rating system. Thus, the Best's rating is only one element in selecting an appropriate insurer.

Loss Reserve Certification

The largest liability of property-liability insurers is the loss and loss adjustment expense reserve. Numerous retrospective studies of these reserves on an industry wide basis and for individual companies indicate the inaccuracies of these values. Although notable exceptions occur, cyclical patterns of over and underreserving tend to occur, and the general effect is to understate the degree of volatility in the underwriting cycle.

In 1980 the Fire and Casualty Annual Statement Blank was revised to allow state insurance commissioners the option of requiring insurers to include a loss reserve certification by a qualified loss reserve specialist. For the 1986 Annual Statements 17 states required at least some insurers to provide opinions on loss reserves. The class of insurers requiring certification varied from Ohio, which applied the regulation to medical malpractice insurers only, to Florida, Hawaii, New Jersey, North Carolina and Texas, which required certification of all licensed insurers.

The primary points of debate on the issue of loss reserve certification are the class of individuals allowed to certify and whether independence is required. In general states allow wide latitude in qualifying loss reserve specialists, including actuaries, accountants and others with experience in this area. Independence of the certifier is also not required, so company employees can, if qualified, provide the necessary certification.

Despite the growing popularity of the loss reserve certification program, no evidence yet suggests that reserves are more accurate, or more conservative, when certification is required.

State Guaranty Funds

State guaranty funds exist to pay the claims of insolvent insurers so that policyholders do not suffer a financial loss when an insurer becomes insolvent. All states except New York have a post-assessment funding provision under which all insurers are assessed a percentage of net direct premiums written in order to pay the claims of an insolvent insurer. New York has a pre-assessment plan under which funds are accumulated prior to any insolvencies by assessments on all insurers operating in the state. The pre-assessment plan works similarly to the post-assessment basis, except the added political problem of diversion of accumulated assets exists in New York. This fund is often viewed as available for other purposes and can be far more easily diverted from its intended application by political maneuvering.

Insurance guaranty funds operate on a state basis and are intended to cover residents of the particular state or property permanently located within the state. Numerous variations exist in the individual state statutes, but the

general guidelines included in the NAIC Post-Assessment Property and Liability Insurance Guaranty Association Model Act of 1969 provide a measure of similarity among the state statutes. Under the Model Act provisions the guaranty fund is dormant until an insolvency occurs and then a not-for-profit association is established to collect assessments from insurers in proportion to premium writings in the state and to pay the claims as they occur, subject to the availability of funds. The maximum allowable assessments on an insurer in a given year range from 1 to 2 percent of premium. Most states segregate workers' compensation and automobile insurance from other covered lines in determining assessments. The funds generally pay claims subject to a deductible and a maximum limit. Deductibles range from zero to $200 and limits range from $50,000 to $1,000,000. Most states include unearned premium as an allowable claim.

The effect of post-assessment guaranty funds is to force the surviving insurers to fulfill the obligations of an insolvent competitor. Concern about the domino effect of one insolvency on a marginal, but solvent, insurer have been raised, but not resolved. A current problem concerns the inclusion of medical malpractice insurance in the state guaranty funds. Most medical malpractice insurance is now written by health care provider controlled insurers. In many cases physicians are determining the prices to be charged for this coverage with the knowledge that the state guaranty funds will pay claims if the organization becomes insolvent. The lengthy payout pattern on malpractice claims produces a potential major solvency problem. If the premiums charged by a provider owned carrier are inadequate, the providers benefit in the short run by lower insurance costs. If the insurer later becomes insolvent, then insurers in other lines of business will be assessed for any shortages, and these assessments will be passed on to their insureds. Thus, general insurance consumers could in the future pay more for insurance to subsidize lower insurance costs for medical providers now. This link through the guaranty fund system indicates the general concern over the pricing practices of provider owned insurance carriers.

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Part 2 - Section B
Risk Theory

Risk theory is the use of mathematical models to quantify uncertainty. The primary application of risk theory has been to the insurance industry, but extensions of developments in this area can be made to any enterprise dealing with risk and uncertainty. European actuaries, particularly from Scandinavia, have pioneered this area, with American actuaries only recently addressing risk theory issues.

Typical applications of risk theory involve assuming that loss frequency and loss severity follow standard statistical distributions allowing calculations of insurance pricing, ruin probability and credibility. Such families of distributions as the binomial, Poisson, negative binomial, geometric, lognormal, pareto, Burr, generalized pareto, gamma, transformed gamma, loggamma and Weibull have been used to model insurance losses and arrive at specific risk loadings. As the mean, variance, moment generating functions and derivatives of these distributions can generally be calculated, quantifiable results can be obtained.

The two main areas of application of risk theory have been in ratemaking and in assessing financial solvency. In ratemaking the use of risk theory allows mathematical determination of an appropriate risk loading. In solvency considerations, risk theory leads to measurement of ruin probability given particular premium writings and surplus positions. Confidence intervals, which indicate the likelihood that actual outcomes will fall within prespecified limits, can be determined from the statistical properties of the distributions included in the model.

Insurance ratemaking historically has involved use of the expected value for losses, ignoring the variability around the mean value. Often the selected underwriting profit margin is applied to all lines or coverages without consideration of the degree of volatility of a given coverage. In this situation an insurer would include the same profit loading for lines that have very predictable loss patterns due to the high frequency, low severity nature of losses as it would for a much harder to predict line that has low frequency but high severity, if the expected losses for the two lines were equal. Use of risk theory to model these respective lines would entail using a distribution with a higher variance for the more volatile line. In choosing a rate level that would be adequate to cover losses a specified percentage of the time (eg: 75 or 95 percent), the risk loading in the more volatile line would be higher, reflecting the greater variability of the distribution.

Typical applications of risk theory to ratemaking focus on the total variability of the expected loss distribution. The larger the variability, the higher the risk loading necessary in rates or the greater probability of ruin derived in solvency testing. A different view of risk is taken by the area of financial economics. These theories, including the Capital Asset Pricing Model and the Arbitrage Pricing Model, propose that only nondiversifiable risk should be priced in an insurance contract. Diversifiable risk, although contributing to the total variability of losses, is considered irrelevant to the owner of the insurance company as this risk is offset by other investments in the owner's investment portfolio. Additional research that seeks to resolve these divergent views is required.

Another risk theory topic is utility theory. In utility theory, levels of

satisfaction or utility are established to correspond with various possible outcomes. As individuals, and perhaps corporations, are not necessarily twice as satisfied with twice as much money, mathematical functions are assumed to describe the intangible satisfaction levels of the decision maker. The shape of the describing function corresponds with the individual's or entity's attitude toward risk. A risk neutral decision maker would have a utility function that is linear. A risk averse one would have a utility function that increased at progressively lower rates, or a negative second derivative. A decision maker that favored risk would have a utility function that increased at progressively faster rates, or a positive second derivative. As many individuals both gamble, a characteristic of a risk seeker, and insure, a characteristic of a risk averse entity, then actual utility functions are likely quite complex. Utility theory attempts to approximate the actual satisfaction levels of various outcomes to indicate the optimal strategies to follow in risky situations. Products of this area of research have been the optimal insurance policies to purchase, including deductibles and policy limits, and when to self insure risks.

Another aspect of risk theory is termed the theory of games. Game theory contemplates the involvement of more than one player, each with a set of strategies. The payoffs of the game are dependent on the intersection of the strategies chosen by each player. Each player selects a strategy and the resulting payoff for each player is determined by the selected strategy in combination with the strategies chosen by the other players. Each person attempts to maximize the utility of his or her own payoffs, but, since the player cannot mandate the choices of the remaining players, the optimal strategy often involves anticipating the choices of others, negotiating the individual selection of strategies or randomly selecting a strategy to prevent opponents from correctly anticipating one's selection.

Two branches of risk theory have evolved, individual and collective. Individual risk theory analyzes individual insurance policies to measure the likelihood that losses will exceed premium income. Total company operations are determined by summing the results on individual policies. Collective risk theory disregards individual policies and instead addresses the total gain or loss of the company on the entire book of business.

Examples of Risk Theory

Heckman and Meyers apply collective risk theory to describe an algorithm that calculates the cumulative probabilities and excess pure premiums for a book of insurance policies. This technique, although mathematically complex, can be used to determine the pure premium for a policy with an aggregate limit, the pure premium for an aggregate stop-loss policy and the risk loading for a multi-line retrospective rating plan.

Venezian develops a mathematical model of accident proneness that can be used to demonstrate that an upper bound of classification efficiency exists and is below 100 percent and that underwriting can serve to offset weaknesses in any classification system. In his model two types of drivers exist with different accident propensities. Young drivers all initially have a higher loss likelihood, but randomly switch to the lower likelihood category over time. Drivers also can randomly shift from low loss likelihood to the higher category. The constant state of flux in classification, modeled to approximate empirical data, creates the classification problem and allows measurement of

classification error.

Hayne applies risk theory to loss reserving by analyzing the variability of age-to-age and age-to-ultimate loss development patterns. The lognormal distribution is fitted to empirical data. Use of this model provides projections of loss development factors to aid in the standard loss reserving problems facing actuaries. In addition, this model allows the determination of estimates of statistical variability of loss reserves, which are difficult to determine using the current reliance on empirical data.

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Part 2 - Section C
Planning and Forecasting

Planning and forecasting are two separate, but interrelated, functions. Planning is a multi-step process involving establishing objectives, identifying alternative courses of action, establishing assumptions to evaluate the alternative courses of action, implementing a plan and monitoring the outcome of the plan. Forecasting is the projection of the consequences of a particular course of action or the maintenance of the status quo. Actuarial involvement in the forecasting process is generally invited in order to determine the financial consequences of a set of contingencies. Planning relies on forecasting to evaluate the financial outcomes for potential courses of action. Forecasting of the likely results of the current course of action often inspires planning to avert the shoals sighted dead ahead.

The planning process can be subdivided into financial planning and operational planning. Lowe [ ] describes the centerpiece of financial planning as a financial forecast of operating results over the next one to five years and indicates that this process is currently done by most major property-liability insurers. He defines operational planning as that done by divisions within an insurance company that seek to accomplish area objectives.

Insurers, just as other business enterprises, need to use planning and forecasting in order to improve the decision making process. If operational changes are necessary, any enterprise has more alternatives and more leeway if the time horizon for implementing the decision is further away. Finding out about problems too late provides for little choice in decision making. If these situations are foreseen, then management has time to consider the alternatives and make the most appropriate choice. Thus, the first step in the planning and forecasting process is the financial forecast described by Lowe. The key elements of this forecast are generally direct and net premiums, both written and earned, underwriting expenses, incurred and paid losses and loss adjustment expenses, dividends, investment income and surplus on a total company basis and often subdivisions of this information, where appropriate, to lines of business and geographic areas.

The next step in the process is often to ask "What if?" questions. What would happen if we cut rates to write more business? What would happen if we pulled out of a particular market? What would happen if we changed our underwriting rules? Depending on the answers to these questions, a new course of action may be implemented.

Actuaries, as the recognized resource within the insurer for quantifying future financial contingencies, are usually involved in the planning and forecasting process. In some cases the actuary is "responsible" for the entire planning process, but as the responsibility for establishing corporate objectives and the authority for implementing operational changes is rarely, if ever, included with this assignment, this planning exercise is, in essence, restricted to a forecasting project. The actuary projects trends from available data, makes educated guesses about future developments and calculates the resulting financial situation of the insurer.

A more comprehensive planning and forecasting process would include representatives from all affected divisions within an insurer, including the actuarial department. Management would be responsible for establishing corporate objectives, which could range from maximizing profits over a certain

period to attaining or retaining target market share values or achieving a particular rating from Best's. Marketing, underwriting, claims, accounting, data processing and other operating divisions within the company would be included in developing and implementing the plan. The actuary would at the very least provide information about rate adequacy and reserve development, and may be the one responsible for quantifying the financial results of the alternative courses of action. Some insurers maintain corporate planning departments that regularly produce plans for various aspects of the company's operations. Alternatively, a resource person familiar with the planning process may be called upon to assist the individuals responsible for implementing the plan to devise the plan.

Common Problem Areas

The primary problem area in planning and forecasting that appears consistently across firms is the excessive reliance on the forecasted results and the effort expended in explaining why actual results differed from the forecast. Once developed, the forecasted results take on an aura that many managers find difficult to dispel. The forecasted results become the goal and any divergence from those values creates a hunt for what area is at fault. If the actual results are worse than forecasted, the search for a scapegoat begins. If the actual results are better than the forecast, then the area responsible for the erroneous projection is sought. As the actuary is usually involved in developing the forecast, any deviation of results from the forecast tends to reduce the credibility of the entire actuarial process.

The common defense against the over reliance on forecasted results is to produce so many forecasts that the actual results are bound to fall in the projected range. One notable application of this strategy is the set of four actuarial projections produced by the Social Security Administration: optimistic, intermediate, intermediate with optimistic economic assumptions and pessimistic. As long as the actual results fall within the range of the forecasts, the producer of the forecast can deflect criticism. A more mathematically valid, albeit more difficult to explain, defense is to produce confidence intervals for the projected results based on the statistical properties of the distributions used in modeling the forecast. When producing such a forecast, the actuary should concentrate on the interval within which results should fall the selected percentage of the time and avoid use of the mathematical expression "expected value" which carries a different meaning for non mathematicians. This problem is generally only overcome when, after long experience with planning and forecasting, managers learn that the forecasted results are only estimates of future results and not inviolate goals.

Another common problem in planning and forecasting is to implement shifts in operations that were not contemplated by the plan, but to still expect the forecasted results to be valid. Such operational shifts could include negotiating a new reinsurance treaty, offering a new compensation package to producers, implementing a new claims payment procedure, expanding or curtailing operations in a given area or line or any of a number of changes that could affect the company's financial position. The need for planning to be a continual process, constantly updated to include operational changes and revised assumptions must be stressed to avoid this pitfall.

For actuaries, a major drawback of planning and forecasting is the tendency of forecasts to be, to invent a term, "self unfulfilling." This

tendency expresses itself in the ratemaking process through input from the other divisions involved in establishing rate levels. If the forecasted results are favorable, then pressure to avoid or minimize rate increases develops. As the adequacy of the rate levels falls, the favorable results forecasted cannot be attained. Conversely, if the forecast is dire, then normal opposition to rate increases disappears and the rate levels adjust more quickly than would be expected. Thus, results are often better than the forecast. Projecting the psychological effects of a particular forecast on the internal operations of an insurer and revising the forecast to reflect this feedback is rarely, if ever, taken into account.

Forecasting Techniques

A large number of mathematical techniques are available for use in forecasting results. These techniques depend on the validity of past data to predict future results. Despite the apparent sophistication of these techniques, any change that affects the usefulness of historical data for predictive purposes negates the value of these techniques.

One common technique for fitting a time series model is termed simple linear regression. In this procedure past data are used to fit the model:

1) $y_t = a + b\,x_t$

where y_t = observation of the dependent variable at time t
a = intercept
b = slope
x_t = observation of the independent variable at time t

The estimates of a and b are usually chosen to minimize the squared value of the difference between the actual and fitted data, which is called the least squares estimate.

Two special cases of simple linear regression are deserving of note. In some cases the independent variable is simply the time period. In this case, $x_t = t$. Under the exponential trend model, the dependent variable is a function of an exponential expression:

2) $y_t = e^{a+bt}$

or $\ln y_t = a + b\,t$

Multiple linear regression is similar to simple linear regression, except that the dependent variable is assumed to be a function of more than one independent variable. A time series example of this model would be:

3) $y_t = a + b\,x_t + c\,w_t + d\,z_t$

where w, x and z are independent variables
b, c and d are unknown parameters
t is the time period

Again, the estimates of the parameters are generally chosen based on the least squares criteria. The validity of all regression models is dependent on the assumption that the observations of the independent variables are themselves independent of each other. For most time series, this assumption is violated. This technique also assumes that the errors from the model (the difference

between actual and forecasted values) are normally distributed.

A time series could also be generated by a constant process that reflects a moving average. Such a model would be:

3) $x_t = a$
where a = mean of the last T observations

A moving average can also have a linear trend process such as:

4) $x_t = a + b\,t$

Under a process termed simple exponential smoothing, the dependent variable is assumed to be a function of one independent variable. The model could be similar to the moving average shown in equation (3) except the parameter is chosen not on the least squares basis but is selected to minimize the errors with a greater weight given to recent data. The weights assigned to each error term is k^{T-t} where T is the total number of observations used to project the dependent variable and k is a selected weighting factor between zero and one. The weights of the error terms decrease geometrically with the age of the data. Similar smoothing calculations can be made for linear trend processes and for multiple independent variables.

The most sophisticated class of forecasting models currently available is known as Box-Jenkins. Many computer statistical packages include this modeling process. The Box-Jenkins model is a three step iterative process in which a tentative model is identified through an analysis of the historical data, the unknown parameters are estimated and then diagnostic tests are performed to determine the adequacy of the model. The class of models used in the Box-Jenkins procedure are termed autoregressive integrated moving average (ARIMA) and the process allows for any combination of these characteristics (autoregression and moving averages) to be included in the final model. Choice of the initial model is made after analyzing the autocorrelation and partial autocorrelation functions of the historical data.

The major drawbacks of the Box-Jenkins approach are the requirement of at least 50 historical observations, the need to completely refit the model periodically as no convenient way to update the parameters is available and the time and expense involved in developing a Box-Jenkins model when the final forecast involves numerous individual time series variables.

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Part 2 - Section D
Data Sources

Industry Data

The insurance industry generates massive volumes of information in the process of its operations. The entire business of insurance is dependent on the statistics generated by the insurance process. Although much of the data generated is kept confidential as it has proprietary value, the regulatory process requires the promulgation of a significant portion of insurance data. Much of this information is available for applications of actuarial problems. Also, other non insurance information sources can be utilized by actuaries. The purpose of this section is to increase the awareness of available information that can be used to improve actuarial applications.

Annual Statement

The Annual Statement is the primary source of public information about insurers. This document is required to be filed with each state insurance department in which the insurer is licensed by March 1 of the subsequent year. The exhibits included in the Annual Statement are summarized in Table 8-2-D-1.

Table 8-2-D-1
Annual Statement Exhibits

Balance Sheet
- Assets by Type of Investment or Non-invested Category
- Liabilities, Surplus and Other Funds

Income Statement
- Underwriting and Investment Income Exhibit
- Analysis of Change in Capital and Surplus Account

Reconciliation of Funds Provided and Funds Applied
Investment Income by Type of Investment
Capital Gains and Losses by Type of Investment
Premiums Earned, In Force and Written by Line
Losses Paid and Incurred by Line
Unpaid Losses and Loss Adjustment Expense by Line
Expenses Paid by Category
Analysis of Admitted and Non-Admitted Assets by Type
Reconciliation of Ledger Assets
Premiums and Losses for the Particular State
Five-Year Historical Data on:
- Gross and Net Premium
- Underwriting, Investment and Net Income
- Selected Balance Sheet Items
- Allocation of Investments
- Gross and Net Paid Losses
- Operating Ratios
- One and Two Year Loss Development

Investments Owned, Acquired and Sold by Type
Investments Owned by Type and by Country
Maturity Distribution of Bond Investments

Ceded and Assumed Reinsurance
Analysis of Loss Development by Line
Premiums and Losses by State

Insurance Expense Exhibit
Premiums, Losses, Expenses and Net Income by Line

A. M. Best, National Underwriter

A. M. Best collects and disseminates reams of statistical information on the insurance industry, with much of the data gleaned from Annual Statement data. Industry figures for premiums, expenses, losses and investment income, including an aggregate Annual Statement, are promulgated in a publication entitled Best's Aggregates and Averages. Experience in total and by line is shown for the industry and for stock, mutual and reciprocal insurers. Each annual volume includes both the most recent data as well as historical data to facilitate long term and trend analysis. This publication is generally the first source of analysis for comparative studies of industry performance.

Another A. M. Best publication is Best's Insurance Reports, which is a voluminous listing of detailed information on individual insurers. For each insurer, financial information is summarized, the history, management, operations and reinsurance program are described, and the Best's Rating and comparative financial and operating exhibits displayed. The financial information shown for each insurer includes a summary of assets, liabilities and surplus for the current and prior year and investment data.

In addition to published data, A. M. Best can provide databases in computer readable form on tape or diskette. This information is taken directly from the Annual Statement and provides the detail necessary to fully analyze each insurer. The user can obtain the data for the industry or for selected companies. The availability of this data enables the user to custom design any research.

The major competitor to A. M. Best in providing insurance information is the National Underwriter company which publishes the Argus FCSS Chart. This more compact reference source provides information on the assets, liabilities, surplus, written and earned premiums, net income, investment income earned, underwriting gain or loss, premiums by line and loss, expense and combined ratio, each for the current and prior year.

GAAP Financials

The Annual Statement, A. M. Best and Argus data are all based on statutory financial data, except for the items displayed by Best's as adjusted in the rating analysis section. Statutory data does not necessarily represent the true financial position of the insurer. The use of amortized values for bonds and the lower of cost or market values for real estate, the unrecognized equity in the unearned premium reserve, the dismissal of non-admitted assets and the failure to consider the present value of loss reserves all distort the statutory values. When financial statements are required to be produced by auditors for shareholders, adjustments to financial data are required by Generally Accepted Accounting Principles (GAAP). GAAP accounting recognizes the equity in the unearned premium reserve, the deferral of federal income taxes, salvage and subrogation recoverable and some non-admitted assets.

Stockholder owned insurers are required to file annual reports, form 10-Ks

and other documents with the Securities and Exchange Commission (SEC), similarly to publicly-held companies in other industries. These data are on a Generally Accepted Accounting Principles (GAAP) basis, as opposed to a statutory basis. In addition, companies with significant (as defined by the SEC) property-liability insurance operations are required to submit additional data and discussion.

SEC regulations require stockholder owned insurers to submit a Loss Reserve Disclosure report that displays historical loss development of the ten prior years' loss and loss adjustment expense reserves on a cumulative, rather than accident year, basis. Additional information required includes a three year reserve reconciliation and an historical summary of various balance sheet and income statement items, and discussions regarding the differences between GAAP and statutory loss reserves, loss reserve discounting, the effect of inflation on loss reserves, loss portfolio transfers and other significant reinsurance transactions, significant line of business mix changes and significant adjustments to prior years' reserves.

External Data

As the insurance industry shifts to a total rate of return pricing structure, investment data assume an increasingly important role in the actuarial functions of pricing, reserving and forecasting. Current and projected rates of interest, inflation and stock market returns are needed to incorporate into actuarial models.

Data on current interest rates are available from the Treasury Department, Moody's Investors Service, Standard & Poor's Corporation and business publications such as the Wall Street Journal. Two useful compilations of aggregate data are Standard & Poor's Trade and Security Statistics, which is updated monthly, and the Economic Report of the President, published annually. Both references include historical as well as current values to facilitate trend analysis. Interest rate levels on short, intermediate and long term securities issued by the U. S. Government, states and municipalities, and corporations are included.

Government data may also be used for the underwriting, as opposed to investment income, component of insurance pricing. For example, the Highway Loss Data Institute (HLDI) publishes crash statistics for each automobile model by year, for possible use in pricing automobile collision coverage. The Department of Labor and the Bureau of Labor Statistics also publish statistical information that may be useful in particular ratemaking situations.

Price level volatility has become an important aspect of insurance ratemaking, requiring consideration of general inflation rates in the pricing process. The Consumer Price Index, promulgated monthly by the Commerce Department, provides the most widely based inflation measure. Current and historical levels are published in Standard & Poor's Trade and Security Statistics. In recognition of the inadequacy of a general price index for insurance purposes, Norton Masterson has developed a series of specific cost indices for insurance values that was first published in 1968 in the Proceedings of the Casualty Actuarial Society. These indices are periodically updated in Best's Insurance Management Reports.

Investment results on stocks are both more variable than returns on bonds, but also are more difficult to measure. The commonly reported barometer of the stock market, the Dow Jones Industrial Average (DJIA), is the arithmetic

average of current prices of a portfolio of 30 individual issues. This is a price weighted index, so changes in the levels of higher priced stocks carry more weight than changes in lower priced issues. The composition of the portfolio is also periodically revised to reflect shifts in the industrial sector. As a price index, it is not useful in measuring the total return on securities, which would include dividends.

A broader market index that is value rather than price weighted is the Standard & Poor's 500. This index includes 425 industrial stocks, 50 utilities and 25 transportation securities. Although this index avoids some of the DJIA problems, it does not allow for a total rate of return measure. However, several publications compile dividend calculations for the securities included in the S&P 500 to allow such a calculation.

Numerous other market indices are available to reflect the investment performance of broader or more specialized issues. The Wilshire 5000 is the broadest based U. S. stock index, encompassing securities on the New York Stock Exchange, American Stock Exchange as well as the OTC (which traditionally stood for Over The Counter) Exchange. Stock indices for individual foreign countries are published, as is a composite world index, both in local currencies and denominated in dollars to account for currency fluctuations. Specialized indices including insurance, utilities and banks are reported daily in business publications.

Commercial Forecasting Services

Current and historical values of financial and economic data are readily available, but actuarial calculations often require forecasted values of these items. Actuaries can either generate their own forecasts or pass the responsibility for any forecast errors off on someone else by utilizing the services of an econometric service bureau. The business of selling economic data has developed over the last two decades, propelled by increasing computer power, enhanced mathematical tools and increased economic volatility. The three basic services provided by econometric service bureaus are forecasts, data base access and economic consultation. Three firms dominate the industry, Chase Econometrics, Data Resources, Inc. and Wharton Econometrics, but numerous smaller and more specialized firms exist.

The specific econometric techniques used by the different bureaus differ, but the overall operations are similar. All utilize government sources supplemented by their own surveys to compile the data base. The forecasting techniques all involve econometric models, judgement, time series analysis and current data analysis. The number of equations used in the overall macro economic model ranges from 455 to over 1000 and the number of variables forecasted range from 700 to 10,000. Each of the major firms provides monthly updates of the forecasts which predict from two to ten years ahead. Each firm has made infamous inaccurate forecasts, but the overall track records of the forecasts are reasonably good. The specific costs of the forecasts depend on the extent of the services requested, but some major firms expend in excess of $100,000 per year for econometric forecasts.

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