Fair Value Accounting for Property-Casualty Insurance Liabilities

Executive Summary

The accounting standards boards have adopted fair value measures for financial assets and liabilities, subject to reasonable constraints from established practice and uncertainties in the new procedures. FASB and IASB standards since 1992 have espoused a consistent fair value perspective for long-term bonds, common stocks, and derivative securities. The benefits of fair value for relevance, reliability, and transparency cannot be gainsaid.

For assets and liabilities with liquid markets, fair values are easily measured. For property-casualty policy benefit reserves, which are not traded, fair values are disputed:[1]

- Financial economists use the present values at a risk-free rate as the fair value.[2]
- Some company actuaries and state regulators advocate additional risk margins.[3]

Much of this dispute stems from misunderstanding about risk margins in efficient markets and the cost of holding capital in a regulated industry.

- Financial economists are correct that underwriting risks are diversifiable and are not compensated by higher returns in efficient markets. Risk margins would not be warranted in fair value policy benefit reserves if insurers did not hold capital above the present values of future loss payments or there no double taxation of corporate profits.
- Insurers are correct that risk margins are needed in regulated markets with capital requirements, double taxation, and other costs of holding capital. These margins are based on financial theory, not on the actuarial risk load literature.

This paper explains fair value accounting for property-casualty insurance. The fair values of policy benefit reserves – the present values at the risk-free rate plus the risk margin for the cost of holding capital – are based strictly on financial theory. They assume that underwriting risk is diversifiable and receives no additional return in efficient markets.

The cost of holding capital for property-casualty insurance operations is debated. We present the range of views and explain the implications for fair value accounting. We provide readers with the tools to judge fair value positions; we do not provide a single fair value estimate.

Many fair value issues have been obscured by partisan lobbying: some parties wish low loss reserves with no risk margins and others wish high loss reserves with material risk margins. It behooves actuaries to provide clear and objective analyses, with no motive other than the proper market-based estimates of unpaid losses.

BENEFITS OF FAIR VALUE ACCOUNTING

GAAP and statutory accounting now report full value loss reserves, not the present value or market value of unpaid losses.[4] Fair value accounting requires financial assets and liabilities, including unpaid losses, to be held at market values. If a liquid market exists, the fair value is the trading price If no liquid market exists, the fair value *considers* present values and risk margins. Risk margins adjust present values to market values (trading values); they are not used for conservatism or similar regulatory purposes.

The benefits of fair value accounting are greater relevance, reliability, and transparency.

(1) An accounting entry is *relevant* if it reflects a value of concern to users. The primary audience for general purpose financial statements is investors and creditors, not regulators or policyholders.[5] Investors and creditors wish to know the firm's market value and the change in this market value during the accounting period.[6] They seek the market value of unpaid losses, not the nominal value of ultimate losses.

Nominal reserves diminish the value of financial statements. Loss ratios and combined ratios are not well understood by outsiders. When interest rates are high, a 110% combined ratio for workers' compensation is more profitable than a 100% combined ratio for Homeowners; when interest rates are low, the opposite is true. Insurance managers compare actual combined ratios with targets that vary by line of business, by year (depending on interest rates), by policy type (such as first dollar coverage vs large dollar deductible business), and by state if the loss payment pattern depends on the state compensation system. Even skilled underwriters cannot measure profitability without the aid of actuarial software programs.

Reliability, or *representational faithfulness*, is the relation of the accounting measure to the objective. The accounting standards boards provide a hierarchy of fair value: market values, market proxies, and valuation methods.

- The most reliable measure of market value is the trading price in a liquid market. For financial assets with liquid markets, we use observed trading prices.
- For assets that are not publicly traded, we use market proxies when available.
- For non-traded assets with no market proxies and for unpaid loss liabilities, we use valuation techniques (see below).

Illustration: For a publicly traded bond, the market value is the fair value, even if we believe the bond is over- or under-valued. An efficient (arbitrage free) market does not admit of mis-statements, since mis-statements would be eliminated by arbitragers.

Illustration: A privately traded bond (private placement) with no market value of its own may have market proxies. A privately traded 8% coupon 20 year bond of an A-rated firm is valued like publicly traded bonds of similar coupon, maturity, and quality, with a discount for illiquidity.

Relevance and *reliability* are different attributes. Relevance is the objective of users; reliability is the means of achieving that objective. If users want market values, then market value is the relevant objective. If the asset or liability trades in a liquid market, the trading price is the fair value measure, and reliability is not an issue. If no liquid market exists, we use a valuation method that is most representationally faithful (most reliable).

An fair value accounting measure is reliable if it agrees with the market value.

- Market value, by definition, is reliable.
- Proxies for market value are reliable if the proxies have similar attributes.
- A valuation model is reliable if it agrees with market value for securities that have market values.

Illustration: Long-term options given to a firm's executives have no market values if the options are not traded. The options are valued by a Black-Scholes formula. This formula is reliable because it gives results close to market values when applied to publicly traded options.

Illustration: Discounted cash flow analysis shows the value of fixed-income securities, if the capitalization rate for the firm can be estimated. The appropriate capitalization rate, or the spread over Treasury securities, can be estimated from other valuation techniques, such as the CAPM, or from market values of bonds issued by similarly rated firms.

Unpaid losses have no market values or market proxies. We measure fair value with valuation models, such as discounted cash flow models. Underwriting risks are diversifiable, just like the unique risks in other industries; they do not affect the capitalization rate.[7] Insurers hold capital to support unpaid losses, so their fair values are their present values plus the cost of holding capital.[8]

Transparency refers to users' ability to derive the objective from the accounting measure. Readers of general purpose financial statements are rarely familiar with cash flow patterns by line of business or the regulatory capital requirements for various risks. Management should show the fair value risk margin with the quantification method in footnotes.[9]

Regulatory vs Economic Margins

To ensure that insurers meet their claim obligations, regulators set risk-based capital (RBC) requirements and require full value loss reserves. The RBC reserving risk charge uses discounted reserves at a conservative valuation rate plus a margin based on the total volatility of the reserves. RBC reserves (with or without the capital charge) do not reflect market values. Regulators set regulatory margins; fair value uses economic risk margins.

- An economic margin is the difference between the market value and the present value at a risk-free interest rate (termed the certainty equivalent present value). It is the margin needed to induce an entity to hold an asset or assume a liability. Economic

margins are attributes of the asset or liability; they do not depend on the entity holding the asset or liability or the other parties with claims against the entity.

- A regulatory margin is the additional amount above the economic value required to safeguard the interests of consumers or policyholders. Regulatory margins depend on the entity holding the asset or liability and other parties with claims against the entity.[10]

Illustration: if the market is efficient, the market value of an asset is the same for a risk-averse person as for a risk-neutral person. The fair value of a policy benefit reserve is the same for a financially strong insurer and a financially troubled insurer. Regulators may require a greater margin for the financially troubled insurer to safeguard the interests of its policyholders. Risk-based capital charges are higher for small life insurers and rapidly growing property-casualty insurers, who may be more subject to adverse scenarios.

We seek the economic margin for property-casualty policy benefit reserves, not the regulatory margin. But a regulatory margin combined with double taxation and other costs of holding capital affects the economic margin in fair value entries. A higher regulatory margin combined with a high cost of holding capital causes a risk-neutral party to require more cash to assume the liability. This paper accepts the economic assumptions for risk margins and the cost of holding capital, and it derives the appropriate fair value for policy benefit reserves.

Risk and Return

The market values of financial assets reflect their systematic (non-diversifiable) risk . Asset specific variance (unique risk) can be diversified and is not compensated in efficient markets, so it does not affect market values or fair values.[11] Underwriting risks are independent of capital market movements; these risks are diversifiable and do not warrant additional returns. The arbitrage arguments that diversifiable risk should not be rewarded by additional return are generally accepted and are not reviewed here.[12]

Some actuaries argue that investors who can diversify their assets are not compensated for diversifiable risk; insurers can not diversify their writings and should be compensated for underwriting risk. This argument is specious. All specific risk (unique risk) is non-diversifiable to the specific firm. No firm can diversify its exposure to unique risk; its *owners* diversify by investing in a variety of firms. Just as the insurer cannot diversify the risk of natural catastrophes, the auto manufacturer cannot diversify the risk of labor strife. But the shareholders of insurers and auto manufacturers can diversify both types of risk, so neither risk warrants higher returns. Diversifying one's products to smooth earnings does not benefit shareholders, who can diversify more efficiently on their own.[13]

Spreads vs Risk Margins

The fair value risk margins for unpaid losses are like the spreads on corporate bonds, which compensate for expected defaults, not like the risk margins on common stocks, which reflect their covariance with market returns. Only a small part of the spread on risky

bonds reflects the covariance of bond defaults with market declines. Similarly, the fair value risk margin for unpaid losses reflects the cost of holding capital, not the covariance of underwriting risk with market returns.

Illustration: If the risk-free rate is 8% per annum, a high yield bond may pay 15%, and a common stock may yield 15%. Of the 700 basis point spread for the bond, perhaps 600 compensates for the expected defaults. The expected return on the bond is 9%, and only 100 basis points is a reward for additional risk. In contrast, the entire risk premium for the common stock is a reward for additional risk.

Defaults on high-yield bonds rise when the economy is weak and market returns are low. Bond returns are slightly correlated with market returns, giving a 100 basis point risk margin. Underwriting risks are fully diversifiable, and none of the fair value risk margin for unpaid losses is a reward for additional risk.

Illustration: Suppose the nominal value of an unpaid loss to be paid in 5 years is $100,000, the present value at an 8% risk-free rate is $68,000, and the cost of holding capital is $12,000, so the fair value is $80,000.

- If an insurer receives $80,000 to assume this unpaid loss, it earns 8% over the five year period, *after paying the costs of holding capital*.
- If an insurer receives $68,000 to assume this unpaid loss, it earns about 6% over the five year period, after paying the costs of holding capital.

If the appropriate capitalization rate in the absence of any costs of holding capital is 8%, the fair value of the reserves is $80,000, not $68,000.

FINANCIAL ASSETS VS INSURANCE OBLIGATIONS

Risk-based capital requirements for insurers are similar to the capital needs of other firms. Just as shareholders provide the capital for insurers, they provide capital for other firms. Just as insurers incur double taxation for the equity held to support loss reserves, a manufacturer incurs double taxation on the equity raised to build plants or buy equipment.

The double taxation costs are embedded in the discounted cash flow analysis of the firm's value. The future cash flows of the firm for discounted cash flow models are after-tax; the capitalization rate is the pre-tax cost of equity capital for investors. The net present value of a project implicitly considers the double taxation of equity capital.

Many firms have financial assets (bonds or stocks) or liabilities (corporate debt). They need no capital to hold these assets or liabilities, so they incur no cost of holding capital.

Insurers and banks differ in that their capital requirements are determined by regulatory fiat to protect consumers, not to maximize shareholder value. Investors holding financial assets have no capital requirements, since declines in asset value do not harm other

parties. Insurers and banks have long term obligations to consumers. A decline in asset values may impair their solvency and harm policyholders and depositors.[14]

Insurers and banks are unique in that they must hold regulatory capital to support their financial assets and liabilities. Insurers holding unpaid losses are subject to regulatory constraints on the assets backing these unpaid losses: full value loss reserves and risk-based capital requirements.

Illustration: An investor holding 2,000 shares of a high-beta stock (a risky asset) has no capital requirements, since a decline in the share value harms only the investor. An insurer holding workers' compensation loss reserves with a present value of $2.5 million might hold $3.5 million of assets backing nominal reserves plus $0.5 million of additional capital to assure that it can pay the loss even in adverse circumstances.

The risk-based capital is designed to protect policyholders and depositors, not shareholders. The cost of holding regulatory capital is allocated to policyholder reserves, whether the regulatory capital is a function of the unpaid losses or of the assets and receivables backing these losses.

Valuation Inputs

We use five inputs to compute fair values for property-casualty unpaid losses: nominal value, discount rate, payment pattern, capital requirements, and the cost of holding capital. We explain each input and how it is measured.

The *nominal value* of unpaid losses is the ultimate dollars paid. Either nominal values or present values may be estimated first. If loss cost trends are steady, we determine nominal values from historical loss triangles. If loss cost trends vary from year to year, we may derive the real dollar cost of unpaid losses from deflated loss triangles and project loss cost inflation to derive nominal values.[15]

Nominal values determine the assets required to back full value loss reserves and the capital required by regulatory risk-based capital requirements and rating agency capital adequacy measures. We determine capital requirements and assets backing reserves from the nominal values, use risk-free interest rates to derive present values, and add the risk margin for the cost of holding capital to derive fair values.

The *discount rate* is commonly a risk-free rate, reflecting the time value of money but no default risk or risk margin.[16] Treasury yields were once used as the risk-free rates, but since Treasuries have state tax advantages and high demand by foreign governments, they understate the risk-free rate and overstate fair values.[17] LIBOR is the preferred choice for the risk-free rate, though the LIBOR market is not as large or liquid as the Treasury market.[18]

If the term structure of interest rates is not flat, the maturity of the security affects its yield. Some financial analysts use a yield that is duration matched to the insurance liabilities, even if duration matching is not the optimal investment strategy. If the duration of unpaid losses is one year, the chosen risk-free rate is 12 month LIBOR, even if the insurer invests in 30 year corporate and municipal bonds.[19] Other analysts use a duration corresponding to the investment strategy of the insurer or the insurance industry.[20] The text of this paper refers to the risk-free rate, and does not specify which rate is appropriate.[21]

The *loss payment pattern* is derived by actuarial methods. Paid loss development factors are derived from historical triangles of cumulative paid losses, and the percentages of losses paid by each development date are the reciprocals of the development factors. Empirical factors are smoothed by fitting to mathematical curves, such as inverse power curves or exponential decay. If loss cost trends are changing, nominal dollars are detrended and the analysis performed on real dollar figures.

Capital Requirements

The capital held by industrial firms is primarily fixed assets, such as plants and equipment, and working capital used for operations. Efficient firms that produce with less capital drive out less efficient firms. In a competitive industry, the capital used is a reasonable measure of the capital needed.

In insurance and banking, capital serves to protect consumers, not to produce the product. Required capital is determined by regulatory fiat or by rating agency measures.[22] Risk-based capital formulas are minimum capital standards; insurers hold about 2 to 2½ times the RBC requirements to avoid regulatory interventions into their operations or to compete for consumers seeking financially strong firms.[23]

Most insurers track rating agency capital adequacy measures, and they base their target capital on the rating agency standards. The illustrations here use RBC charges because they are well known and transparent.

We assume insurance markets are efficient and the capital ratios held by financially sound insurers as a reasonable measure of required capital. Alternative capital formulas allocate capital differently by line of business and between loss reserves vs unearned premium reserves, but the total cost of holding capital does not change.

Insurers hold capital for unpaid losses in two places:

- Statutory accounting requires (i) full value loss reserves, not the present value of future loss payments, and (ii) gross unearned premium reserves, with no offset for deferred policy acquisition costs.[24] Even if fair value (general purpose) accounting statements show unpaid losses at market values, insurers hold assets supporting nominal reserves and gross unearned premium reserves for statutory financial statements.

- Regulatory risk-based capital requirements and rating agency capital adequacy measures demand additional capital held explicitly in surplus.

Industry vs insurer: We used the industry average ratio of actual capital to required capital. Some actuaries argue that an insurer holding more capital provides greater security to its policyholders, justifying higher fair value risk margins and higher premiums, so we should use insurer specific ratios. An insurer targeting consumers seeking a financially strong insurer has a high fair value risk margin; an insurer targeting consumers seeking low premiums has a low fair value risk margin. Ideally, we should use the insurer's *desired* capital ratio. But its *actual* capital ratio reflects its past profitability, not just its desires. Given the difficulties of using insurer specific ratios, we use the industry average.[25]

Insurer attributes: Some actuaries compute RBC requirements based on the insurer's own characteristics. A small, rapidly growing, monoline carrier has lower loss and premium concentration factors, a lower covariance adjustment, and additional growth charges, giving higher fair value risk margins. Other actuaries say that insurance is sold in competitive markets, so industry average characteristics should be used.[26]

Cost of Holding Capital

We differentiate among several costs of holding unpaid losses: investment restrictions, double taxation, competitive costs, and other friction costs.[27] The importance of each costs depends on the industry; for property-casualty insurers, double taxation is the largest cost.

- Investment restrictions affect the fair value of banking deposits. If banks hold 10% of checking deposits as vault cash or non-interest-bearing deposits with the Federal Reserve Board, and the opportunity cost of capital (or the available rate on alternative uses of the funds) is 8%, the economic cost is 0.8% of the deposits per annum. Insurers have some investment restrictions, but the economic cost is less clear. Investment restrictions prevent insurers from holding too high a proportion of equities or real estate; they favor high-grade government or corporate bonds. If these securities are sold in efficient markets, the economic costs may be nil.
- Capital required by regulatory margins incurs double taxation. If regulatory standards require capital margins of 20% of reserves, the investment yield is 10% of assets, and the corporate tax rate is 35%, the economic cost is 0.7% of the reserves per annum.[28]
- Rating agencies have capital adequacy ratios that may exceed regulatory requirements. Insurers feel compelled to comply with rating agency capital adequacy measures to retain their business. If rating agencies set a target capital margin of 30% of reserves for an A- rating, the investment yield is 10% of assets, and the corporate tax rate is 35%, the economic cost is 1.05% of the reserves.
- Principal agent problems raise the cost of holding capital. Suppose shareholders wish the insurer to write profitable but risky business, but managers avoid risk or buy reinsurance to protect their jobs. The lower return to shareholders, or the cost of incentives to induce managers to take more risk, are a friction cost included in the cost

of holding capital. These costs are no different for insurers than for other firms, they are rarely large, and they are not easily measured. We ignore them in this paper.

Double taxation is clearly a cost of holding capital that affects property-casualty insurers. Double taxation is the same for property-casualty insurers as for other fully taxed entities, and discounted cash flow models used to value projects includes this cost. Two differences make this cost stand out for property-casualty insurers:

- For other firms, double taxation is subsumed under the cost of buying fixed assets. For insurers, investable assets earn investment income while they are held. The tax liability on the investment income earned on assets backing the present value of unpaid losses is offset by the unwinding of the implicit interest discount on the losses. The tax liability on the capital supporting the unpaid losses is a cost to the insurer.
- Other firms may use debt to fund fixed assets. Interest payments on the debt is tax deductible, eliminating the cost of double taxation. Property-casualty insurers are funded by equity, not by debt, so double taxation is a major cost.[29]

Illustration: An industrial firm uses $100 million of capital to build a plant with an expected life of 40 years. If the risk-free rate is 8% per annum, the cost of holding capital is $8 million each year plus economic depreciation on the plant.

Illustration: Suppose a $200,000 loss liability will be paid in one year and has a surplus requirement of 20% of reserves. The risk-free interest rate is 8% per annum and insurers must hold full value loss reserves.

- The present value of the unpaid loss is $200,000 / 1.08 = $185,185, and the implicit interest discount in the full value loss reserves is $200,000 – $185,185 = $14,815.
- The capital held to support the unpaid loss is $14,815 + 20% × $200,000 = $54,815.

If the insurer's owners invest the capital on their own, they receive $54,815 × 8% = $4,385 of interest. If the insurer invests the capital, it pays 35% × $4,385 = $1,535 of federal income tax and its owners receive $2,850. The $1,535 cost of holding capital is the fair value risk margin for the unpaid loss liability.

Some financial economists say that the cost of holding capital is just the 8% × 35% = 2.8% cost of double taxation on risk-free investments.[30] If the equityholders wish a risky 12% return, the insurer can invest its capital in risky 12% investments. Capital markets are efficient, so

- the present value of risky 12% investments is the present value of the 8% risk-free rate
- the after-tax present value on the risky investment is valued at a 12% × (1 – 35%) = 7.80% rate and equals the after-tax present value of a risk-free investment valued at an 8% × (1 – 35%) = 5.20% rate.

Some actuaries say that investment in low risk securities is a cost of insurance operations.[31] Equityholders may wish to invest in riskier securities, such as common stocks and venture capital, but choose lower risk securities to comply with the NAIC Model Investment Act and ensure high ratings from Moody's, S+P, and A. M. Best.[32]

The cost of holding capital varies with the duration of the unpaid losses, where the duration is the time to settlement adjusted for interest.[33] Four years to settlement with a 5.2% after-tax yield (8% pre-tax yield) gives a duration of $(1 + 1/1.052 + 1/1.052^2 + 1/1.052^3) = 3.718$; five years gives a duration of $(1 + 1/1.052 + 1/1.052^2 + 1/1.052^3 + 1/1.052^4) = 4.541$.

ENTITY-SPECIFIC VS MARKET MEAURES

For fair value risk margins, market-based measures are preferred to entity-specific measures. We use industry capital levels as indicators of needed capital, not the capital held by the reporting company. Insurers with ratings of A- or A commonly hold about 2.0 to 2.5 times the RBC requirements. Rating agencies differ in their capital adequacy ratios: S+P has higher capital requirements and A. M. Bests has lower capital requirements. We use industry average ratios; we do not judge which capital adequacy ratio is correct.[34]

Illustration: Two insurers write workers' compensation; one holds weak reserves and has a 150% RBC ratio, and the other holds strong reserves and has a 300% RBC ratio. The economic value of the unpaid loss liability does not depend on the entity holding the reserve. Both insurers use the same fair value measures.

COMPONENTS OF CAPITAL

For fair value risk margins, we estimate the capital supporting unpaid losses. We divide the RBC charges into three parts:[35]

A. Capital supporting unpaid losses on earned exposures
B. Capital supporting unpaid losses on unearned exposures
C. Capital supporting surplus funds

The RBC written premium risk charge supports unpaid losses on unearned exposures and the reserving risk charge supports unpaid losses on earned exposures. Reinsurance (credit risk) charges apply to all unpaid losses. Asset risk charges apply to all capital.

Illustration: Suppose $110 million of unpaid workers' compensation losses on earned exposures has $10 million ceded to reinsurers. The net unpaid losses are funded 80% by bonds and 20% by common stock. Surplus is funded 50% by bonds and 50% by common stock. The required capital comprises

- reserving risk charges on $100 million of net reserves
- equity risk charges on $20 million of common stock
- fixed income risk charges on $80 million of bonds

- credit risk charges on $10 million of reinsurance recoverables
- asset risk charges on the four pieces above

If the required capital for the unpaid losses is $15 million, the asset risk charges on this capital is allocated to the unpaid losses. The fair value risk margin is the present value cost of holding all the capital required for the unpaid losses.

ENTRY FAIR VALUE SYSTEMS

An *entry* fair value system assumes that the fair value risk margin in a competitive market is the profit provision in the sale price. The fair value risk margin for insurance obligations is the profit margin in the premium.

Illustration: Suppose an office building can charge rents of $12 million a year for 50 years, after which the building has no salvage value. If the risk-free rate is 8% per annum, the value of the building is $12 million × $(1 - 1.08^{-50}) / (1 - 1.08^{-1})$ = $159 million. If the building sells for $112 million, the implied fair value risk margin is ($159 – $112) / $159 = 29.56% of the discounted value at the risk-free rate. Alternatively, the sale prices implies a capitalization rate of 12%, since $12 million × $(1 - 1.12^{-50}) / (1 - 1.12^{-1})$ = $112 million.

Some actuaries have suggested using an entry fair value measure for insurance products. Prices in a competitive market are the best measures of fair value, and premiums in competitive insurance markets are indicators of fair value. But policy premiums are not a substitute for valuation methods:

- The profit margin in the premium reflects both pricing risk and reserving risk. Actuaries differ on the relative size of these two risks and their effect on fair value risk margins.[36]
- The relative size of the fair value risk margin for unpaid losses on unexpired vs expired exposures depends on regulatory and rating agency capital requirements.[37]
- The profit margin in the premium reflects both underwriting risk and investment risks.[38] For life insurers, investment operations have larger capital charges than underwriting operations. Assigning risk margins to each segment of the insurance company can be done by a valuation model, not by the profit margin in the premium.
- The profit margin in the premium varies through the underwriting cycle; the fair value of unpaid losses does not. Underwriting cycles reflect long-term competitive strategy, not the estimated costs of the policy.

An entry fair value system applied over a long period may be a check on the valuation model, if all risks are estimated, both underwriting and investment. The benefit of this check is probably less than the effort of analyzing all risks, underwriting cycle movements, catastrophes, and other distortions.

Pre-tax vs After-tax Risk Margins

Taxes have two effects on fair value risk margins:

- Double taxation is a cost of holding capital even though the capital earns a fair return. The cost of holding capital creates the risk margin.
- If the tax basis does not include the risk margin, the after-tax risk margin must be grossed up by $1 / (1 - \tau)$, where τ is the corporate tax rate.

The gross-up on fair value risk margins is large for fully taxable insurers.[39] Unpaid losses are not traded, and their fair values must be determined by formula. The IRS uses the present value of unpaid losses at the risk-free rate with no risk margin, which maximizes taxable income. The fair value risk margin on policy benefit reserves is underwriting income when the policy is sold. If the insurer needs a 10% *after-tax* risk margin, it must charge the policyholder a 10% / (1 – 35%) = 15.38% *pre-tax* risk margin.

Illustration: Suppose the present value of unpaid losses is 70% of the nominal value and the cost of holding capital to support these reserves is 10% of the nominal value, so the fair value of the unpaid losses is 80% of the nominal value.

If the nominal unpaid loss is $100,000, the insurer must collect $80,000 from the policyholder to earn a risk-free return on the capital supporting the loss. If the risk-free rate is the same as the inflation rate, the insurer earns no profit on the transaction. But the IRS values the loss at $70,000, so it sees a $10,000 profit in the transaction and charges a tax liability of $3,500. For the insurer to receive $10,000 after-tax, it must charge the policyholder $70,000 + $10,000 / (1 – 35%) = $85,385.[40]

Some analysts say the $3.585 million paid to the IRS when the policy is sold is a sunk cost, which does not affect the fair value risk margin. The better view is that this cost is marginal, since the tax liability is transferred if the unpaid losses are sold.[41]

Illustration: Unpaid Losses on Earned Exposures

We compute the fair value risk margins for unpaid losses on unearned and earned exposures. We begin with earned exposures, for which the capital requirements stem entirely from unpaid losses.[42] Our focus is the components of the risk margin, not the details. The computation highlights the elements affecting the risk margins, and the overall result is reasonable.

An insurer holds $100 million of workers' compensation loss reserves which will be paid (on average) in *seven* years. The average loss is paid 4½ years after its occurrence.[43] Small losses are paid more quickly than large losses, so the average maturity of unpaid losses on earned exposures (loss reserves) is longer than the average maturity of those on unearned exposures (accident year losses).[44]

Financial environment: The risk-free rate is 8% per annum, the insurer's investment yield on the assets backing its reserves is 9% per annum, the federal income tax rate is 35%, and the insurer's shareholders would earn 12% on funds invested in equally risky projects.

We distinguish underwriting risks from insurance operations. Insurance operations are risky, with an opportunity cost of capital 400 basis points above the risk-free rate. This is consistent with the observed beta of property-casualty insurers, which is slightly below average, and with the historical returns on the insurance industry.[45]

WORKERS' COMPENSATION CAPITAL REQUIREMENTS

The RBC workers' compensation charges are 11% for reserving risk and 20% for written premium risk, assuming average underwriting experience and loss development.[46]

- The RBC reserving risk charge is a 0.273 RBC ratio and a 0.872 adjustment for investment income, giving a charge of (1 + 0.273) × 0.872 – 1 = 11.01%.
- The RBC written premium risk charge is a 1.008 industry loss ratio, a 0.836 adjustment for investment income, and an assumed 36% expense ratio, giving a charge of 1.008 × 0.836 + 0.370 – 1 = 20.27%.[47]
- We use the industry average company adjustment of 1.000 and a growth charge of zero, since workers' compensation is growing less than 10% per annum.

We use premium and loss concentration factors of 85%, a covariance adjustment of 59%, and a ratio of adjusted surplus to RBC requirements of 200%; these are rough industry averages.[48] The marginal charges are ∂(Total Capital Requirement)/∂(Reserving Risk Charge) = $2 \times R_4 / [10^2 + 15^2 + (20 - 10)^2 + (75 + 10)^2 + 75^2]^{½} = 85/115.217 = 73.77\% \approx 74\%$ for reserving risk and $2 \times R_5 / [10^2 + 15^2 + (20 - 10)^2 + (75 + 10)^2 + 75^2]^{½} = 75/115.217 = 65.09\% \approx 65\%$ for written premium risk.

The marginal effects of the reserving and written premium risk charges is about 85% × 70% × 200% = 119.00%. The actual effect depends on the insurer's targeted RBC ratio and its base (NAIC RBC or rating agency formula) and ranges from 100% to 150%. We use 100% for the illustration, to avoid over-stating the capital requirements. A $1 increase in a reserving or written premium risk charge causes a $1 increase in the market-based capital requirement.

Pre-paid acquisition expenses are 25% and maintenance expenses are 10% of premium. The policies are fairly priced, so $1.00 of premium creates $1.00 × (1 – 25% – 10%) = $0.65 of discounted unpaid losses plus profit.

Unpaid losses on earned exposures (loss reserves) are paid in seven years, on average. For $100 million of nominal unpaid losses, the present value at an 8% risk-free rate is $100 million / 1.08^7 = $58.35 million.[49]

The cost of holding capital is disputed. The minimum cost is double taxation, or 35% × 8% = 2.80% at an 8% risk-free rate. The maximum cost is the difference between the opportunity cost of capital and the after-tax investment yield, or 12% – 8% × (1 – 35%) = 6.80% at a 12% capitalization rate. We use the average, or ½ × (2.80% + 6.80%) = 4.80%. The cost of holding capital affects the size of the fair value risk margin, not the derivation.

ASSETS BACKING UNPAID LOSSES

The assets needed by the insurer to hold the unpaid losses have three components:

- The present value of the unpaid losses.
- The implicit interest discount in the full value loss reserves.
- The explicit capital held for the reserving risk charge, the asset risk charge, and the credit risk (reinsurance) charge. For simplicity, this illustration has no reinsurance.

The unpaid losses are held for seven years (on average). The fair value risk margin is the present value at the after-tax risk-free rate of the cost of holding assets in excess of the present value of the unpaid loss. We use the after-tax rate because the IRS uses the present value of unpaid losses at the risk-free rate to determine the tax liability, not the fair value. For tax purposes, the risk margin is an allocation of *after-tax* surplus.[50]

The cost of holding capital the first year is 4.80% × $51.65 million = $2.48 million.[51] The implicit interest discount in the unpaid losses declines each year. We can model the loss payment pattern several ways:

- For pricing studies, we use the actual loss payment pattern, IRS loss reserve discount factors, and statutory deferred tax assets until losses reach final settlement.
- For algebraic formulas, we can approximate the payment pattern by a geometric decay of the unpaid losses, assuming Z% of held reserves are paid each subsequent year. A seven year duration has Z = 14.28%. The geometric decay simplifies the formulas, since the duration of remaining reserves remains constant.[52]
- This illustration assumes the reserve portfolio with weekly benefit payments from various policy years is traded for a lump sum payment in seven years. This allows simpler derivation of the required capital and the fair value risk margin.[53]

For the second year, the implicit interest discount is $100 million × (1 – 1.08^{-6}) = $36.98 million. The total capital is $11 million + $36.98 million = $46.98 million, and the cost of holding capital is $46.98 million × 4.80% = $2.26 million.

Year	*Implicit Interest Discount*	*Required Capital*	*Cost of Holding Capital*	*PV(COHC)*
1	41.65	52.65	2.53	2.53
2	36.98	47.98	2.30	2.19
3	31.94	42.94	2.06	1.86

4	26.50	37.50	1.80	1.55
5	20.62	31.62	1.52	1.24
6	14.27	25.27	1.21	0.94
7	7.41	18.41	0.88	0.65
Total				10.96

We use the *after-tax* investment yield to compute the total cost of holding capital, since capital is an after-tax cash flow. An 8% pre-tax yield is a 5.2% after-tax yield.

The fair value risk margin is $10.96 million; this is 10.96% of undiscounted unpaid losses or $10.96 / $58.35 = 18.78% of discounted reserves. The fair value liability for unpaid losses on earned exposures is $58.35 million + $10.96 million = $69.31 million.[54]

Profit Margin (Pricing) vs Risk Margin (Valuation)

In a competitive market, all costs are ultimately borne by consumers. The $10.96 million cost of holding capital is part of the fair value of unpaid losses, just as other loss costs or loss adjustment expenses. The IRS views this cost as profit and taxes it at 35%.[55] The *pre-tax* cost to the policyholder) is $10.96 million / (1 – 35%) = $16.86 million. The cost to reinsure the losses is $16.86 million plus their present value and any expenses of the reinsurer.[56]

The fair value is the market value in an efficient market with no transaction cost or other expenses but including the cost of holding capital to support the asset or liability. The fair value is the cost to reinsure the unpaid losses, or $16.86 million.[57]

Just as the profit margin in the premium is primarily tax costs, the fair value risk margin reflects tax costs. The pre-tax profit margin is about 60 to 70% paid to the IRS and the remainder paid to equityholders. The large IRS portion reflects the multiple taxes: underwriting income when the policy is written and investment income as long as unpaid losses remain on the books. The IRS again taxes shareholders on their dividend income and capital gains. Double taxation is the largest component of the cost of holding capital. The profit margin paid to equityholders may reflect the systematic investment risk on the assets supporting reserves, not the RBC charges; this is not part of the fair value risk margin.

ALLOCATION OF WRITTEN PREMIUM RISK CHARGE

This illustration allocates the written premium risk charge to the unpaid losses on unearned exposures (the loss portion of the unearned premium reserves). The written premium risk charge covers the uncertainty in rate adequacy and random loss fluctuations.

- Underwriting cycles cause premium fluctuations and losses from competitive pressures.

- State regulation affects the premiums charged and the actual profitability of the policies.
- Random loss fluctuations reflects catastrophes and other sources of process risk.

We allocate the written premium risk charge to unpaid losses on unexpired exposures.[58]

For simplicity, one might use the same fair value risk margin for unpaid losses on unearned vs earned exposures. The total cost of holding capital is assigned to all unpaid losses. If all unpaid losses are aggregated in fair value accounting statements, with no distinction between unpaid losses on expired vs unexpired exposures, why bother determining the appropriate charge for each?[59]

ASSET RISK CHARGES

We assume the unpaid losses are backed 80% by high grade bonds with an average risk-based capital charge of 2% and 20% by common stocks with a charge of 15%; the average charge is 2% × 80% + 15% × 20% = 4.60%. These are industry averages for property-casualty insurers. The actual bond charges range from 0% for Treasuries to 30% for bonds in default. The common stock charges are 15% for property-casualty insurers and 30% for life insurers.[60]

The asset risk charges are much smaller than the underwriting risk charges for property-casualty insurers, so the covariance adjustment greatly reduces their marginal effect on overall capital requirements.[61] For simplicity, we assume the asset risk charges are about one fifth the size of the underwriting risk charges, so the covariance adjustment reduces their marginal effect on total capital requirements to about 0.46%, and the 200% RBC ratio raises the required capital to 0.92%. The total assets (including the assets backing the reserving risk charge and the asset risk charges) backing the unpaid losses are about 100% + 11% + 0.92% ≈ 112% of the full value loss reserves. The required capital backing these assets is 0.92% × 112% = 1.03% ≈ 1%.

This charge is held for seven years. The fair value risk margin is the cost of holding capital times this charge for seven years, discounted at the after-tax risk-free rate:

Year	*Required Capital*	*Cost of Holding Capital*	*PV(COHC)*
1	1.030	0.049	0.049
2	1.030	0.049	0.047
3	1.030	0.049	0.045
4	1.030	0.049	0.042
5	1.030	0.049	0.040
6	1.030	0.049	0.038
7	1.030	0.049	0.036

Total	0.299

Adding the reserving risk and asset risk charges gives a total fair value risk margin of 10.96% + 0.30% = 11.26%.[62] We gross-up the charge to a pre-tax basis by dividing by (1 – 35%).

CREDIT RISK CHARGES

Premium receivables include earned but unbilled and accrued retrospective premiums, agents' balances, and reimbursements from employers on large dollar deductible policies. The credit risk charges for these receivables create additional cost of holding capital.

Illustration: An insurer has $100 million of workers' compensation premium each year, of which 5% are earned but unbilled premiums collected in one year and 5% are accrued retrospective premiums collected in three years, for an average of two years overall. None of the receivables are secured.[63]

- 10% of the receivables are not admitted on the statutory balance sheet.
- 10% of the receivables are admitted, so the RBC credit risk charge is another 90% × 10% = 9%. The covariance adjustment and RBC ratio of 200% translate this into about a 5% capital requirement.[64]
- The capital required from equityholders is 15% of the premium receivables. The cost of holding capital for two years (using 4.8%) is 15% × 4.8% × $(1/1.052^{½} + 1/1.052^{1½})$ = 1.37%.[65]

We allocate these costs to unpaid losses.[66]

REINSURANCE RECOVERABLES

The risk margin for reinsurance risk charges can be imposed on the reinsurance recoverable itself or on the unpaid loss.[67] Since the charge is designed to protect policyholders, we assign it to the unpaid losses.

The charge for reinsurance recoverables depends on the capital formula. The NAIC formula has a 10% charge for reinsurance recoverables and moves half the charge into the reserving risk category before the covariance adjustment. The marginal effect of the 10% reinsurance risk charge is about a 6% reserving risk charge.[68]

Reinsurance increases the fair value risk margin even if it decreases the risk of the losses. Suppose an insurer cedes workers' compensation losses with a nominal value of $100 million, a present value of $58 million, and a fair value of about 117% × $58 million = $67.86 million, for a premium of about $110 million plus expenses of the reinsurer. For simplicity, we assume expenses are zero. The premium is a decrease in cash.

- The statutory balance sheet shows a net unpaid loss of zero and an increase in surplus of $42 million.
- The present GAAP balance sheet shows a direct unpaid loss of $100 million and a reinsurance recoverable of $100 million. The increase in GAAP equity is zero, since the gain is deferred over the life of the claims.
- The fair value balance sheet shows a direct unpaid loss of $68 million + the cost of holding capital for the reinsurance charge of about $3.5 million. The reinsurance recoverable is $68 million. The primary insurer has a tax refund for 35% of the written premium risk charge and an after-tax loss of about $2 million for the credit risk charge.[69]
- Gains and losses on the fair value balance sheet are recognized immediately, as on the statutory balance sheet; they are not deferred over the life of the claims.[70]

Fair Value of Assets vs Unpaid Losses

An asset's market value does not depend on the entity holding the asset if it is traded in a liquid market. If the fair value of a share of stock depended on the risk-based capital requirements, the same share would have a different value if it is held by a mutual fund (with no risk-based capital requirements), a property-casualty insurer, with a low risk-based capital charge (about 3% of the stock's value), and a life insurer, with a high risk-based capital charge (about 40% of the stock's value).[71] But the stock has a single value. The risk-based capital charges raise the cost of insurance, not the cost of stocks.

If the fair value of unpaid losses depends on the cost of holding capital, which differs by insurer depending on their capital structure, their lines of business, and their asset portfolios, the fair value of unpaid losses depends on the entity holding the loss. This fair value can not be the market value in a liquid, efficient market.

Asset markets for common stock and bonds are efficient. Arbitrage prevents the asset's fair value from varying by its holder. The market value includes the cost for the marginal investor. Investors self-separate based on their costs. Personal investors with a low tax rate on capital gains but a high tax rate on dividends and interest income hold growth stocks. Insurers, with a high tax rate on capital gains and a low tax rate on dividend income, hold municipal bonds and income stocks. The marginal investor is generally the low cost investor. For common stocks, the marginal investor is the mutual fund serving personal investors, so we use no capital requirements for the stock's fair value.

Insurance markets are not efficient, or all insurers would charge the same price for the same policy, and all insurers selling the same policy would have the same expected returns. But insurer's expenses vary widely, of which the different costs of holding capital is a small part.[72]

Fair Value of Unpaid Losses on Unexpired Policies

The market price in an efficient market with no transaction costs or other expenses is the fair value. If a common stock sells for $80 a share and the investor pays $80 plus $5 of

brokerage fees per share, the fair value is $80 a share. In this situation, the transaction costs of $5 a share are listed explicitly and the market value of the common stock is clear.

An *entry fair value system* uses the profit margin in a competitive insurance market as a proxy for the fair value risk margin, since the profit margin is the risk margin needed to transfer the risk. The risk margin is taxable income, so the profit margin in the premium is grossed up for federal income taxes. We compute the fair value risk margin using the full premium, so that the fair value risk margin equals the equilibrium pre-tax profit margin.[73]

The written premium risk charge is a function of the gross premium, not the pure premium. One might infer that the written premium risk charge on the non-loss part of the premium (the expense and profit provision) should not be part of the fair value risk margins for unpaid losses on unearned exposures. But the risk charge is computed from the volatility of the loss ratios, so we assign the complete risk charge to the fair value risk margin.

In the illustration, unpaid losses of $55 million stem from $100 million of gross premium, with held capital of $20 million stemming from $10 million of written premium charges. This capital is held for a full year.[74]

The unearned premium reserves for annual policies are held for half a year. The $25 million of pre-paid acquisition costs are funded by equityholder capital, for an additional $12.5 million of dollar-years. We assume the insurer holds capital of twice the RBC requirements, so the capital needed the first year is 2 × $10 million + $12.5 million = $32.5 million. The cost of holding this capital is $32.5 million × 4.80% = $1.56 million.

The undiscounted losses are $55 million × $1.08^{4.5}$ = $77.76 million. These losses are held in reserves for four years before they are paid. The capital held for the reserving risk charge is $77.76 million × 11% = $8.55. We work out the implicit interest discount and the total capital need.

For the first year, the implicit interest discount is $77.76 million × $(1 - 1.08^{-4})$ = $20.60 million. The total capital is $8.55 million + $20.64 million = $29.15 million, and the cost of holding capital is $29.15 million × 4.80% = $1.40 million.[75]

Year	*Implicit Interest Discount*	*Required Capital*	*Cost of Holding Capital*	*PV(COHC)*
1	20.60	29.15	1.40	1.40
2	16.03	24.58	1.18	1.12
3	11.09	19.64	0.94	0.85
4	5.76	14.31	0.69	0.59
Total				3.96

The present value of the total capital charges is $1.56 M + $3.96 M = $5.52 million.

$$\$1.56 + \$1.40 + \$1.18/1.052^{1} + \$0.94/1.052^{2} + \$0.69/1.052^{3} = \$5.52 \text{ million.}$$

As a percentage of the present value of losses, this is \$5.52 / \$55 = 10.04%. This is the after-tax cost; the pre-tax cost is \$5.52 million / (1 – 35%) = \$8.49 million, or \$8.49 / \$55 = 15.44% of unpaid losses on unearned exposures.

RELATIVE SIZE OF RISK MARGINS

In this illustration, the fair value risk margin for unpaid losses on earned exposures (losses that have already occurred) is greater than the risk margin for unpaid losses on unearned exposures (losses that have not yet occurred). This seems counter-intuitive, since the uncertainty on unearned exposures is greater than that on earned exposures. For most blocks of business, the fair value risk margin is higher on unearned exposures.

We chose this illustration to emphasize that uncertainty is not the source of the risk margin, since underwriting risk is diversifiable and receives no extra return in efficient markets. The fair value risk margin stems from the cost of holding capital. Most of the capital held for workers' compensation supports the implicit interest discount in the full value loss reserves: the difference between discounted and undiscounted unpaid losses.

For workers' compensation, temporary total disability claims and medical-only claims form a large part of the unpaid losses on *unearned* exposures. These claims are paid rapidly and have little implicit interest discount, so the fair value risk margin is small. The unpaid losses on earned exposures are long-term disability claims, with high implicit interest discounts and high fair value risk margins.

CONCLUSION

We summarize the fair value of unpaid losses.

- The fair value of a financial asset or liability is (a) its market value if it is traded or (b) the presumed value in a liquid market if it is not traded.
- If insurers held no capital or had no cost of holding capital, the fair value of unpaid losses would be their present value at the appropriate capitalization rate.
- Unpaid losses have no systematic risk, since underwriting risk is diversifiable. Their present value is their nominal value discounted at a risk-free rate.[76]
- Insurers hold undiscounted losses for statutory accounting and they hold capital to satisfy regulatory and rating agency requirements.
- The cost of holding capital is the cost of double taxation and perhaps other costs.
- Capital is held each year that losses are unpaid. The cost of holding capital is the present value of future annual costs.
- The capital supporting unpaid losses is viewed as profit by the IRS. Future costs are discounted at an after-tax rate, and the present value is grossed up to a pre-tax value.
- The reserving risk charge is allocated to unpaid losses on expired exposures.
- The written premium risk charge is allocated to unpaid losses on unexpired exposures.

- Capital charges on assets, receivables, and reinsurance recoverables are designed to protect policyholders, not the insurer's shareholders, so they are allocated to unpaid losses.
- If insurer sold unpaid losses in a perfectly efficient market with no transaction costs, they would pay the present value of the unpaid losses plus the cost of holding capital.
- The cost of holding capital is a cost of losses just like losses and loss adjustment expenses. It is a liability, not an allocation of surplus. It is paid by the insurer (primarily to the IRS) as the losses are paid.

APPENDIX: AFTER-TAX AND PRE-TAX DISCOUNT RATES

For pre-tax cash flows, such as incurred losses, we use pre-tax discount rates. For after-tax cash flows, such as the fair value risk margins, we use after-tax discount rates.

- The present value of the unpaid loss is an offset to taxable income. The unwinding of the interest discount on unpaid losses offsets the taxes on the investment income on the assets backing the unpaid losses.
- The fair value risk margin is *not* an offset to taxable income. All risk margins are treated as profit by the IRS and taxed during the policy year. Even if the loss plus the risk margin is considered a liability by GAAP, the risk margin is re-classified as equity by the IRS.[77] No interest unwinding offsets the taxes on the investment income on the assets backing the fair value risk margins.

Illustration: An insurer has unpaid losses with a nominal value of $100,000 to be paid in five years. At an 8% discount rate, the present value is $100,000 / 1.08^5 = $68,058. For simplicity, we assume the cost of holding capital is $1,000 each year for five years. (In truth, the cost of holding capital depends on the implicit interest discount.) We derive the proper fair value risk margin as the present value of the five $1,000 annual costs.

- A statutory balance sheet shows assets of $100,000 backing the undiscounted losses.
- A tax balance sheet shows unpaid losses of $68,058 with no risk margin.

Investment income on the $68,058 of assets backing the present value of the incurred loss, or $68,058 × 8% = $5,445, is offset by interest unwinding on the incurred loss. The net tax liability is zero, and we use the pre-tax interest rate to value the incurred loss.

If we use the pre-tax rate to value the fair value risk margin, we need assets of

$$\$1{,}000 \times (1.08^{-1} + 1.08^{-3} + 1.08^{-3} + 1.08^{-4} + 1.08^{-5}) = \$3{,}993.$$

One year later, the fair value risk margin is

$$\$1{,}000 \times (1.08^{-1} + 1.08^{-3} + 1.08^{-3} + 1.08^{-4}) = \$3{,}312.$$

The $3,993 of assets earns interest income of $3,993 × 8% = $319, which is taxed at 35%, leaving $319 × (1 – 35%) = $208. After paying the $1,000 cost of holding capital, the remaining assets are $3,993 + $208 – $1,000 = $3,201, which is insufficient to back the fair value risk margin the next year.

If we use the after-tax rate of 8% × (1 – 35%) = 5.20% to value the fair value risk margin, we need assets of

$$\$1{,}000 \times (1.052^{-1} + 1.052^{-3} + 1.052^{-3} + 1.052^{-4} + 1.052^{-5}) = \$4{,}306.$$

One year later, the fair value risk margin is

$$\$1{,}000 \times (1.052^{-1} + 1.052^{-3} + 1.052^{-3} + 1.052^{-4}) = \$3{,}530.$$

The $4,306 of assets earns interest income of $4,306 × 8% = $344, which is taxed at 35%, leaving $344 × (1 – 35%) = $224. After paying the $1,000 cost of holding capital, the remaining assets are $4,306 + $224 – $1,000 = $3,530, which is just sufficient to back the fair value risk margin the next year.[78]

[1] Policy benefit reserves are loss reserves plus the loss portion of unearned premium reserves.

[2] (Details are provided in end-notes so as not to obscure the text of the paper.) The IRS uses the 60 month moving average of the federal mid-term rate for its loss reserve discount factors; this is the average Treasury yield for securities with 3 to 9 years remaining to maturity. The NAIC uses the lesser of yield on Treasury bills with a maturity equal to that of the average loss reserves and the insurer's own return on invested assets as the maximum permitted discount rate; see statement of statutory accounting principles No. 65, property-casualty insurance contracts, paragraph **. Woll [1987] and Lowe [198*] use risk-free interest rates.

[3] Butsic [1988] uses a risk margin of about 300 basis points subtracted from the discount rate. Conger, Hurley, and Lowe use substantial risk margins for workers' compensation and medical malpractice. Actuarial Standard of Practice #20 requires actuaries to consider risk margins if reserves are discounted.

[4] Statutory reserve are discounted in three instances: (i) tabular discounts on long-term disability and similar workers' compensation indemnity benefits, (ii) monoline (often single-state) medical malpractice carriers, and (iii) financially troubled insurers with explicit permission for discounting granted by their state insurance department. For simplicity, we do not discuss tabular discounts in this paper.

[5] Pure fair value is not appropriate for statutory financial statements geared to regulators safeguarding policyholder interests. Regulators must ensure that insurers can meet their insurance obligations even in adverse scenarios. Regulatory risk margins reflect the total risk of the asset or liability, not just the market risks that are relevant for fair values.

[6] The change in the market value, after adjusting for dividend distributions and capital contributions, is sometimes called economic income. Others use the term economic income for book measures that reflect the change in market value, such as the change in the net present value of the firm.

[7] Some actuaries say that underwriting risks are not diversifiable for the insurer, so they affect prices in product markets for insurance policies. This is no different for insurance than for other industries. Prices in product markets may reflect principal agent problems when unique risks affect managers' behavior. We include principal agent problems as one cost of holding capital; see the discussion below.

[8] Assessing the reliability of a valuation model for the fair value of unpaid losses is not easy. An insurance valuation model applied to unpaid losses of unexpired policies can be compared with the market premiums minus expenses. But premiums are based on claim severity and frequency trends and expected investment yields, with parameters chosen by the pricing actuary. Premiums fluctuate with underwriting cycles and they vary greatly by insurer. Insurance contracts are not traded, so arbitrage arguments do not ensure a fair value. Competition works slowly, since consumers face high costs of switching insurers. Comparison with market premiums is rarely a good judge of fair value.

[9] Transparency refers to *users' understanding*, not to the reporting entity's ease of deriving the measure. Fair values of non-traded assets or liabilities can be presented in two ways:

- Management's best estimate of the market value.

- The valuation model and inputs that management uses to estimate the market value.

The better presentation depends on the objectivity of the valuation inputs and the ease of calculation.

- If the inputs are objective but the valuation method is complex, management should provide best estimates of the fair value, with the inputs and valuation method as footnotes.
- If the inputs are subjective but the valuation method is simple, management should provide the valuation method and best estimates of the inputs in addition to the estimated fair value.
- If the valuation method is disputed, management should provide the inputs and the valuation method it uses, along with the results of that method.

Illustration: For a straight (non-callable) bond, the valuation method is simple; for a callable bond, the valuation method is complex.

- A privately issued bond has no market value. We value the bond using a discounted cash flow model and the following inputs: par value, maturity, coupon, the firm's debt rating, and the yield to maturity of publicly traded bonds issued by firms with the same debt rating. For a straight privately traded bond, management should provide at least the subjective inputs: the credit rating of the firm and the assumed yield to maturity corresponding to that credit rating and bond maturity.
- For a callable privately traded bond, the valuation method is complex, since it relies on binomial lattices and the assumed interest rate volatility. Management should provide the estimated fair value, with the inputs and valuation method as footnotes.

Similarly, market values of unpaid losses can be presented in two ways:

- Management's best estimate of the market value.
- The nominal value, discount rate, payment pattern, capital requirement, and cost of holding capital that management uses to estimate the market value.

For unpaid losses, financial professionals agree on the nominal values, payment patterns, and risk-free discount rates, though debate continues about the details. Capital requirements and the costs of holding capital are more subjective, with large effects on fair value risk margins.

The valuation method is complex, and users cannot determine fair values from the valuation inputs. Transparency requires management to compute the final fair values. Valuation inputs and methods should be disclosed, since users of financial statements are not familiar with the methods. This is informational disclosure; it does not take the place of fair value reporting. The assumed capital requirements and cost of holding capital should surely be disclosed, since the range of reasonable choices is wide.

[10] The NAIC risk-based capital formula uses a 5% discount rate for unpaid losses in its reserving risk charge and written premium risk charge; this rate was about 200 basis points below the risk-free rate in 1993. The RBC charges are regulatory margins; they depend on the characteristics of the insurer, such as its growth rate for property-casualty insurers and its size for life insurers.

[11] Many financial economists presume that systematic risk is measured by the covariance of an asset's returns with those of the overall market, as reflected by the Capital Asset Pricing Model. The theoretical foundations for the CAPM are strong, though the empirical evidence is weak. Nothing here relies on the CAPM. Risk that is independent of market returns is not systematic risk, but we do not specify the return required as a function of covariance with market returns.

Some economists say the property-casualty insurance industry is over-capitalized, and average returns are lower than would be expected based on the CAPM. The over-capitalization stems from historical regulation of insurance products and declining demand for many products (such as fire insurance and workers' compensation). Actual returns are lower than average, but this does not indicate low risk.

[12] Some financial economists (Hill, Fairley, Kahane) have tried to back into a systematic risk portion of underwriting, but their efforts have not been replicated by other theorists. Some actuaries say that arbitrage pricing theory, consumption CAPM, and behavioral theories take a broader view of systematic risk than covariance with market returns. This is true, though relatively few economists espouse these theories and most of the controversy relates to the exact risk-return relation.. These actuaries then argue that underwriting risks should be included within this broader view of systematic risk. This is a *non sequitor*, since underwriting risk is easily diversified by investors.

[13] Some actuaries argue that firms do diversify, indicating that smooth earnings are rewarded in efficient markets. But financial theory attributes firm diversification to principal-agent problems and other market imperfections.

- Shareholders wish the firm to focus on its strengths, even if this focus is risky.
- The largest asset of the firm's managers is their jobs; senior managers rarely obtain equivalent jobs if the firm fails. Their incentive is to diversify the firm's operations and engage in less risky projects, even if these are less profitable.

Shareholders induce managers to take risky projects by incentive compensation, stock options, and generous retirement packages. But it is difficult to prevent managers from diversifying their operations and choosing less risky projects. We include principal agent problems as a cost of holding capital.

[14] Similarly, a firm needs no capital to support its corporate debt. If a bond debenture requires the issuer to hold more equity capital than it would otherwise hold, the double taxation on this additional equity is a cost of issuing the debt. In an efficient capital market, the bondholders would require higher coupon payments if the debenture did not have the equity requirement. The difference in interest payments offsets the cost of holding the equity capital, or the firm would issue the higher coupon debt.

[15] For inflation sensitive annuities, such as workers' compensation permanent total disability cases, the payment stream and life expectancy provide the present value. For indemnity payments, the present value is sufficient to determine the fair value. For medical payments, which are shown at full value on statutory statements, nominal values are derived from present values to compute the fair value risk margins.

[16] To price insurance policies, we use a benchmark investment yield (the insurer's expected return) if investment risk is included in the target return on capital. To value unpaid losses independently of the assets backing them, we use a risk-free rate. GAAP standards for pension liabilities use a conservative investment yield, not the risk-free rate. These rates are too high for fair values, and it is uncertain if FASB would repeat its recommendation now even for pension liabilities. The cost of holding capital also varies with the risk-free rate. A higher rate gives lower present values of the unpaid losses, but a slightly higher fair value risk margin.

[17] If the risk-free rate is 8% per annum and state income tax rates average 2.5%, the Treasury yield is 8% × (1 – 2.5%) = 7.80%. The demand for Treasuries by foreign governments is driven by uncertainty about the world bond and equities markets and a reluctance to invest in private securities, reducing the yield on Treasury securities another 10 or 20 basis points.

[18] LIBOR is the London Interbank Offering Rate, or the rate at which large international banks lend funds to one another. Credit risk is almost nil on these loans, and no tax effects or unusual demand affects them.

[19] The NAIC Statement of Statutory Accounting Principles #65, *Property-Casualty Insurance Contracts*, on the maximum non-tabular discount rate matches the *maturity* of the risk-free securities with that of the unpaid losses. The IRS specifies the maturity of the Treasury securities as federal mid-term rates. A five year maturity is often assumed for casualty reserves. This choice avoids the effects of interest sensitivity on the effective duration of casualty loss reserves.

[20] The duration of property-casualty unpaid loss liabilities is disputed, with views ranging from a few months to several years. At issue is the inflation sensitivity of unpaid losses and the relation of interest rates to inflation rates. When the term structure of interest rates is steep, the chosen risk-free rate may vary as much as 200 or 250 basis points, causing a swing in fair values of as much as 10% for long-tailed lines of business. Insurers often hold long duration securities, for two reasons: (i) If renewal rates are high, the maturity of unpaid losses over a policy's lifetime, is long; and (ii) Property-casualty insurers are not subject to disintermediation, so higher yielding, long term securities do not pose additional risk.

[21] The 8% risk-free rate in the illustrations is heuristic. It is high for the low interest rate environment of the 1990's and early 2000's, and low for the high interest rate environment of the 1980's and late 1970's. A lower interest rate based on a shorter maturity gives a higher fair value but a lower fair value risk margin. A higher interest rate based on a longer maturity gives a lower fair value but a higher fair value risk margin.

[22] Moody's, Standard and Poor's, and A. M. Best all have capital adequacy ratios. The formulas have similar structures to the risk-based capital formula, though they include more risks. We use the RBC formula for the illustrations, since it is the best known and the most transparent. The capital adequacy standards of the rating agencies are proprietary, and their capital measures are not as clear.

[23] The average RBC ratio has increased over the past decade, as the rating agencies have placed more stress on capital adequacy.

[24] The NAIC reduces the RBC reserving risk charge by the implicit interest discount in the reserves and it treats the equity in the unearned premium reserves as the capital charge for unpaid losses on unexpired policies. Similarly, the rating agencies use the implicit interest discount in loss reserves and the equity in the unearned premium reserves as offsets to required capital.

[25] High ratios of actual to required capital may reflect management's desires, not those of owners. The managers are agents of the shareholders, but they set the capital structure to achieve their own goals.

[26] For pricing studies, the second perspective is correct. Insurance markets are competitive, so insurers are price-takers. Risk margins are based on industry characteristics, not the solvency ratios of individual firms. Both perspectives can be justified for fair value risk margins. We recommend the second perspective for risk margins as well:

- The fair value of a security is an attribute of the security, not of the entity holding it.
- The accounting standards boards favor market measures over entity-specific measures.

The cost of holding capital may also vary with the valuation date and the reserve valuation rate.

Valuation Date: The illustration values the fair value risk margin at year end. Some actuaries say that if the year-end capital requirement is $1,000, the requirement is $1,000 / 1.052 = $951 at the beginning of the year and $1,000 / $1.052^{½}$ = $975 at mid-year. Other actuaries say that the fair value risk margin should assume a current RBC valuation. An insurer with a $100 million capital requirement holds $100 million throughout the year, not just at year end. We follow the second perspective here.

Reserve valuation rate: Some actuaries say that the cost of holding capital varies with the reserve valuation rate used for statutory accounting: higher for undiscounted reserves and lower for discounted reserves. The illustrations assume the insurer holds full value loss reserves on its statutory books. Some insurers hold lower reserves for long-tailed products and during downturns of the underwriting cycle. Similarly, an insurer might use tabular discounts for long-term disability reserves. An insurer that holds lower reserves might have lower or higher fair value risk margins, depending on rating agency valuations.

Other actuaries say that the rating agencies consider reserve adequacy and tabular discounts when estimating capital requirements, and the procedure used by the insurer in its statutory financial statements is not relevant.

[27] *Operational Costs* are also relevant. Regulators may require insurers to assess the adequacy of their reserves, complete time-consuming forms, and pay for financial examinations. The costs of completing Schedule P and analogous SEC exhibits and the costs of triennial exams by state insurance departments are an additional cost of holding capital.

[28] The personal tax rate for capital gains is lower than that for interest income, and this may offset part of the cost of double taxation. Financial economists are unsure how to measure the economic costs of personal tax rates affecting shareholders of insurance companies.

[29] Some property-casualty insurers use debt funding, by surplus notes, capital notes, or corporate debt issued by holding companies or affiliates. Industry figures are not readily available for debt funding.

[30] We seek the fair value risk margin for unpaid losses without adulteration by the fair value risk margin for risky assets. To separate the insurer's underwriting risk from its investment risk, we use risk-free rates to estimate fair value risk margins for unpaid losses.

[31] Cf. Atkinson and Dallas [2000].

[32] This view is hard to judge, since many insurers do invest in common stock, real estate, high-yield bonds, and venture capital. We do not judge between these two perspectives. Our objective is to explain *how to derive* fair value risk margins, not to estimate the cost of holding capital or the other parameters.

[33] This *duration* is *not* the modified duration or Macaulay duration for fixed-income securities.

[34] Some actuaries argue that the ratio of needed capital to RBC requirements should vary by line of business. The RBC underwriting risk charges reflect the underwriting cycle of the early and mid 1980's, which was most severe in medical malpractice and other commercial liability lines of business. The charges do not consider natural catastrophes that affect property returns, the insurer's reserve adequacy, unfunded asbestos and pollution exposures, existing reinsurance arrangements, or interest rate risk.

Fair value is a market measure, not an actuarial measure. In theory, we use the market ratios of held capital to RBC requirements or rating agency capital standards by line of business. Ratios by line are hard to estimate. This paper explains how to derive fair value risk margins; it does not judge the various capital measures. Capital adequacy measures differ among rating agencies and regulatory bodies, but the method of deriving fair value risk margins is the same.

Some actuaries supplement the regulatory risk measures with theoretical analyses, such as tail value at risk and expected policyholder deficit measures. For accounting fair value standards, we use market-based estimates based on regulatory requirements.

[35] An analysis on rating agency capital adequacy ratios might allocate the risk margin differently by line of business or between losses on expired vs unexpired policies. The various formulas have similar structures, and the differences are not great.

[36] Philbrick assigns the same risk to the loss portion of the unearned premium reserves as to loss reserves. Butsic assumes pricing risk is greater than reserving risk but the difference is not great. Hodes, Feldblum, and Blumsohn ascribe most underwriting risk to claim occurrence for lines of business with statutory benefits.

[37] The capital requirements reflect total risk, which are higher for unpaid losses on unexpired policies. The idiosyncracies of the capital adequacy formulas sometimes cause higher risk margins for unpaid losses on expired exposures. We show this below for first dollar workers' compensation coverage.

[38] Some analysts presume that insurers have large systematic investment risk but not underwriting risk.

[39] Not all analyses of fair value risk margins include the second tax effect. The tax is incurred when the policy is written, and some analysts view it as a sunk cost. But the tax is recouped if the unpaid losses are sold (reinsured). They are a marginal cost of unpaid losses, not a sunk cost.

[40] We compare with investable assets, where the tax basis includes the risk margin. The investment illustration highlights the extra cost for unpaid losses, where the tax basis does not include the risk margin.

Illustration: Suppose the risk-free rate is 7% per annum, the market risk premium is 8%, a common stock pays an annual dividend of $5 in one year, the dividend growth rate is 3% per annum, and the stock's CAPM beta is 1.250. We derive the expected stock price from the dividend growth model and its risk margin.

- The stock's capitalization rate based on the CAPM is 7% + 1.25 × 8% = 17%. The stock price based on the dividend growth model is $5.00 / (17% – 3%) = $35.71.
- If all investors were risk-neutral, the capitalization rate would be 7% and the stock price would be $5.00 / (7% – 3%) = $125.00.

The investor buys the stock of $35.71 a share. The value of the stock has two pieces: $125.00 a share (if all investors were risk-neutral) *minus* a risk margin of $125 – $35.71 = $89.29.

The risk margin is part of the market value of the stock, so the tax liability upon buying the share is zero. If the IRS valued the stock using a risk-free discount rate (as it does for unpaid losses), its value would be $125.00 a share, and the investor would owe a tax liability of $89.29 × 35% = $31.25. When the investor sells the share, the IRS would pay a refund of $31.25.

[41] If Insurer A transfers $100 million of unpaid nominal losses to Insurer B, it must give Insurer B $80 million in after-tax funds. The IRS values the unpaid losses at $70 million, so the IRS charges Insurer B with $10 million of underwriting income, on which the tax liability is $3.5 million. For Insurer B to receive $10 million of after-tax funds, Insurer A must pay a $10 million / (1 – 35%) = $15.385 million pre-tax risk margin to create a $10 million after-tax risk margin, or a total of $85.385 million.

- Insurer B has a $15.385 million pre-tax underwriting gain, giving it a tax liability of $5.385 million and a $10 million after-tax underwriting gain.
- Insurer A has a $15.385 million pre-tax underwriting loss, giving it a tax refund of $5.385 million and a $10 million after-tax underwriting loss.

[42] For unearned exposures, the capital requirements reflect the uncertainty in losses and the risks of marketplace competition, state regulation, and unemployment that may cause rates to be inadequate. We assign them all to the fair value risk margin on unpaid losses, but not all analysts agree with this.

[43] The illustration uses a 7 year average duration of unpaid losses on earned exposures. The average maturities of unpaid losses on earned vs unearned exposures depends on the policy type (in addition to line of business, industry class, and state):

- For first dollar coverage in low hazard classes, incurred losses are primarily temporary total and permanent partial cases, with short to medium durations. Unpaid losses on unearned exposures are predominantly longer-term disability cases.
- For large dollar deductible coverage with a high deductible, incurred losses and unpaid losses are the same types of claims. The unpaid losses on unearned exposures are older claims with shorter remaining maturities.

The average duration of unpaid losses has the greatest effect on the risk margin, since the present value of

the cost of holding capital depends on the duration. Long duration claims are not necessarily riskier; we do not quantify the risk of the reserves.

[44] The illustration below uses an idealized payment pattern to show this difference.

Illustration: Suppose losses are $100 million, ¾ of the losses are paid one year after they occur and ¼ are paid 15 years after they occur. The average loss is paid ¾ × 1 + ¼ × 15 = 4½ years after it occurs. Policies are written evenly through the year.

- At the end of the policy year, half the losses ($50 million) have occurred and are held in reserves and half the losses have not yet occurred. The average policy effective date is mid-way through the year, so the average accident date for losses which have occurred is ¾ of the way through the year. At year-end, the average age of losses which have occurred is 3 months (¼ year). ¾ of these losses have 9 months left to payment and ¼ have 14 years and 9 months. The average remaining duration is ¾ × ¾ yr + ¼ × 14¾ yr) = 4¼ years. This makes sense: no losses have yet been paid; the average loss is paid 4½ years after it occurs; the average loss is ¼ of a year old; the average reserve is paid in 4¼ years.
- One year later, all the losses have occurred and ½ × ¾ = ⅜ have been paid. (The paid losses are the small losses occurring the first 12 months of the policy year.) The remaining losses are $25 million of large losses and $32.5 million of small losses. The large losses remain in reserves for another 13 years. The average remaining duration of these reserves over the next 13 years is (13¾ + 12¾ + … + ¾) / 13 = 7¾ years. The small losses remain in reserves for ¼ of a year, on average.
- The last year (15 years after inception of the policy year) only $12.5 million remains in reserves, with an average duration of ¼ years.

In a steady state, each year gets equal weight. The total reserve at any year end is $50 M + $32.5 M + 13 × $25 M + $12.5 M = $420.00 million. The average duration of unpaid losses on earned exposures is ($50 million × 4¼ + $32.5 million × ¼ + 13 × $25 million × 7¾ + $12.5 million × ¼) / $420 million ≈ 7 years.

The workers' compensation size-of-loss distribution is similar. Most claims are temporary total disability or medical-only that are paid within a year or two. A small percentage of claims (though a large portion of loss dollars) are permanent total or partial disability claims that remain open for up to 30 or 40 years. The unpaid losses held in reserves for older accident years are long-term disability cases, with average payments 10 to 15 years after occurrence.

[45] Insurance operations have two sources of risk: investment risk and underwriting risk.

- Some financial economists say that underwriting risk is fully diversifiable, and the 400 basis point spread stems from investment risk. If the investment yield is 9% per annum, or 100 basis points above the risk-free rate, the ratio of assets to capital is 4 to 1.
- Other economists say that some pricing risks are systematic: underwriting results are correlated with market returns, because premiums are positively correlated with economic conditions or losses are negatively correlated with economic conditions.

Empirically, workers' compensation losses are slightly *positively* correlated with economic conditions (higher in more prosperous years), and premium rates *seem* to be uncorrelated with economic conditions (underwriting cycles seem uncorrelated with business cycles). Premium *volume* is positively correlated with economic conditions, since prospering firms have higher payrolls and higher premiums. Losses rise more rapidly with higher payrolls, so the correlation of workers' compensation underwriting profits with economic conditions should be slightly negative.

Insurance operations are no different from those of other industries that are uncorrelated with economic conditions. The CAPM betas for most of these industries are below average but close to one, not close to zero. The relation of the CAPM beta to a firm's operations is not well understood, and we do not judge this issue here. We assume that underwriting risk is diversifiable and warrants no additional return.

[46] The actuarial accuracy of these charges is not our concern. The regulatory and rating agency formulas affect the capital held by insurers, determining the cost of holding capital and the market values of unpaid losses. For simplicity, we use the NAIC's risk-based capital requirements. Many insurers use capital adequacy standards of the major rating agencies. The by-line allocation of capital depends on the capital formula, but the concepts discussed here are the same.

[47] The RBC offsets for investment income (0.872 for reserving risk and 0.836 for written premium risk) imply a shorter duration for unpaid losses on earned exposures, contrary to the assumptions in this illustration. The RBC charges do not reflect the workers' compensation loss payment pattern. Workers' compensation has many short term temporary total disability claims and medical-only claims, for which the adjustment for investment income is slight, along with long-tailed permanent disability claims, for which the investment income adjustment is great. (Risk-based capital formula uses the term *adjustment for investment income* instead of discount factor.) The incurred losses in an accident year are a mix of these two types of claim, but the unpaid losses held in reserves are almost entirely the latter type.

The 0.836 factor for written premium risk was calculated from the IRS loss payment pattern in 1992 along with a 5% discount rate; we presume the factor is correctly computed. But the reserving risk charge using the stated RBC procedure came out to about zero. This gave an insurer a greater capital requirement if it retroactively reinsured its workers' compensation loss reserves than if it retained them, since the RBC charge for reinsurance recoverables is 10%. The NAIC thought this is counterintuitive, since reinsurance *reduces* risk, so it changed the reserving risk charge to 11%. The 0.273 adverse development and the 0.872 adjustment for investment income were selected to give an 11% reserving risk charge; they have no necessary relation to the actual loss payment pattern.

[48] The details of the computation are:

- The premium and loss concentration factors assume that premium and reserves for the largest line are half the insurer's total premium and reserves: 70% + ½ × 30% = 85%.
- The 59% covariance adjustment assumes a 10-15-20-75-75 split of risk charges among fixed-income (R_1), equity (R_2), credit (R_3), reserving (R_4), and written premium risks (R_5). The total RBC charges are 195. The covariance adjustment uses the square root of the sum of squares after moving half the credit risk into the reserving risk charge: $[10^2 + 15^2 + (20 - 10)^2 + (75 + 10)^2 + 75^2]^{½} = 115.217$. The covariance adjustment is 115.217 / 195 = 59.09%.
- The 200% ratio of adjusted surplus to RBC requirements reflects an A rating from A. M. Best. Standard and Poor's and Moody's use more stringent capital adequacy ratios. The 200% RBC ratio corresponds to an A- rating from these agencies and is now slightly below the industry average.

[49] We have no direct (closed form) method to derive the profit margin; we use iterative methods for pricing studies, which are difficult to present in an expository paper. Our purpose is to derive fair value risk margins, not to solve for equilibrium profit margins, so we assume that the pre-tax profit margin in the premium is abut 7% after investment income. Since the IRS takes about 70% of the pre-tax profit margin, this is 3% after-tax. A premium to surplus ratio of 2 to 1 is about a 1 to 1 premium to capital ratio for workers' compensation, creating a 3% return on capital, the assumed cost of double taxation. With acquisition expenses of 25%, maintenance expenses of 10%, and profit of 7%, $1.00 of premium creates 58¢ of discounted losses.

[50] A more accurate analysis uses a pre-tax discount rate and separately models the tax cash flows.

[51] If loss cash flows occur at mid-year (on average), they occur six months after the valuation date, so some analysts discount by another half year. The illustration assumes the losses are paid seven years after the valuation date, so we use no additional discount. For pricing studies, we use exact loss payment patterns.

[52] For most lines of business, the geometric decay is a reasonable approximation, and the loss of precision is not great. For workers' compensation, the loss payment pattern is slower, with a thicker tail.

[53] We do not assume that the average loss is paid in seven years. If losses occur at mid-year (on average) and are paid seven years after they occur, the average year-end reserve duration would be (6.5 + 5.5 + 4.5 + 3.5 + 2.5 + 1.5 + 0.5) / 7 = 3.500 years.

[54] Some analysts adjust for half a year of additional discount, as mentioned earlier.

[55] Not only is the burden of supporting unpaid losses with high capital requirements placed on consumers, but they are taxed a second time for the privilege of doing this. Politicians presume that high-income insurance company executives pay this cost, but the true cost is borne disproportionately by blue collar manufacturing and construction workers (for workers' compensation) and young, inner-city residents (for personal auto insurance).

[56] The capital cost to reinsure the losses is $16.86 million. Some analysts say the ceding company receives a tax refund of $16.86 million × 35% = $5.90 million, so the *net* cost is $16.86 million – $5.90 million = $10.96 million. But the $5.90 tax refund offsets the taxes paid of $5.90 when the policy was written. The market value of the unpaid losses is the pre-tax value of $16.86 million.

[57] This is the same as the treatment of high yield bonds. Suppose the risk-free rate is 8% per annum, an investor expects defaults equivalent to 5% per annum on the high yield bond, and returns on the bond are not correlated with market returns (the CAPM beta is zero). The after-tax return on a risk-free security is 5.2%. If the investor receives 8% + 5% + 13% on the high yield bond and *capital losses could offset interest income*, the after-tax return on the bond is 5.2%. But capital losses (such as bond defaults) can offset only capital gains, which are taxed at 15% for personal taxpayers, so the investor must receive more than a 13% pre-tax return to achieve a 5.2% after-tax return. The pre-tax premium for the high yield bond depends on the tax status of the marginal investor.

An increase in the tax rate on interest income raises the pre-tax premium for high yield bonds, just like an increase in the tax rate on underwriting income raises the fair value risk margin for unpaid losses.

For common stocks, the market risk premium is a pre-tax premium. An increase in the tax rate on equity income (common stock dividends and capital gains) vis-a-vis interest income raises the market risk premium. Firms would use more debt financing, which becomes cheaper relative to equity financing. An increase in the tax rate on all income has less clear effects. Everyone requires a higher pre-tax income to receive the same after-tax income, but the higher tax rate reduces equilibrium output. In aggregate, all workers receive less pre-tax income, and the incidence of the tax depends on elasticities of supply and demand.

[58] Four methods of allocating the written premium risk charge are possible:

- *0%:* In theory, the reserving risk charge supports unpaid losses on expired exposures, the charge on unearned premium reserves supports unpaid losses on unexpired exposures, and the written premium risk charge supports adverse experience on next year's business. The equity in the unearned premium reserves is large enough that no further charge is needed in the risk-based capital formula. From this perspective, the written premium risk charge should be allocated to *next year*'s writings. This is mistaken, since we use the economic incidence of the charge, not its intended purpose. An insurer incurs the charge by writing business this year, not by writing business next year.

- *50%:* Suppose an insurer writes policies evenly over the year. At the end of the year, half the losses have occurred and half have not occurred. The written premium risk charge should be allocated half to unpaid losses on unexpired exposures and half to unpaid losses on expired exposures. But the written premium risk charge is incurred when the policy is written, not when the policy is earned. At policy inception, none of the exposures are earned, so the entire charge is allocated to unpaid losses on unexpired exposures.

- *66.7%:* The unpaid losses are about two thirds of the policy premium. The written premium risk charge is a function of the gross premium, not of the net premium. Higher expenses cause a higher written premium risk charge, just as higher expected losses cause a higher written premium risk charge. But policyholders pay for the insurer to assume their loss costs, and they pay the full written premium risk charge. The charge reflects the fluctuations in losses, not the fluctuations in expenses.

- *100%:* We allocate the full written premium risk charge to unpaid losses on unexpired exposures, since the insurer incurs the full charge when it writes the policy. One might argue that the charge stays with the losses until they are settled, so the charge should be pro-rated over the lifetime of the claims.

Illustration: An insurer writes policies with $100 million of unpaid losses that will be paid in five years. One year later, the exposures are earned, and only the reserving risk charge remains (along with asset charges and credit risk charges). If the insurer sells the loss reserves to a reinsurer, the reinsurer incurs both written premium risk charges and reserving risk charges, and the primary insurer has negative net written premium and reduces both its written premium risk charges and reserving risk charges.

This would be correct if the underwriting risk charges were like the risk charges on common stock. The common stock doesn't change over time, so the risk charge remains with the stock. But the underwriting risk charges relate to the costs incurred by the insurer. The reserving risk charges are incurred each year; the written premium risk charge is incurred up front.

[59] Needless accounting expenses should not be incurred for actuarial purity. But these accounting expenses are not material. The fair value risk margins are industry measures, not entity-specific measures. Once the cost of holding capital is quantified as a percentage of the unpaid loss, the insurer uses a leverage ratio for the fair value risk margin. If a rating bureau determines a fair value risk margin of 10% of the unpaid loss, an insurer need not redo the computations on its own data.

The true fair value risk margin differs for expired vs unexpired exposures. The market values of the unpaid losses is useful for many contexts, so we quantify the market values separately for expired exposures vs unexpired exposures. But an insurer may decide to show all unpaid losses as a single entry with the same fair value risk margin. This raises the risk margin on earned exposures (loss reserves) and lowers the risk margin on unearned exposures (the loss portion of the unearned premium reserves), with no effect overall.

[60] Some actuaries notionally allocate fixed-income securities to back unpaid losses and equity to back surplus. But surplus supports unpaid losses, and the cost of holding capital for the asset risk charges on surplus funds are allocated back to unpaid losses. In theory, we might use different percentages of bonds vs stocks by line of business, depending on the ratio of surplus to unpaid losses. For workers' compensation, with a high reserves to surplus ratio, we use a higher percentage of bonds; for commercial fire, with a low reserves to surplus ratio, we use a higher percentage of equities. This procedure is reasonable, though the effect on the fair value risk margin is not material.

[61] The opposite is true for life insurers, whose fair value risk margins depend primarily on asset risk charges.

[62] As for the underwriting risk charges, we may discount for an additional half year, reflecting the payment date of the unpaid losses.

[63] The non-admitted asset is 10% of the unsecured receivables.

[64] Half the credit risk charge is moved to the reserving risk category R_4, which has a marginal effect of 100% on statutory surplus. The other half remains in the credit risk category R_3, which is about a tenth the size of the reserving risk category and has about one tenth the marginal effect on statutory surplus: ½ × 9% + ½ × 9% × 0.1 = 4.95% ≈ 5%.

[65] From a calendar year perspective, if the premium each year is $100 million, the receivables each year are $5 million of earned but unbilled premiums and $15 million (3 years of $5 million each) of accrued retrospective premiums. The calendar year charge is 15% of the total receivables with no discount for the second year. In a steady state, the real premium is the same each year, but the dollars increase with inflation. If inflation is the same as the discount rate, the two perspectives give the same cost.

The calendar year perspective is used by many accountants, but it is not always accurate. A policy incurs charges for the risks it creates, not for other charges on the balance sheet. Premium receivables stemming from past business are a cost of the past business, not a cost of the current business.

[66] Some analysts view the risk margin on uncertain premium receivables like the risk margin on other uncertain assets. It is allocated on the uncertain asset, or deducted from the certainty equivalent value of the asset. This is mistaken. The *expected uncollectible* portion of the premium receivables is deducted from the asset as a bad debt, since an insurer concerned about collectibility adds a risk margin to the premium receivable and charges for the expected uncollectible portion in the premium. The premium receivable is higher than it would be if it were certain, and the net value is the certainty equivalent.

The credit risk charge is designed to protect claimants from insolvency risk stemming from uncollectible receivables, not to protect the insurer. The cost of holding capital for credit risk is included in the fair value risk margins for unpaid losses. The capital requirements for all assets are not designed to protect the insurer from asset default but to protect the policyholder from insurer default. The market values of the assets contain risk margins to protect investors; the additional margins imposed by risk-based capital requirements and capital adequacy ratios protect policyholders.

The rationale for a single risk margin on unpaid losses is strong. The receivables can be sold (factored) to an non-insurance company, which has no capital requirements or admissibility constraints. The market value of the receivables depends on their expected cash flows and capitalization rate. The cost of holding capital is peculiar to the insurer holding the unpaid losses.

[67] The two methods are

- *Risk margin on the recoverable:* Fair value financial statements show unpaid losses gross of reinsurance. The credit charge for reinsurance recoverables reduces the value of the recoverable; it does not affect the fair value of the gross unpaid losses.
- *Risk margin on the unpaid loss:* An insurer might not write the business unless it could reinsure an excess layer. The cost of reinsurance is part of the cost of writing the business, and the capital needed for the reinsurance credit risk charge is part of the capital needed to support the unpaid losses.

[68] The rating agency capital adequacy ratios generally focus on expected collectibility by reinsurer.

[69] Alternatively, the direct unpaid loss on the fair value balance sheet would not include the risk margin for the reserving risk charge, which is imposed only on net statutory unpaid losses. It would still include the risk margin for the reinsurance risk charge. The fair value income statement also shows an expense for the reinsurer's underwriting and acquisition costs, as does the statutory income statement. For the GAAP income statement, the expenses are amortized over the life of the claims.

[70] Fair value accounting entries for the risk margins and deferred tax assets and liabilities are unclear; the text shows one method of recording them. Accountants differ on the proper format.

[71] Risk-based capital requirements for common stocks are 15% for property-casualty insurers and 30% for life insurers. The covariance adjustment reduces the charge by about 90% for property-casualty insurers and by about 30% to 40% for life insurers. The 200% market ratio for the capital actually held gives the figures in the text. The high cost for life insurers further discourages them from holding common stock. The fair value risk margin is the cost of holding this capital: 3% × 4.8% = 0.144% for property-casualty insurers.

[72] In the long-run, more efficient firms may drive out less efficient firms. In the short run, material cost differences cause immediate changes. When the Congress changed the tax laws in 1980, 1982, and 1984 reducing or eliminating the tax benefits of municipal bonds for commercial banks, yields on the bonds rose and property-casualty insurers bought more of them. Friction costs prevent immediate changes. The costs of trading bonds or stocks exceeds the cost of holding capital. Insurer change their asset portfolios incrementally over many years, by buying less of the low yielding assets and more of the high yielding assets. Similarly, the risk-based capital formulas may encourage small firms to merge or be acquired by larger firms.

[73] If insurance markets were perfectly efficient, the fair value risk margin should equal the profit margin in the premium. Premium rates should change only as estimates of losses change. In fact, premium rates fluctuate widely from year to year, reflecting insurer business strategies, not just new loss expectations. Arbitrage prevents cycles in efficient markets. If stock prices followed predictable cycles, investors would buy at low points and sell at high points. But insurance policies can not be stored for future use.

We assume that insurance markets are competitive in the long-run. Over a full underwriting cycle, the profit margin in the premium should be close to the fair value risk margin.

[74] The risk-based capital charges for the policy year and the first reserve year overlap by half a year. This is a quirk of the RBC formula.

[75] For the second year, the implicit interest discount is \$77.76 million × $(1 - 1.08^{-3})$ = \$16.03 million. The total capital is \$8.55 million + \$16.03 million = \$24.58 million, and the cost of holding capital is \$24.58 million × 4.80% = \$1.18 million.

For the third year, the implicit interest discount is \$77.76 million × $(1 - 1.08^{-2})$ = \$11.09 million. The total capital is \$8.55 million + \$11.09 million = \$19.64 million, and the cost of holding capital is \$19.64 million × 4.80% = \$0.94 million.

For the fourth year, the implicit interest discount is \$77.76 million × $(1 - 1.08^{-1})$ = \$5.76 million. The total capital is \$8.55 million + \$5.76 million = \$14.31 million, and the cost of holding capital is \$14.31 million × 4.80% = \$0.69 million.

[76] Principal agent problems might cause a lower rate for catastrophic exposures; we do not quantify this.

[77] Capital is an after-tax cash flow, so we use an after-tax discount rate. Capital is not generally viewed as a flow; it is a stock of money held by the firm. For modeling fair value risk margins, we conceive of capital as an annual flow from shareholders to the firm.

[78] Investment income on the \$68,058 of assets backing the present value of the incurred loss is offset by interest unwinding on the incurred loss. The net tax liability is zero, and we use the pre-tax interest rate to value the incurred loss. Investment income on the assets backing the fair value risk margin is *not* offset by interest unwinding on the risk margin, which is not an offset to taxable income. The net tax liability is 35% of the investment yield, and we use the after-tax interest rate to value the risk margin.

Both the present value of the unpaid loss and the fair value risk margin are paid by the policyholder. But for tax accounting, the unpaid loss is an offset to taxable income, but the IRS treats the fair value risk margin as after-tax uses of capital, and the risk margin is a profit margin. The fair value risk margin is taxed as profit during the policy year, and the net after-tax money pays the cost of holding capital.

Fair value accounting highlights an inequity of insurance taxation. The proper offset to taxable income is the market value of the unpaid losses, or the present value plus the fair value risk margin. But the IRS uses the present value of the unpaid losses at the risk-free rate, which is much lower, giving higher taxable income and a higher tax liability. The tax basis reserves do not include the fair value risk margin, which makes them too low and the tax liability too high. If GAAP adopts fair value unpaid losses, the IRS ought to use fair value

reserves for tax returns, lowering the tax liability.