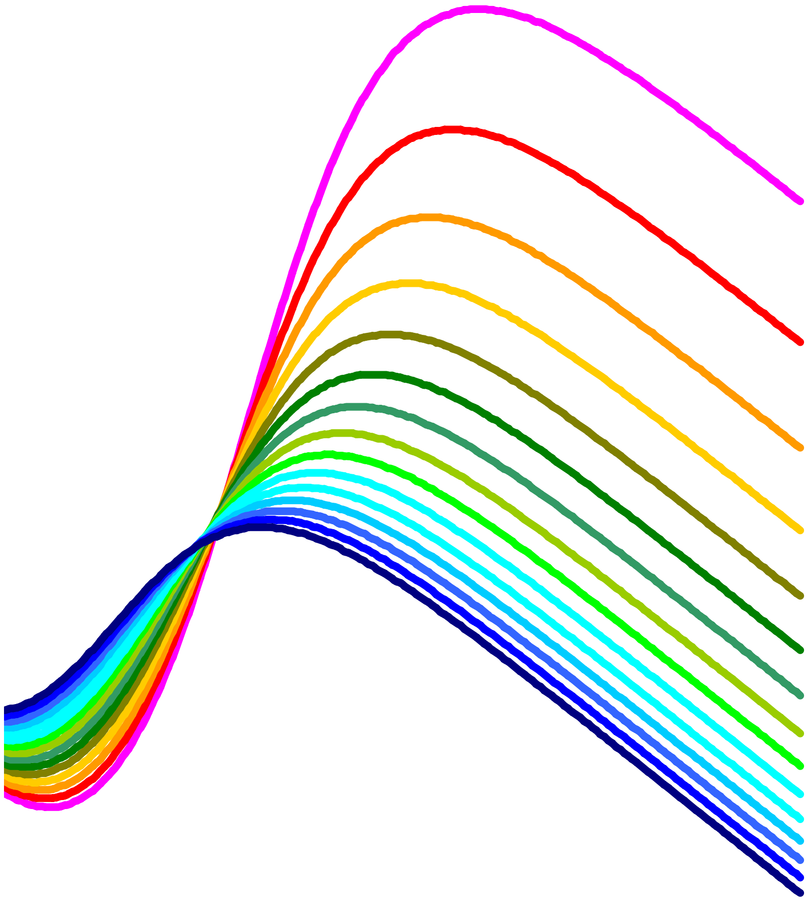

Managing the Invisible:

Measuring Risk, Managing Capital, Maximizing Value

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Executive Summary

Enterprise Risk Management (ERM) is a body of knowledge – concepts, methods, and techniques – that enables a firm to understand, measure, and manage its overall risk ***so as to maximize the firm's value to shareholders and policyholders***. The purpose of this paper is to demonstrate this often-asserted but seldom-described linkage between ERM on the one hand, and maximizing a firm's value on the other. In Part 1 I argue that ERM, by measuring the firm's aggregate risk exposure, enables the firm's managers to identify and choose value-maximizing combinations of risk and capital. In Part 2 I describe and critique the rules of thumb that CFO's typically rely on to make critical decisions concerning the firm's capital structure, and propose value maximization as an alternative. Part 3 describes alternative approaches to valuing a firm, and Part 4 presents a valuation model for a property-casualty firm. Part 5 shows how this valuation model can assist managers in making value-maximizing strategic decisions, and Part 6 emphasizes the substantial importance to insurance executives of value-focused ERM, which makes the value of the firm both visible and manageable.

Keywords: Enterprise Risk Management, ERM, franchise value, valuation, capital structure, optimization, property-casualty

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1 Introduction

"The purpose of computing is insight, not numbers." Richard Hamming, computer scientist

Enterprise Risk Management (ERM) is a body of knowledge – concepts, methods, and techniques – that enables a firm to understand, measure, and manage its overall risk ***so as to maximize the firm's value to shareholders and policyholders***.[1] The purpose of this paper is to demonstrate this asserted linkage between ERM on the one hand, and maximizing a firm's value on the other.

Most existing literature on ERM focuses on specific concepts, methods, and techniques for measuring particular risks and constructing an aggregate risk distribution for the firm as a whole. Important issues include the selection of appropriate risk measures, techniques for measuring the distribution of particular risks, alternative ways of representing dependencies among different risks, methods for producing an aggregate measure of firm-wide risk, and whether and how to allocate capital among alternative sources of risk within a firm.

Implicit in this rapidly growing body of work is the assumption that measuring its overall risk exposures will enable a firm to "better" manage its risk, and that this capability will add value. Typically missing is any concrete specification or demonstration of what this means and how it will come about. Notably scarce, for example, are papers that describe and critique alternative strategies for managing firm-wide risk or that define what is meant by "adding value" and propose ways that this could be implemented and measured in practice or even in principle.

What I demonstrate in this paper is that there are optimal combinations of risk and capital – optimal in that they maximize the value of the firm. Specifically, for a given level of risk there is a value-maximizing amount of capital. Alternatively, if capital is the constraint, then for a given level of capital there is an optimal (value-maximizing) level of risk exposure for the firm. ***ERM therefore can add to a firm's value because, by measuring the firm's aggregate risk exposure, it enables the firm's managers to identify and choose value-maximizing combinations of risk and capital.***

This demonstration takes the form of an explanatory model that presumes that the ERM group at the modeled firm has successfully measured its risk exposures and has correctly constructed from them an aggregate distribution of potential firm-wide losses. The model shows how to use this aggregate distribution, together with other financial information about the firm, to identify value-maximizing combinations of risk and capital. It is an *explanatory* model because it is deliberately simplified so that the virtues and defects of its fundamental logic will be readily apparent. If I have constructed this model correctly it should lead to approximately the same conclusions as an *elaborated* model, which includes numerous complexities found in most actual firms, or a *calibrated* model, which is an elaborated model with detail and parameters that match those of a particular firm. In contrast to an elaborated or calibrated model, then, the principal purpose of an *explanatory* model is insight, not numbers.

Not all firms are alike, and not all insights can be readily transferred from one industry to another. Here my focus will be on ERM as applied to a property-casualty insurer, and on surplus as the critical component of its capital structure. Although I

[1] This definition is quite similar to that of the CAS Advisory Committee on ERM: "ERM is the process by which organizations in all industries assess, control, exploit, finance, and monitor risks from all sources for the purpose of increasing the organization's short and long term value to its stakeholders."

recognize that reinsurance, debt, and various hybrid securities can be important components of an insurer's capital structure, I will treat them in a subsequent paper rather than add to the length and complexity of this one. Despite these limitations, I hope that the model and conclusions presented here add substantially to our understanding of the "M" in ERM.

2 Capital Structure in Theory and Practice

"I have become a bit disenchanted with the indiscriminate use of superrationality as the foundation for models of financial behavior." Franco Modigliani (1988), Nobel economist

It may seem foolhardy to speak of "optimal capital structure" when the phrase itself is considered an oxymoron by many financial economists and their present and former students. Indeed, Modigliani and Miller were recently honored with Nobel prizes in part for their assertion and proof of what is sometimes called the "capital structure irrelevance theorem," which is taught to virtually every MBA student. The theorem is indeed valid, but – and this crucial qualification is typically forgotten or ignored – only under circumstances that are rarely if ever encountered.[2] When bankruptcy and its associated costs are possible, the irrelevance theorem is itself irrelevant. But the influence of M&M's original work was so powerful and pervasive that, even today, bankruptcy is virtually ignored in many of the leading textbooks on corporate finance! Even in the recent professional literature bankruptcy is treated as one among a number of supposed "frictional costs" that cause the real world to deviate from the conditions originally assumed by M&M. But, given the rarity of convincing attempts to clarify or quantify frictional costs, most CFOs would be hard pressed to draw any practical conclusions from the corporate finance literature generated since the early 1980's, if not before. As a consequence, the term "oxymoron" is perhaps better suited to the phrase "applied corporate finance."[3]

In the absence of useful academic guidance, CFOs necessarily adopt pragmatic principles as guides to decision making concerning capital structure. Here are a few of them and the difficulties inherent to each.

a. **Maintain roughly the same financial ratios as peer companies.** This criterion shifts the task from determining the right financial ratios to determining the right peer companies, which may be different from the companies that currently are the most similar to one's own. In practice this criterion works only because firms <u>assume</u> a set of peer companies to which they compare themselves.
b. **Maintain the financial ratios consistent with our corporate risk tolerance.** This is often mentioned but virtually never specified. What is a corporate risk tolerance? How is it measured? How is such a measure related to possible financial ratios? Who is consulted in these decisions? Note that executives, policyholders, bond holders, and stockholders may disagree considerably on this criterion.[4]

[2] The real significance of M&M's path-breaking work was its use of arguments based on arbitrage – arguments that have fundamentally affected the evolution of finance as well as of financial securities and markets. For succinct reviews of portions of the voluminous relevant literature see Rubinstein (2003), Modigliani (1988), and Giesecke (2004).

[3] A refreshingly frank admission is found in Copeland, Weston, and Shastri (2005), p. 611: "How Does a Practitioner Use the Theory to Determine Optimal Capital Structure? The answer to this question is the Holy Grail of corporate finance. There is no completely satisfactory answer . . ."

[4] I am indebted to Richard Goldfarb for his numerous insights on this topic.

c. **Maintain the financial ratios required to achieve or maintain a target financial rating.** Using target ratings ignores the problem of choosing which rating to have, which may, in turn, depend on the clients that the firm serves or wishes to attract, the nature of the products offered by the firm (short-term versus long-term, and any guarantees associated with each), and the type of distribution system that it has established (agents may be sensitive to credit quality).

d. **Maintain a target beta and associated target cost of capital, as defined by the capital asset pricing model (CAPM).** This seems plausible except for the fact that, by assuming the validity of CAPM, it confronts and is refuted by the original M&M arguments. In my view, the story we tell ourselves to make "measuring relative stock market performance" equivalent to "measuring our cost of capital" requires, like many stories, a suspension of disbelief that is unsustainable when carefully scrutinized. But having admitted to such heretical doubt, I must nonetheless postpone defending it to another occasion. What I attempt instead is to outline an alternative story that may prove more useful.

Here I propose an alternative criterion: **for a given set of risk exposures, select the capital structure that <u>maximizes shareholder or policyholder value</u>.** (This restatement of the problem assumes that risk exposures are fixed and that capital structure is flexible. An alternative but equivalent criterion is as follows: for a given capital structure, select the aggregate risk exposure that maximizes the value of the firm to shareholders and policyholders. The two problems are mathematically equivalent – a fact that is analogous to the duality theorem in linear programming – but not necessary identical in practice.)

For this alternative criterion to be practical (i.e., one that can be implemented), we need a measure of value that can be derived from obtainable data (unlike risk tolerance), that is understandable by senior executives (unlike beta), and that can be used to explore and evaluate alternative capital structures and corporate strategies.

3 Valuing a Property-Casualty Insurance Firm

"Point of view is worth 80 IQ points." Alan Kay, a computer science pioneer

Like an unwelcome guest at an elegant dinner party, a central question in corporate finance is almost universally ignored: how to measure the value of a firm[5]. In practice there are two ways of answering this question. One might be called the *cross-sectional approach*, since it deals with the firm at a given point in time. This approach starts with the accounting balance sheet of a firm, adjusts it for differences between book value and economic value, and uses the result as an estimate of the firm's value. For a property-casualty insurer, this approach is implemented by estimating the market value of the firm's assets and subtracting from that the estimated present value of the firm's liabilities (obtained by discounting the forecast liability cash flows). The result is considered the current economic value of the firm. This approach was developed and widely adopted in the domain of asset-liability management, where the objective was to protect this economic value of the firm from potential loss due to changes in interest rates.[6] An alternative, described in greater detail below, is the *longitudinal* or *going-concern approach*, which values the

[5] In finance, the phrase "value of the firm" in fact refers to the value of its assets, not the value of its equity. Here I will use the phrase to mean a firm's market capitalization – the aggregate value of its stock – either as observed or as estimated by the model presented later on.

[6] For a critique of and correction to that approach, see Panning (1994, 2006).

firm as the default-risk-adjusted present value of its future earnings or cash flows.

The cross-sectional approach ignores two important but inconvenient facts that it cannot explain. First, the market value of a firm's equity may exceed the value of its assets. From a cross-sectional point of view such a situation would be absurd, since the value of equity is equal to the market value of the firm's assets less the market value of its liabilities. Even if the firm had no liabilities at all, its equity value could not exceed the value of its assets. The inconvenient fact, however, is that one firm in our industry recently had $12 billion in assets, $9 billion in liabilities, and therefore $3 billion in net worth. Since the firm's assets and liabilities were both relatively short-term, so that their book and market values were virtually identical, the firm's economic value was roughly $3 billion, according to the cross-sectional point of view. And yet this firm's market capitalization was approximately $14 billion, some $2 billion more than its total assets!

A second inconvenient fact is that, from a cross-sectional point of view, firms that directly market insurance to their clients behave irrationally – that is, in ways that appear to reduce, rather than increase, the economic value of the firm. I became acutely aware of this puzzle when, as a junior analyst for a large insurer, I was asked to help build a financial planning model for a new division that would directly market auto insurance.[7] The firm's existing model, based on GAAP (Generally Accepted Accounting Principles) showed that the division's prospective earnings would be unacceptably low, since every new policy written would lose money and add to the deficit already created by the considerable startup expenditures. But slowing the rate of growth only postponed the day when the operation would become profitable. At first, glance, there appeared to be no way to salvage an initiative on which the CEO had staked his reputation with the board.

The solution, it turned out, lay in thinking about the problem in an entirely different way. The key was to think about the business longitudinally – as a going concern -- rather than cross-sectionally, at a given point in time. From a cross-sectional point of view it made no sense at all to spend $100 in marketing costs to sell a policy that would, apart from those costs, make, say, $50 in profit. But for a going concern considered longitudinally, such a strategy made enormous economic sense, for the original $100 in marketing costs was a one-time expenditure. Those who purchased policies had a very high probability of renewing them even in the absence of subsequent additional marketing costs, and despite the lack of any contractual obligation to renew. So in the second and subsequent years, each new policy generated $50 in profits, with a renewal probability of some 90%. At the time of the original sale, the present value of these future profits far exceeded the initial $100 marketing cost.

Since neither GAAP nor statutory accounting recognizes the value of future renewals (because policyholders are not legally obligated to renew), from a cross-sectional accounting perspective there was no convincing reason to sell policies at all under the circumstances just described. But from a longitudinal going-concern perspective, it made sense to sell as many policies as possible, since doing so would maximize the present value of future earnings.

In the *longitudinal* or *going concern approach*, the value of a firm is the present value of its expected future earnings or cash flows. Here we will focus on earnings, since they are easier to assess than cash flows, and since insurance regulators typically permit dividends that are proportional to earnings rather than cash flows. For convenience we will focus on a firm with expected earnings E

[7] The experience described here has also been discussed in Panning, 2003a.

in every future year, absent default, with constant annual survival probability p, and with a risk-free interest rate of y. Let df = 1/(1+y) be the time discount factor, and D = p*df. Then the default-risk-adjusted present value of future earnings is equal to the series $E*(D+D^2+D^3+ . . .+D^n) = E*D*(1+D+ D^2+D^3+ . . .+D^{n-1})$. If we multiply this series by the ratio (1-D)/(1-D) we obtain $E*D*(1-D^n)/(1-D)$. Since D^n approaches zero as n approaches infinity, the default-risk-adjusted value of the firm is E*D/(1-D). This model easily explains how the present value of future earnings from a policy can exceed a substantial one-time initial marketing cost.

This model can easily be extended to incorporate modest levels of growth. Let G = 1+g, where g is the annual growth rate of the firm. In this case the default-risk-adjusted present value of future earnings is equal to the series $E*(D+G*D^2+G^2*D^3+ . . .+G^{n-1}*D^n) = E*D*(1+G*D+ (G*D)^2+(G*D)^3+ . . .+(G*D)^{n-1})$. If we again simplify and then let n go to infinity we obtain the default-risk-adjusted value of the firm as E*D/(1-G*D). This extended model easily explains how a firm's market capitalization can exceed the value of its assets.[8]

Alan Kay was entirely correct: adopting the right point of view matters enormously. The cross-sectional accounting point of view failed to explain how a firm's equity value could exceed the value of its assets or how a firm that directly sold insurance to consumers could survive or prosper. By contrast, viewing an insurer as a going concern immediately solves both puzzles and, as we will show, has important implications for strategies to maximize the value of an insurance operation.

[8] Growth is an issue with numerous facets that cannot be adequately treated in the space available, and so will be treated in a subsequent paper. One well-known issue is that high growth rates cannot be sustained indefinitely. Dealing with this issue requires a more complex model than the one just presented.

From a longitudinal or going concern point of view, the market value of a firm can considerably exceed the economically-adjusted current accounting value of its net worth. This difference can be called the firm's *franchise value*, since it reflects the present value of profits from business that the firm has not yet written but can reasonably be expected to write.[9] A rough but reasonable measure of a firm's franchise value is the excess of its market value over its book value.

4 A Longitudinal Valuation Model

In this section I present a detailed valuation model that incorporates the longitudinal point of view just described. The value of an insurance firm is here represented as the default-risk-adjusted present value of its expected future earnings plus the present value of any residual that may remain should the firm be reorganized. The preceding sentence contains within it several important features of the model that need to be stated explicitly.

1. The focus of the valuation model is on earnings rather than cash flow. This occurs because the firm is assumed to pay dividends to its shareholders equal to its annual after-tax net income, if positive.

[9] For an earlier model of franchise value see Panning (1994), which focused on the risk to franchise value of changes in interest rates. Panning (2006) is a briefer and more sophisticated treatment of that topic, which likewise excludes consideration of default risk. Hancock, Huber, and Koch (2001) provide an intuitive synthesis of franchise value, default risk, and optimal capitalization. Smith, Moran, and Wolczak (2003) and Exley and Smith (2006) present models with implications very similar to the ones presented here, but with a more thorough and sophisticated basis in financial theory. By contrast, I have deliberately – and perhaps unwisely -- traded sophistication for simplicity. Despite their differences, all these papers nonetheless appear to arrive at similar conclusions, which therefore become even more convincing.

2. These anticipated future dividend payments are discounted, at the risk-free rate, to obtain their present value.
3. These anticipated future dividend payments are further adjusted to reflect the fact that the stream of expected dividend payments will end if the firm is reorganized due to an extraordinary loss. Given its surplus, pricing, expenses, and other parameters, in every year there is some likelihood – typically quite small -- that the firm's losses will exceed some critical amount that triggers reorganization or bankruptcy. If this occurs, the firm is essentially dissolved, and the stream of dividend income will cease permanently. Each future dividend payment is therefore multiplied by the probability that it will occur, or, equivalently, the probability that reorganization has been avoided in prior years.
4. By reorganization I simply mean that the firm ceases to exist as a going concern. Its assets are liquidated to pay policyholders and reorganization costs. Any cash that remains after these are paid (i.e., any residual) is distributed to shareholders.

If we ignore for a moment the value of any residual cash distributed to shareholders after a reorganization, the essence of the model presented below is quite simple. I will assume that every year the firm begins with a given amount of surplus and writes the same volume of business with the same expense ratio, the same expected loss ratio, and therefore the same expected net income after tax (*NI.AT*) as in prior years.[10] Its actual loss ratio and actual net income are stochastic. If the firm's net income is positive, it dividends that amount to shareholders; if negative, it raises sufficient capital (from existing shareholders) to restore its surplus to the previous amount. Every year the firm has some constant probability (*Prob.Survival*) that its losses will be below the amount (*Critical.Loss*) that triggers a terminal reorganization. Consequently, the risk-adjusted present value of its earnings one year from now is *NI.AT***Prob.Survival*/(1+*yield*), where *yield* is the risk-free rate. Let *Discount.Factor* be *Prob.Survival*/(1+*yield*). Then the default-risk-adjusted present value of the firm's future income, considered as a perpetuity, is *NI.AT***Discount.Factor*/(1-*Discount.factor*).[11]

The details of this valuation model are as follows.

Underwriting

1. The firm writes 100 units of premiums every year; a unit is some fixed amount in dollars – $1 million, for example.
2. All policies are written on 1/1 and take effect at 12:01 am that day.
3. All policies have a term of one year, and expire at midnight on 12/31.
4. At midnight on 12/31, the losses associated with these policies become known precisely, and are paid immediately.

As a consequence of these assumptions it follows that accident-year, policy-year, and calendar-year financials are identical for this firm.

[10] Terms in italics are the actual names of variables used in the model presented below.

[11] This last result is obtained by first representing the risk-adjusted present value of the firm's future income as *NI.AT**[*Discount.Factor* + *Discount.Factor*^{2} + . . . + *Discount.Factor*^{n}], and then simplifying this result as described near the end of the preceding section of the paper.

Cash Flow and Earnings

5. All premiums are paid when the policies are written – i.e., at 12:01 on 1/1.
6. All expenses are known precisely and paid immediately, at the inception of the policy.
7. The firm earns investment income, at the risk-free rate, on its cash balance during the year. This cash balance consists of written premiums, less expenses, plus surplus.
8. The firm pays taxes on positive net income, and may receive tax rebates on net losses if it can utilize net operating loss carryovers to recover taxes paid on earnings in preceding years.
9. The firm's after-tax net income is known at midnight on 12/31 (recall that losses are known and paid at that time, as stated in assumption 4).
    a. When after-tax net income is positive, the firm immediately pays a dividend in that amount to its shareholders.
    b. When after-tax net income is negative, but the loss is less than some specified critical percentage of surplus, then the firm immediately sells additional shares (to existing shareholders) to bring its surplus to the level that existed at the beginning of the year. The firm therefore has a constant surplus from one year to the next.
    c. If the firm's operating loss exceeds some specified critical percentage of its beginning surplus, then a reorganization occurs that results in liquidation of the firm through bankruptcy or purchase by some third party.
    d. If a reorganization occurs, bankruptcy costs (consisting of a known percentage of written premiums) are incurred.
    e. If a reorganization occurs, any assets remaining after losses and bankruptcy costs are paid are sold at fair value and the proceeds returned to shareholders.

Losses and Enterprise Risk

10. The only stochastic feature of this firm's operation is its losses, which are lognormally distributed with a known mean and standard deviation. These losses are a net result of *all* of the risks -- not just claims -- that affect the earnings and cash flow of the firm. They encompass multiple lines of business as they are affected by pricing risk, credit risk from policyholders and suppliers, operational risk, catastrophe risk, and the like. Losses, then, are a random draw from an enterprise-wide distribution of potential losses, as estimated by an ERM task force.
11. Assuming that these aggregate losses are lognormally distributed is a convenience, not a necessity. It enables the results presented here to be calculated directly rather than through the use of simulation. Many aggregate distributions can also be closely approximated by a mixture of parametric distributions. Doing so here would have made the results more complex and less transparent, with no offsetting benefit.

Essential Input Parameters

The input parameters for the model are shown in Table 1. For purposes of the analysis presented here, I will ignore the cost of reorganization, should it occur, and the consequent payment to shareholders of residual assets, if any. Relative to other variables, these two have a very small impact on the results but a rather large impact on the length and complexity of the presentation. Implicitly, then, I am here assuming that residual payments to shareholders will always be zero.

Table 1: Input Parameters and their Initial Values

Premiums (both written and earned)	100
Surplus	50
Loss.Ratio	70%
Expense.Ratio	25%
Yield (risk-free rate)	6%
Tax.rate	35%
SD.Losses (standard deviation of losses as a percent of expected losses)	25%
Crit.Pct.Surplus (percent loss of surplus that triggers reorganization)	35%
Tax.Loss.Carrybacks ("yes" if taxes paid in prior years can offset net operating loss)	yes

Implications: Unconditional and Conditional Losses

The value of the firm has two components. One is the default-adjusted present value of the firm's *NI.AT* so long as it survives. The other is the present value of whatever residual payments are received when the firm is terminally reorganized, if ever. Here this is assumed to be zero. The first component requires that we determine the expected value of *NI.AT* for years in which the firm survives, which in turn depends upon *C.Losses*, expected losses conditional on the firm's survival. By contrast, unconditional expected losses (*E.Losses*) include both *C.Losses* and also *Tail.Losses*, the expected value of losses that exceed the *Critical.Loss* that triggers reorganization. By definition, *Tail.Losses* must exceed the *Critical.Loss*. It necessarily follows that *C.Losses* must be less than *E.Losses*, since *E.Losses* include *Tail.Losses* but *C.Losses* exclude them.

Table 2: Calculating Conditional Losses and the Probability of Survival

Variable	Value	Definition
E.Losses	70.00	= *Premiums**Loss.Ratio*
Critical.Loss	109.42	= *Premiums – Expenses + yield**(*Premiums – Expenses + Surplus*) + *Surplus***Crit.Pct.Surplus*/(1 - *tax.rate*)^(1*(Tax.Loss.Carrybacks ="yes"))
E.Tail	0.321	= *E.Losses** NORMSDIST(LN(*E.Losses*/*Critical.Loss*)/*SD.Losses* + *SD.Losses*/2) *Critical.Loss**NORMSDIST(LN(*E.Losses*/*Critical.Loss*)/ *SD.Losses* - *SD.Losses*/2)
Tail.Prob	2.79%	= NORMSDIST(LN(*E.Losses*/*Critical.Loss*)/*SD.Losses* - *SD.Losses*/2)
Prob.Survival	97.21%	= 1 - *Tail.Prob*
Tail.Losses	120.91	= *E.Tail*/*Tail.Prob* + *Critical.Loss*
C.Losses	68.54	= (*E.Losses – E.Tail.Losses***Tail.Prob*)/*Prob.Survival*
Discount.Factor	91.70%	= *Prob.Survival*/(1+*yield*)

Table 2 shows the calculations that determine *C.Losses* A key step is determining the *Critical.Loss* that corresponds to the *Crit.Pct.Surplus* and so triggers reorganization. Next one must determine *E.Tail*. This is an integral which, for all losses that exceed the *Critical.Loss*, calculates the excess of its value over the

Critical.Loss and weights each of these values by its probability of occurring. Since the distribution of losses is lognormal, the value of *E.Tail* is mathematically identical to that of a call option where the stock price is equal to *E.Losses*, the exercise price is equal to the *Critical.Loss*, the volatility is equal to *SD.Losses*, the time to maturity is 1, and the risk free rate is zero. The formula for calculating *E.Tail* is the Black-Scholes option pricing formula with these values inserted and irrelevant variables omitted.

Tail.Prob, which is the probability that actual losses will exceed *Critical.Loss*, is similarly calculated from the term N(d2) in the Black-Scholes formula, and similarly simplified.[12] Calculating the conditional tail expected losses, *Tail.Losses*, from these earlier results is straightforward, as is calculating *C.Losses*. The formula ensures that *C.Losses**Prob.Survival + Tail.Losses*Tail.Prob = E.Losses*. Finally, Table 2 shows the formula for the *Discount.Factor*. All these variables, as well as those in Table 1, apply to a single period, and should have a time subscript. However, I have omitted it since the fundamental assumptions of the model directly imply that their values will be constant in all periods prior to any reorganization or default.

The fact that *C.Losses*, losses conditional on the firm's survival, are necessarily lower than unconditional expected losses has an important implication – namely, that observed rates of return on premiums or on surplus are likely to be biased upwards. Firms that experience extremely high losses will be reorganized and disappear from view. So unless the underlying data-gathering process is extremely thorough, both the industry and the firms within it will appear to be more profitable than underlying risk exposures would warrant. A similar phenomenon occurs in the investment world, where funds that significantly under-perform market averages are liquidated or merged, so that statistics concerning their poor results disappear with them. Given the cyclical nature of property-casualty insurance, such upward bias could significantly distort the view and actions of both regulators and investors.

Table 3: Calculation of Net Income and Firm Value

Variable	Value	Definition
Premiums	100.00	= Input
C.Losses	68.54	= see Table 2
Expenses	25.00	= *Premiums*Expense.Ratio*
UW.Income	6.46	= *Premiums - C.Losses - Expenses*
INV.Income	7.50	= *yield*(Premiums – Expenses + Surplus)*
NI.BT	13.96	= *UW.Income + INV.Income*
NI.AT	9.08	= *NI.BT*(1 - tax.rate)*
Equity.Value	100.32	= *NI.AT*Discount.Factor/(1 - Discount.Factor)*
PE.Ratio	11.05	= *Discount.Factor/(1 - Discount.Factor)*
Value.Added	50.32	= *Equity.Value - Surplus*
Price.to.Book.Ratio	2.01	= *Equity.Value/Surplus*
Return.Period	35.79	= 1/*Tail.Prob*

Implications: Net Income and Valuation

Table 3 shows how net income and firm value are calculated in the model. The first part of the table is simply an income statement that calculates before-tax and after-tax net income. The value of the firm, *Equity.Value*, as described earlier, is the default-risk-adjusted present value of the firm's future earnings. This is simply equal to net income after tax multiplied by the firm's *PE.Ratio*, which in turn is directly calculated from the relevant

[12] Here I have used the Black-Scholes formula and N(d2) *only* as mathematically convenient ways to deal with the lognormal distribution to which they apply. I am *not* claiming to apply an option pricing framework.

Discount.Factor. This rather simple (and elegant, in my view) relationship becomes a bit messier when residual values are introduced, but it provides a simple but close approximation to a more realistic model.

As discussed in Part 5, *Equity.Value* can be very misleading, for adding surplus to a firm necessarily increases its *NI.AT* and *Equity.Value* even when the resulting increase in value is far less than the dollar amount of surplus added. A superior measure of whether the firm has optimally utilized its surplus is *Value.Added*, which is *Equity.Value* minus *Surplus*. Finally, the likelihood of default is conveniently represented by the familiar return period statistic. Return period, defined as 1/p, is the expected number of years between occurrences of some event that has probability p of occurring in any single year. Although return period is normally used to describe the incidence of natural catastrophes, it here refers to the frequency with which a firm could expect its total annual loss to exceed the firm's *Critical.Loss*. As we shall see later on, optimization will tend to increase this return period under most circumstances.

Implications: Market Valuation

Now that we have calculated a value for the firm by estimating the default-risk-adjusted present value of its future earnings, what do we do with it? This question really has two parts. First, what is the relationship between the value we have calculated and the actual market value of the firm, if it is publicly traded. Second, if there are important factors omitted from the model presented here, can a firm that improves its modeled value be reasonably confident that doing so will improve its real-world market valuation as well?

I suspect that the value of a firm, as calculated using this model, may be somewhat overestimated relative to the value of that firm's shares in the market. This suspicion is based on the fact that yield spreads on corporate bonds typically exceed the break-even spreads necessary to compensate for the historically-experienced probabilities of default for bonds of different credit qualities. This difference is usually described as a risk premium. The model presented here presumes the absence of any such risk premium, since it incorporates only a time-value discount and a discount for the probability of default. If investors require some risk premium as well, then the resulting value of the firm will be lower than estimated by this model. Of course, this is a matter for empirical investigation rather than armchair speculation.[13]

If such a risk premium in fact exists, then it could, at least in principle, be estimated and compared across firms and over time. In derivatives markets, for example, the most difficult variable to estimate is the volatility of the underlying security, which can deviate from estimates based on historical values. A common practice is to determine the value for volatility that is consistent with the observed price of the derivative security. This value, known as implied volatility, can then be compared for different securities or across time for the same security (as, for example, in the VIX index for options on the S&P500). In the model presented here, the volatility of the loss distribution is the most difficult parameter for outsiders to estimate. By analogy to the derivative markets, one could estimate an implied loss volatility that closely fits the observed values of other variables that are more directly observable, and compare this implied loss volatility both across different firms and over time. Whether this is in fact possible or useful depends upon studies yet to be conducted.

Even if a risk premium exists, it is nonetheless plausible to assume (pending empirical studies) a reasonably high correlation

[13] See Elton et al. (2001) for an analysis of the components of a risk premia on bonds, and Derrig and Orr (2004) for a comprehensive review of the empirical literature on the equity risk premium.

between the value of the firm as derived from this model and its value in the marketplace. If so, then actions taken to improve the modeled value of the firm should also improve the actual market value of the firm. In this respect the model can be a useful guide to market-value-improving strategies without necessarily being a perfect predictor of market value.

5 Managing and Maximizing Value

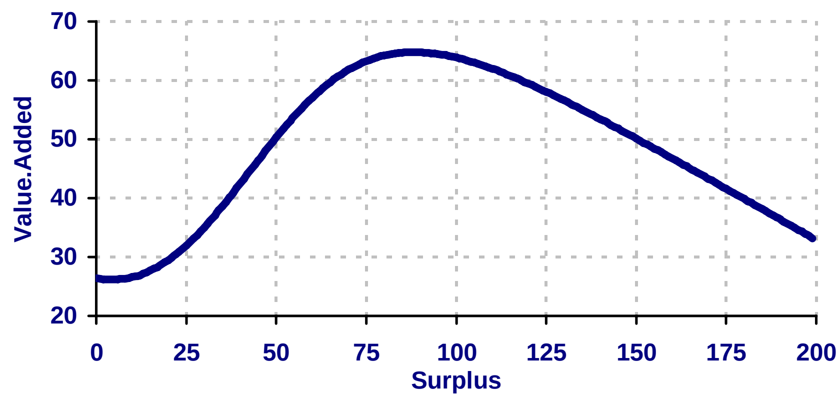
The virtue of having a valuation model is that it enables management to ascertain the likely consequences of alternatives actions or strategies. In this section I will demonstrate how the model can be used in three ways: (a) to estimate how much surplus the firm should have, (b) to estimate the consequences for the firm's value added, optimal surplus, and return period of changing various input variables, taken separately, and (c) to estimate the consequences of simultaneously changing multiple variables, as typically occurs in most strategic decisions.

Managing Surplus to Maximize Value

In Part 2, I described and critiqued four practical principles that CFO's use to determine the amount of surplus their firm should have. I also proposed an alternative principle: choose the level of surplus that maximizes value for shareholders or policyholders. The model presented in section four makes this alternative principle feasible. We must be careful how we implement that principle, however, for a reason that is subtle but important. If we use *Equity.Value* as the variable we wish to maximize, then adding surplus is *always* beneficial, for it increases investment income and makes the firm less likely to default or reorganize. The important question is whether the value of these benefits exceeds the dollar cost of the added surplus. Beyond some point it does not, so that adding an additional dollar to surplus creates additional value of less than a dollar. In this case shareholder value is better served by distributing the additional dollars as a dividend rather than retaining them to increase surplus. To focus on this important question of *marginal* costs and benefits we need to focus on maximizing *Value.Added* (which equals *Equity.Value* minus *Surplus*) rather than on maximizing *Equity.Value*. **To maximize shareholder value, a firm should add (or reduce) surplus so long as doing so increases *Value.Added.***

The relationship between *Surplus* and *Value.Added* is shown graphically in Figure 1 for the firm in our continuing example. This firm has an initial *Surplus* of 50 units and an initial *Value.Added* of 50.3. This graph shows that the firm could increase its *Value.Added* by 30%, to 65, by increasing its surplus to 88.

Figure 1: Effect of Surplus on Value Added



When we examine the whole range of surplus values in Figure 1, from left to right, we find that *Value.Added* first increases, reaches a maximum, and then subsequently declines. At sufficiently high levels of *Surplus*, beyond the range of Figure 1, *Value.Added* actually becomes negative. What produces this pattern is the fact that adding surplus has a cost as well as a benefit. The cost results from double-taxation: the investment income that the insurer receives from the bond purchased with the surplus contribution is taxed at the corporate level, and then taxed again when this after-tax net income is received by the shareholder. The shareholder would be better off by simply owning the bond and receiving income directly. From the standpoint of investment income, then, a dollar of added surplus produces less than a dollar of value to shareholders.

Adding surplus also has an offsetting benefit: it increases the probability of the firm's survival, which in turn makes the default-risk-adjusted present value of the firm's future after-tax income more valuable since it becomes more certain. Consequently the *Discount.Factor* is higher than before. At low levels of surplus this benefit outweighs the cost of double taxation. However, as surplus increases, this marginal safety benefit of adding surplus gradually declines until it falls below the marginal cost of adding surplus. The peak of the curve shown in Figure 1 – at a surplus of 88 – occurs precisely where the marginal cost and marginal benefit are equal.[14]

The precision of this result – optimal surplus is 88, not more, not less – is misleading, since it depends upon the correctness of the valuation model and the precision with which its inputs are measured. I note, however, that the key inputs to the model, shown earlier in Table 1, can all be reasonably measured or estimated. Consequently, I would infer that optimal surplus for this firm is in the upper 80's or low 90's, and is almost certainly not in the neighborhood of 50.

[14] The model presented here also implies that there are certain circumstances – defined by combination of expected loss and standard deviation of loss – in which optimal surplus is zero. In other words, there is a boundary beyond which risks are, in effect, economically uninsurable. This implication of the model must be treated in a separate paper due to space limitations.

The Effect of Other Variables: Sensitivity Tests and Strategic Alternatives

A simple but effective way to determine the precision of a result like that just shown is to perform a sensitivity test, which asks the following question: how much would the result change if the value of another variable in the model is changed from its current value? But the answer to that question has another use as well: it can inform managers concerning the effect on optimal surplus and value added of deliberately changing other variables – for example, by altering the firm's mix of business to change its loss ratio, its expense ratio, or the variability of its losses.

Table 4: The Effect of Loss Ratio Changes on Optimal Surplus, Value Added, and Return Period

Loss.Ratio	Optimal Surplus	Value Added	Return Period
0.60	71	181	657
0.61	73	169	602
0.62	75	157	553
0.63	77	146	510
0.64	79	134	471
0.65	81	122	436
0.66	83	111	405
0.67	84	99	356
0.68	86	88	332
0.69	87	76	294
0.70	88	65	262
0.71	89	53	233
0.72	89	42	198
0.73	89	31	169
0.74	88	20	138

Table 4 illustrates this point by showing the effect on a firm's optimal surplus, value added, and return period, of changing the firm's loss ratio. When the firm's loss ratio is in the vicinity of 64% to 74% or more, optimal surplus remains close to the 88 we obtained earlier. Optimal surplus is therefore is quite robust to potential error in estimating the loss ratio, and therefore resistant to attempts to change it by deliberately changing the loss ratio. By contrast, Table 4 also shows that changes in the firm's loss ratio have a dramatic impact on the firm's value added and its expected frequency of reorganization, as represented by the return period.

Figure 2: The Effect of Surplus on Value Added for Varying Loss Ratios

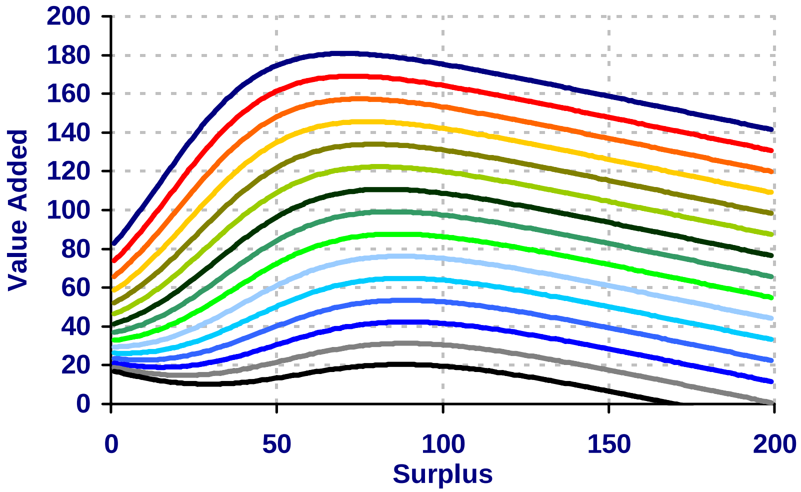


Figure 2 shows the relationship between surplus and value added for each of the loss ratios in Table 4. The top line in this graph is that relationship when the loss ratio is 60%, and the bottom line is for a loss ratio of 74%. Note that as we move from the top line downwards, the surplus corresponding to the peak value of each line gradually moves to the right, to higher values, as shown in the second column of Table 4, while the value added moves lower, as shown in the third column of Table 4.

Table 5 shows the effect of changes in the firm's expense ratio. Their effect on value added and on return period are similar to those for changes in the loss ratio. Note, however, that the optimal surplus remains relatively constant across the range of expense ratios shown here. This means that the estimate of optimal surplus is very insensitive to errors in estimating or forecasting the firm's expense ratio.

Table 5: The Effect of Expense Ratio Changes on Optimal Surplus, Value Added, and Return Period

Expense.Ratio	Optimal Surplus	Value Added	Return Period
0.15	84	181	550
0.16	85	170	528
0.17	86	158	506
0.18	87	146	485
0.19	87	134	440
0.20	88	123	422
0.21	88	111	384
0.22	88	99	348
0.23	88	88	317
0.24	88	76	288
0.25	88	65	262
0.26	88	53	238
0.27	87	42	205
0.28	85	31	167
0.29	83	20	137

Table 6 shows the effect of yield changes. Higher yields increase investment income but nonetheless reduce value added because they reduce the present value of future income. Figure 3 shows the relationship between optimal surplus and value added for each yield level shown in Table 6. The curve that is highest on the right side of Figure 3 is for a yield of 3%.

Table 6: The Effect of Yield Changes on Optimal Surplus, Value Added, and Return Period

Yield	Optimal Surplus	Value Added	Return Period
3.0%	119	108	832
3.5%	112	95	630
4.0%	106	86	500
4.5%	101	78	416
5.0%	96	73	345
5.5%	92	68	301
6.0%	88	65	262
6.5%	84	62	226
7.0%	81	60	206
7.5%	78	58	188
8.0%	75	56	170
8.5%	72	55	154
9.0%	69	53	139
9.5%	67	52	133
10.0%	64	52	119

What is especially noteworthy about Figure 3, and not at all evident in Table 6, is the point on the left side of the figure where all the curves closely converge. At that point, achieved when the firm's surplus is about 52, the firm's value added is virtually constant regardless of potential changes in interest rates. At that point the firm's value added is essentially immunized, provided that the other variables in the model (apart from surplus) remain at their assumed values. Equally notable, however, is the fact that this point is suboptimal for *all* of the interest rates shown in Figure 3 and Table 6. To maximize shareholder value, optimal surplus for this firm ranges from roughly 64, when the yield is 10%, to 119 when the yield is 3%. What this strongly suggests is that ***immunizing a firm's value from potential changes in interest rates, whatever its merits when considered alone, may be a suboptimal strategy when considered within the broader framework of value-focused Enterprise Risk Management.*** This requires a more extended treatment that will be provided in a subsequent paper.

Figure 3: The Effect of Surplus on Value Added for Varying Yields

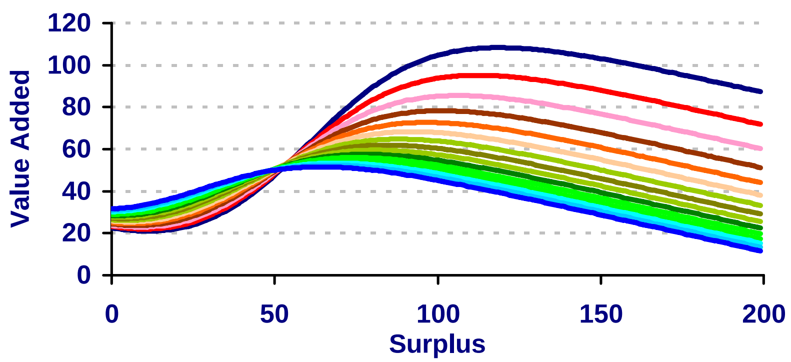


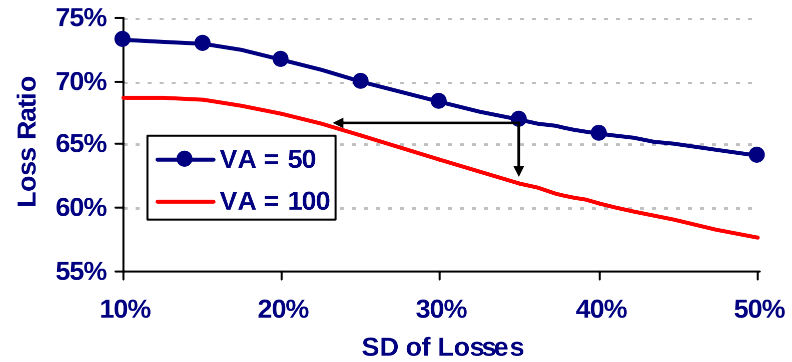
Table 7 shows the sensitivity of optimal surplus, value added, and return period to changes in the standard deviation of losses, expressed as a percent of expected losses. It is clear that optimal surplus is quite sensitive to this variable. This is to be expected, since the standard deviation of losses has a direct impact on the probability of survival in each period. Although optimal surplus therefore increases as the standard deviation increases, the net effect is still a decrease in value added and in the firm's return period.

Table 7: The Effect of Changes in the Standard Deviation of Losses on Optimal Surplus, Value Added, and Return Period

SD.Losses	Optimal Surplus	Value Added	Return Period
11%	30	90	913
13%	38	87	692
15%	47	83	615
17%	55	80	490
19%	64	76	436
21%	72	72	360
23%	80	69	304
25%	88	65	262
27%	96	61	228
29%	104	57	201
31%	111	53	173
33%	119	49	156
35%	125	45	134
37%	131	41	117
39%	137	37	103

A direct implication of Table 7 is that managing a firm's standard deviation of losses can have an extremely important impact on its value added, potentially equivalent in importance to managing its loss and expense ratios. Reinsurance is certainly one of the available means of accomplishing this objective. However, that subject introduces complexities that are beyond the scope of this paper and will be treated on another occasion.

Figure 4: Constant Value-Added Combinations of Loss Ratio and Loss Standard Deviation



The Combined Impact of Changing Multiple Variables

Strategic choices typically involve changes in multiple key variables. The model presented here can assist managers in identifying combinations of such changes that best achieve particular goals. This is illustrated in Figure 4 for just two key variables: loss standard deviation and loss ratio. The two lines in the graph show the combinations of these two variables that produce value added of 50 (top line) and 100, respectively. Graphs of this sort (which can be extended to multiple variables) are useful in several ways. Suppose that an insurer has a current value added of 50, with a standard deviation of 35% and loss ratio of 67%. On the one hand, management might wish to consider all the combinations of the two variables that fall on the same line (the top one in the graph) to see which combinations might have, say, a lower expense ratio, since lowering that ratio would increase value added. Alternatively, they may have a goal of doubling value added to 100, which could be done by moving to a point on the lower line in the graph. This could be achieved by lowering the loss ratio, as shown by the vertical arrow, or by lowering the standard deviation of losses, as shown by the horizontal arrow, or by some combination of the two. The point here is that the model results shown in this graph or others similar to it can assist managers in clarifying strategic alternatives and quantifying their impact on value added.

6 Implications: Managing the Invisible[15]

Ultimately, managers effectively manage only what they can see and quantify. Visibility and quantification are both crucial. Things that are invisible will typically fail to win managerial attention, a scarce resource in most firms. Moreover, without quantification, effective management becomes nearly impossible, for a manager cannot know whether his actions have brought about intended improvements, or even whether conditions are improving or declining.

What is visible at virtually every insurance firm is what has to be reported in the firm's statutory and/or GAAP (Generally Accepted Accounting Principles) financial statements. But these financial statements are essentially cross-sectional, and focus only on income statement and balance sheet values that reflect business already written. While changes in these accounting values from one period to the next can indicate potential trends that may need attention, there is little, apart from claims handling, that managers can do about business already written. Ironically, then, the numbers that managers typically see focus on matters over which they can exercise very little influence. Whatever the value of GAAP and statutory financial statements for audiences outside the firm, their value for managing a firm's future is somewhat dubious.

[15] Some of the ideas stated here draw on Panning, 2003a, 2003b.

Consider, by contrast, the potential value to managers of the valuation model presented in Part 4, and of the sensitivity and strategy analyses presented in Part 5. A firm's value added as calculated in the model is derived from a longitudinal valuation of the firm as a going concern, and the analyses focus managerial attention on the variables with the greatest potential impact on value added and other key statistics. Analyses like these have several important consequences. First, because the model focuses on the default-risk-adjusted present value of future income, it addresses the future of the firm, which can be managed, in contrast to accounting values that reflect the results of past decisions. Second, the model provides managers with a visible and quantitative estimate of the firm's franchise value and its sensitivity to the various significant variables that management can influence. It therefore provides managers with a sound basis for decisions concerning capital structure, in contrast to the rules of thumb described in Part 2.

The third and, to me, the most compelling feature of the model presented here is that it provides a rational dollar-based measure of the cost of risk. The classical problem with risk-return analysis is that it provides no compelling reason for choosing a particular level of risk exposure, since risk and return are incommensurable.[16] This is why appeals to risk tolerance or other rules of thumb are thought to be essential. By contrast, in the model presented here there is a quantifiable cost of risk, measured in dollars. Specifically, if we change the mean or standard deviation (as a percent of the mean) of the firm's aggregate loss distribution, we can use the model to calculate the consequences of doing so, in dollars, for the firm's value and value added.

[16] The Kelly criterion may be an exception to this statement, but the controversy concerning it makes this a topic that is better postponed to another occasion.

This point may be somewhat obscured by the way in which I have approached the problem – as one of optimizing surplus relative to a given level of risk. In fact, this problem is mathematically equivalent to one in which surplus is given and the level of risk is the variable to be managed in order to maximize value added. My rationale for approaching the problem in the way I have is that most insurers will find it easier to change their level of surplus (or reinsurance, for that matter) than to alter their portfolio of business and its characteristics. The latter strategy depends on costly changes to an existing infrastructure (including a distribution system and internal underwriting, pricing, and reserving capabilities) geared towards an existing mix of business. I could equally well have presented the model as one in which surplus was fixed (as for a mutual insurer) but premium volume was variable (since the crucial assumptions are all stated relative to written premiums). In that case the key objective would be to identify the optimum premium to surplus ratio.

In the absence of a model like the one present here, or an equivalent model in which surplus is fixed and risk exposure is variable, the consequences of changing a firm's capital structure are matters of guesswork, and are therefore in practice typically ignored, in favor of actions that change the anticipated distribution of aggregate losses, a domain where consequences are considered more visible and quantifiable.[17]

There are numerous ways of extending the model presented here: (a) by incorporating a more sophisticated model of reorganization costs, (b) by making it possible for shareholders to receive cash remaining after losses and bankruptcy costs have been paid, (c) by incorporating more sophisticated assumptions concerning the tax status of the firm, (d) by taking into account the fact that dividends are taxed differently from ordinary income and so may be more valuable to shareholders than is taken into account here, (e) by incorporating customer preferences, and willingness to pay higher premiums, for policies from firms with low probabilities of default,[18] (f) by incorporating various reinsurance strategies, (g) by incorporating a more sophisticated approach to the effects of growth on the valuation of a firm, (h) by incorporating stochastic interest rates, (j) by taking into account strategies for coping with an underwriting cycle, (k) by incorporating more flexible ways of representing the firm's aggregate loss distribution, and so on. Although I could suggest even more ways to amend and improve the valuation model presented here, I hope that this brief list indicates my recognition that there is much potentially valuable work yet to be done.

Above all, I hope that the model and analysis presented here will have a significant impact on the goals and practice of Enterprise Risk Management. ERM is, in my view, potentially the most significant development in risk analysis and risk management in decades. My greatest concern about the future of ERM is that it will be a victim of excessive hype, based on an implicit assumption that its benefits will somehow become evident to senior management. I strongly believe that what ERM needs to hedge this risk is a compelling value proposition – an answer to the question "what are the benefits to my firm of embracing ERM?" The answer proposed and (I hope) demonstrated here is that ERM, *done properly*, does two things. First, it makes visible a firm's franchise value and so stimulates and enables managers to focus attention on managing the present value of the firm's future income. Second, it enables managers to anticipate and measure the consequences of alternative actions and strategies intended to maximize shareholder value, as estimated by a pragmatic valuation model whose parameters are observable or reasonably estimated. In essence, *value-focused* ERM, as proposed and demonstrated here, can provide managers with reliable tools that can increase the scope and effectiveness of their decisions.

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[17] I am indebted to Richard Goldfarb for this point.

[18] Chris Gross has been persuasive in conversations on this point.

Is this ambitious goal indeed practical, or is it merely wishful thinking? Two facts are strongly encouraging. One is that models similar to the one presented here, although considerably more complex, are already pervasive in significant areas of the capital markets. A second is that managers who attempt to increase shareholder value cannot avoid reliance on a model, but instead face an inevitable choice between an implicit and impressionistic mental model, or, as I propose here, an explicit and empirically verifiable model subject to professional scrutiny and improvement. If Enterprise Risk *Management* is to be more than a passing fad, it must, in my view, accept responsibility for making this second alternative a reality, and so provide managers with the tools that they need to quantify and manage what is now invisible to them.

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