V

Out of Human Bondage

Chapter 4 attempted to prove that the demand for insurance from individuals (physical persons, even if they are members of a group for insurance purposes) is derived from the need to securitize the human capital security. The secondary implication of the perspective is that the standard answer to the question of what insurance companies sell (removal of risk) is somewhat misleading. As pointed out by Mayers and Smith (1993), insurance does not eliminate risk, it merely transfers risk from the policyholder to the insurance company. We still must ask ourselves if a decision to transfer risk is the sole purpose of insurance purchase.

In the modern finance perspective on financial risks, there are two major types of risk: those that can be eliminated through portfolio diversification (diversifiable risks) and those that cannot (nondiversifiable, or systematic risks). If the risk faced by the policyholder is diversifiable, and the policyholder can diversify it, purchasing an insurance policy solely for the purpose of eliminating that risk is often debatable. In contrast, if the risk is nondiversifiable, the only reason to pay someone to assume is the existence of some background risk.

Consider the owner of a single home and his individual insurance purchase decision. Purchasing a policy to eliminate or reduce the risk of theft, or personal liability, reduces risk, which to this individual owner is not diversifiable, while it is diversifiable to the insurance company. Purchasing insurance protecting against a drop in market value of the home is very different. The home is part of the overall portfolio of this homeowner, and so is the mortgage note the homeowner sold (is short). His investment portfolio should be structured in such a way as to diversify the diversifiable risks existing in that portfolio. The systematic risk portion of the portfolio, however, is mostly related to interest rates. Here, the insurance purchase decision can be realized by purchasing interest rate or bond options, but is usually debatable (it may be justified by some background risk). As discussed in Chapter 4, a refinancing option, so common in home mortgages, is much more valuable to young homeowners, who face greater background risk, of job instability and smaller financial asset portfolios, than to older homeowners. Young homeowners have less opportunity for diversification than do older homeowners, who already own many securities benefiting from falling interest rates, one of which is their human capital, which, in the later part of life, tends to be nearly a fixed-income security.

From the perspective of financial economics, the insurance purchase decision by corporations is even more rarely justifiable by pure risk transfer (Mayers and Smith 1982, 1993). Catastrophic losses, death, and disability are nondiversifiable to individuals and closely held corporations, but many such losses are diversifiable to shareholders of publicly held companies. Owners of the latter do not expect risk diversification from managers of their corporate resources, because they can achieve the degree of diversification appropriate for them by buying an appropriately diversified portfolio of shares. Mayers and Smith (1993) point out that corporate insurance purchase decisions can be justified, in certain cases, by the insurance company's comparative advantage in risk bearing because of the following factors:

- Reduction of risk achievable by pooling a large portfolio of risks.
- Superior access to capital markets.
- Expertise acquired through specialization in evaluating and monitoring certain kinds of risks.

However, the overwhelming rationale for corporate insurance relates to the following incentives, which are not derived from risk transfer:

- Low-cost claims administration services.
- Assistance in assessing the value of safety and maintenance projects.
- An improvement in the corporate incentives to undertake investments in such projects.
- Means of transferring risk away from those of company's claimholders who are at a disadvantage in risk bearing.

- Reduction of the company's expected tax liability (especially if the tax schedule is convex, which does happen with alternative minimum tax, carry-back and carry-forward provisions, and progressivity of the schedule).

One major difference between individual and corporate insurance purchases is the presumption of the future life of the insured entity. As pointed out in Chapter 4, the individual insurance purchases are greatly determined by the structure of cash flows of human capital, including the imbalance between the earning and retirement years as well as the catastrophic losses of death, disability, medical expenses, or liability, and the limited time horizon for making up such losses. A corporation purchasing insurance intends to exist for a much longer time than individuals do, preferably forever. The going-concern assumption is one of the major premises of corporate management. The intermediaries are paid for crafting derivatives integrating the cash flows of their customers and their capital assets. Insuring going-concern entities requires a going-concern perspective.

But there is more. This work strives to place ALM in the integrated framework of insurance firm management. The job is to structure the firm's future cash flows to maximize the value of the firm while avoiding insolvency. The 1990 Amendments to the Standard Valuation Law require some form of asset adequacy analysis, implying cash flow testing, of the firm's business in force. While this is entirely consistent with the traditional view of the job description for the actuary, the Canadian standards have evolved toward requiring projections not only of existing business, but also of the entire firm's evolution, including new business that can be expected to develop in the future.

Panning (1993) argues that "the central objective of ALM is to manage the sensitivity of the real economic value of the firm to changes in interest rates." There are several important implications and complications of this statement. The goal of ALM, as Panning (1993) also points out, is to manage the real economic value of the insurance firm. Economic valuation of an insurance firm is not in any way different from valuing any other firm. To its owners, investment in the firm plays the role of prepayment of future consumption. We cannot purchase housing and food 20 years hence. But we can trade our present consumption for future consumption. If future consumption is to exist, today's savings must fund resources that will provide for future consumption. Is the success of such prefunding certain? Of course not, but complete denial of a high chance of success for a diversified portfolio of claims to future cash flows of various enterprises rests its case on the denial of the continued existence of human civilization. Until now, the pessimists have always lost that bet.

Clearly then, ALM cannot be limited to the firm's current picture. It must provide for the development of the firm, and its environment, including such obvious items as interest rate evolution and other macroeconomic factors. This means that value must provide for a going-concern assumption and consider cash flows provided and required by future business. This dynamic valuation perspective, in fact, has been fully accepted as a part of the actuary's job in Canada and the United Kingdom, and represents a rational adjustment to economic reality.

Second, the perspective provided here requires that ALM be moved from the department of tricks with interest rates to the department of strategic management. In particular, ALM is not just asset management (Panning 1987). The common attitude of simply matching assets to liabilities (by cash flow matching or duration matching) misses the central point of management. The firm should also manage its portfolio of liabilities, know its customers' cash flows, and project its future. Furthermore, classification of risks into the main four classes (C-1, C-2, C-3, and C-4) misses several important dependencies among them.

Most actuaries agree that the C-1 and C-3 risks are correlated, and this correlation is represented in the NAIC Risk Based Capital Formula (2.1). We believe that the most important aspect of the nature of that correlation can be expressed by the following observation: *Any attempt to control C-1 risk will generally lead to an increase in the C-3 risk, while any attempt to control C-3 risk will generally lead to an increase in the C-1 risk.*

One example of a move to control the C-1 risk would to structure one's asset portfolio to only hold Treasury securities. Yet, such a portfolio would generally not yield enough to support the business, unless one is willing to greatly extend maturities to take advantage of a generally upward sloping Treasury yield curve. If such an extended portfolio goes beyond the expected maturity of liabilities cash flows, then it becomes mostly an interest rate bet, either on the level of the rates or on the shape of the yield curve, depending on the structure of the portfolio. In contrast, purchasing high-yield, below-investment-grade corporate bonds or mortgages provides a great degree of interest rate protection, through the cushion of its high coupon available for reinvestment. But it also offers a much higher chance of default. This has been clearly the experience of the savings and loan industry in the United States, as it tried to seek higher risk investments in the 1980s to compensate for its experience with the interest rate risk in the late 1970s.

If, however, one moves to control the C-3 risk by purchasing floating rate bonds and mortgages instead of fixed coupon securities, one must face the reality of a greater risk of default of the security issuer. Issuers of floating rate bonds cannot plan their financial obligations as well as fixed rate issuers can, and they have greater volatility of earnings. An extreme example of that was provided in the first Eastern European economy to reform its way out of the command economy: Poland in 1990 (Ostaszewski 1992). During the final stages of the command economy in Poland, state-owned financial institutions suffered massive economic losses because of large amounts of fixed interest rate loans granted to state-owned and private entities in the macroeconomic environment of hyperinflation. On Jan. 1, 1990, the Minister of Finance of the Republic of Poland, Leszek Balcerowicz, initiated a "shock therapy" of free market reforms. One of the key elements of the reform was changing all existing loan covenants in which the state was one of the parties involved into floating interest rate loans. This, of course, remedied the losses from the C-3 risk that the state suffered previously as a lender. The reform also allowed for interest rates to be set freely by the markets. Resulting high real interest rates affected the national economy negatively, and the borrowers found themselves unable to meet the payments. Massive losses resulted again, this time as a result of the C-1 risk.

This, of course, is an extreme case of trading C-3 for C-1 risk, but such a trade does occur, even if reduction in interest rate risk is achieved through the purchase of a swap underwritten by a counterparty other than the issuers of the bonds currently held in the investment portfolio.

C-2 risk is increasingly a function of interest rates and default risks, as the relative significance of the systematic risk, especially in life insurance and annuities, increases. The 1991 insolvencies of Mutual Benefit and Executive Life in the United States illustrate how disintermediation (i.e., exercise of a put of the policy back to the insurance company) is affected by the perceived riskiness of the company's investment portfolio, as well as unjustifiably high interest rate guarantees.

C-4 risk is not just some abstract term for all other business risks, but may encompass the insurance company management's response to the competitive pressures, including such practices as fraudulent reinsurance contracts, questionable sales practices, and pricing policies, all of which generally occur in response to increased C-1 or C-3 risks.

The vision of ALM as merely controlling for the interest rate risk is unduly restrictive. One wants to control for the interest rate risk in order to protect the economic value of the firm. But the interest rate risk cannot be truly separated from other forms of risk, and the value of the firm is best understood within the risk-reward framework. In such a framework, not every elimination of risk is desirable.

Let us now take a closer look at the economic picture of various forms of insurance. When a life insurance policy is issued, the valuation of liability created is affected by the entire stream of future premiums as well as future claim payments and other expenses. This principle holds true for either the statutory or GAAP valuation, but the methods of allocation of value vary between the methods. It is well understood that a policy is almost always unprofitable in the year of issue because of the marketing and underwriting expenses, but the contract is generally viewed as long term, with profits developing over time. As pointed out in Chapter 4, the resulting securitization of human capital addresses the structure of cash flows of the individuals insured. This perspective is in striking contrast with the economics of personal auto insurance (Panning 1993). An auto policy is typically issued for a term of six months or a year and has similar initial expenses as a life policy because of marketing and underwriting. Just as in the case of life insurance, it costs less to continue a policy beyond its initial term than to issue it. Interestingly enough, claim costs in personal auto tend to decline with subsequent renewals, as policyholders who get older tend to have fewer accidents, and higher risk clients are gradually either eliminated or required to pay higher premiums. This, of course, is in striking contrast with a typical life policy, which is already "renewed" for many years when issued, and tends to have increasing claim costs with time because of insureds' aging and antiselection.

In either case, however, an insurer is well aware that, in order to make the line of business profitable, a certain portion of the business should remain on the books for an extended period of time, either through persistency (in the case of life insurance) or renewals (for auto). Panning (1993) points out that among profitable auto insurers, retention rates consistently exceed 90% annually.

From the economic point of view, there is, therefore, great similarity between life and auto insurers' goals. But the accounting principles recognize only the cash flows from the initial auto policy term and treat renewals as separate contracts not yet in existence. From this point of view, the ALM practice of personal auto insurance, or other similar property-casualty insurance business (e.g., home, liability, commercial-lines and reinsurance) must take into account not only the future cash flows from the business existing on the books, but also from the continuance of that business beyond the initial contract term. Furthermore, the *going-concern* perspective also requires making a reasonable provision for the future business to be created by the firm.

This does not necessarily mean that a change in the methods of reserve valuation is called for. In no case can it be argued that the accounting statement of a firm, be it an insurance firm or any other firm in existence, provides a perfect measure of that firm's value,. An accounting statement, despite its best efforts to represent future expectations, is first and foremost a statement of the history of capital and other resources invested in the business. However, ALM is concerned with the insurance firm's future cash flows, and this implies that those cash flows need to be placed in the very heart of the economic valuation of the firm.

The value of the future business yet to be created by a firm is called the *franchise value* (Leibowitz and Kogelman 1990, 1992, 1993). Interestingly, it is afforded partial recognition in the world of GAAP accounting if the firm is purchased for an amount that exceeds its book value. When that occurs, the excess of the purchase price over book value will be shown as *goodwill* on the asset side of the balance sheet of the acquiring firm. However, accounting principles require amortization of goodwill, leading to its eventual disposition, while the very act of acquisition indicates the belief on the part of the acquirer that the goodwill's economic value is real. It should be noted that the existing methods for actuarial appraisal of property-casualty companies recognize the value of the business in force, expected renewals, and the firm's franchise value (Sturgis 1981).

If the economic value of an insurance firm is indeed determined by these three major pieces, what does this mean for ALM practice? This question was addressed by Panning (1993) in a revealing paper, which in many ways provided a vital link between ALM and the capital markets perspective on the valuation of a firm. Let us look at an example developed by Panning. Assume that a property-casualty insurance firm issues a simple policy consisting of a single premium payment at the time the policy is written, net of expenses also paid at issue, and a single loss payment occurring T periods later. The term structure of interest rates is flat, and taxes are ignored. Time variable is denoted by t, and the issue occurs at the time $t = 0$. The following notation is used:

N = premium net of expenses, paid at the time $t = 0$.
L = the expected loss payment.
T = the time at which the loss payment will occur.
i = the T-period spot annual force of interest.
r = the required pre-tax rate of return on surplus (expressed in the force of interest form).
k = the surplus required per dollar of ultimate loss payment.

It is standard in the insurance business that initial surplus is required to write a policy, and this requirement must be included even in the simplest of models. This is caused by both the uncertainty of loss and, in practice (although not in this model), is compounded by the initial marketing and underwriting expenses. The surplus required is kL at the time T, and its value at issue is LE^{-iT}. That amount, together with the premium N, is invested initially and must pay the claim as well as the required return on surplus, resulting in the following equation:

$$(N + kLe^{-iT})e^{iT} = L + (kLe^{-iT})e^{rT}. \qquad (5.1)$$

The premium that satisfies Equation (5.1) is:

$$N = Le^{-iT}\,(1 - k + ke^{(r-i)T}). \qquad (5.2)$$

Now assume that the same firm has written the same policy each year in the past and at the current time $t = 0$ it has just written a new identical policy. If T is an integer, loss payments still to occur will happen at times $t = 1, 2, \ldots, T$. Given that the property-casualty losses are not discounted when reserves are calculated for accounting purposes, the nominal reserves of the firm are $R = TL$. The nominal surplus required to support nominal reserves is kR, and the firm's assets are $A = kR + R = (1 + k)TL$.

The firm's economic balance sheet looks somewhat different. Given that most assets are reported at values relatively close to their economic (market) values, we can assume that the assets of the firm have the same market value $MV(A)$ as their accounting value A. In addition, assuming a flat term structure of interest rates, the market value of the reserves (liabilities) is

$$\begin{aligned} MV(R) &= L(e^{-i} + e^{-2i} + \ldots + e^{-Ti}) \\ &= Le^{-i}\,\frac{1 - e^{-Ti}}{1 - e^{-i}} = Le^{-Ti}\,\frac{e^{iT} - 1}{e^{i} - 1}. \end{aligned} \qquad (5.3)$$

In examining the duration and convexity parameters of these liabilities, we have the duration

$$-\frac{\frac{d}{di}MV(R)}{MV(R)} = \frac{L(e^{-i} + 2e^{-2i} + \dots + Te^{-Ti})}{L(e^{-i} + e^{-2i} + \dots + e^{-Ti})} = \frac{(Ia)_{\overline{T}|}}{a_{\overline{T}|}} = \frac{\ddot{a}_{\overline{T}|} - ne^{-iT}}{1 - e^{-iT}} = \frac{e^{i}}{e^{i} - 1} - \frac{T}{e^{Ti} - 1}. \qquad (5.4)$$

Furthermore,

$$\frac{d^2}{di^2}\ln MV(R) = \frac{e^{i}}{(e^{i} - 1)^2} - \frac{T^2 e^{Ti}}{(e^{Ti} - 1)^2}, \qquad (5.5)$$

which is the logarithmic convexity utilized in this work, whereas the traditional definition of convexity is:

$$\frac{d^2}{di^2}\ln MV(R) + (D(MV(R)))^2 = \frac{T^2(1 - e^{Ti})}{(e^{Ti} - 1)^2} + \frac{e^{2i} + e^{i}}{(e^{i} - 1)^2} - \frac{2e^{i}T}{(e^{i} - 1)(e^{Ti} - 1)}. \qquad (5.6)$$

The economic value of the liability is a simple annuity immediate, and its properties are analogous to those of a liability issued by a life insurance firm. Under the interest rate of 8%, the relationship of the duration of this liability to T is given in Figure 9, and the relationship of logarithmic convexity to T is given in Figure 10, together with the graph of logarithmic convexity of a zero-coupon Treasury of exactly the same duration. We can clearly see that the logarithmic convexity of the reserves is high (more than twice the logarithmic convexity of the corresponding zeros), as expected from the analysis in Chapters 2 and 3.

The firm must commit the portion of the surplus equal to $kMV(R)$ to absorb volatility of claims, and the uncommitted surplus is equal to $MV(A) - (1 + k)MV(R)$, a positive quantity. If the objective of ALM is the standard immunization of surplus, the firm should pursue the strategies described in Chapter 2. However, if the objective is to immunize the dollar amount of uncommitted surplus, the firm should set the dollar durations equal as below in Equation (5.7):

$$MV(A)D(A) = (1 + k)MV(R)D(R) \qquad (5.7)$$

resulting in the following prescription for the duration of assets:

$$D(A) = \frac{(1 + k)MV(R)D(R)}{MV(A)}. \qquad (5.8)$$

This means that when $MV(A) = (1 + k)R > (1 + k)MV(R)$, as is the situation for the nondiscounted accounting of the property-casualty reserve, the asset duration that immunizes the absolute level of the firm's uncommitted surplus is smaller than the duration of the firm's liabilities. *Caveat emptor,* however, because the convexity of the liabilities, especially in the case of a "long tail" of payouts, is most likely higher than any assets available in capital markets.

FIGURE 9

Duration as a Function of Maturity for an Annuity Immediate

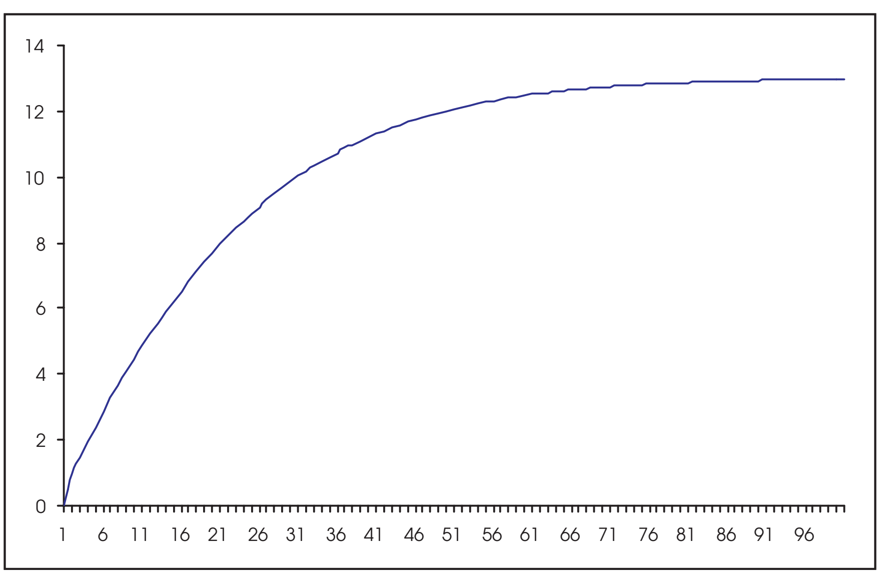
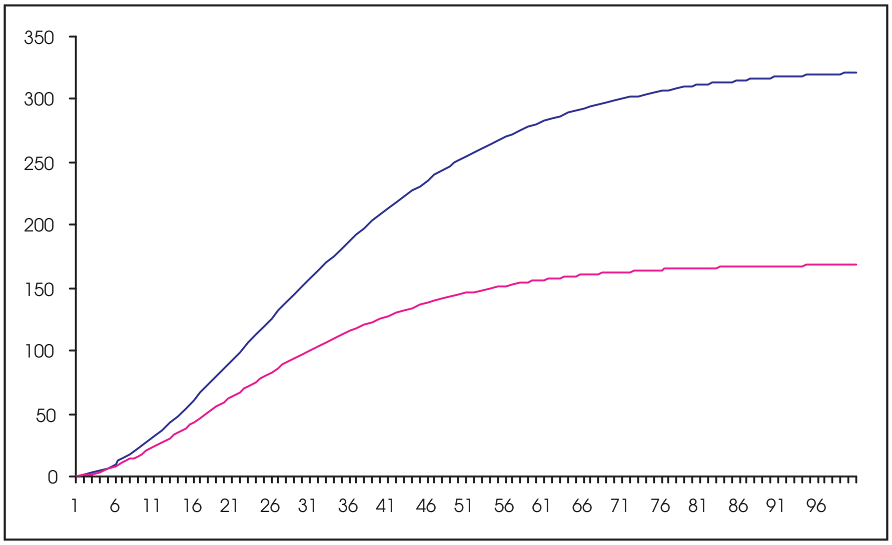


FIGURE 10
Logarithmic Convexity of an Annuity (above) and of a Zero Coupon Bond (Below) as a Function of Maturity



The above estimate merely extends the existing business of the firm; it does not include the future new business to be generated by the firm. Before proceeding with this line of investigation, note that, if we do fully incorporate such dynamic valuation approach into our analysis of the firm's value, we will find ourselves facing the same issues as those encountered in the Franchise Factor Model of a firm developed by Leibowitz and Kogelman (1990). In a series of papers concerning equity valuation, these authors distinguished between a firm's ''tangible value'' (TV) and its ''franchise value'' (FV). TV is derived from the future cash flows attributable to current business, while FV is based on anticipated cash flows from future investments in new businesses. The standard Dividend Discount Model estimates the price of common stock by the formula

$$P = \frac{D_0}{k - g} \tag{5.9}$$

where D_0 represents the initial dividend payable at the end of the year, k is the discount rate representing the rate of return required by the investors, and g is the dividend growth rate. Although formula (5.9) represents a great simplification of the reality, it is a useful tool in basic estimates. It allows for an estimate of the duration of equities, indicated in formula (2.12) as $1/(k - g)$. This estimate suggests that equity portfolios should exhibit very high duration. Yet, as Leibowitz and Kogelman (1993) indicate, empirical estimates of equity duration tend to be between two and six years. How can this divergence be explained?

Leibowitz and Kogelman represent the firm's economic value as the sum of TV and FV. The tangible value is determined by the cash flows produced by the existing business, which generally is assumed to be some form of perpetuity. This is supplemented by an estimate of the franchise value of the firm:

$$\text{FV} = \text{Franchise Factor} \cdot \text{Growth Equivalent} \cdot \text{Annual Earnings},$$

with the franchise factor being defined as the price/earnings ratio per dollar of new investments, the growth equivalent being the present value of new investment divided by the current book value, and the annual earnings representing a perpetuity of positive cash flows from existing business. These quantities represent reasonable estimates of values of future investments anticipated to be made by the firm.

Leibowitz and Kogelman (1993) indicated that the existing and future businesses are both affected by inflation, but differently. It is less likely that the cash flows of the existing business will adjust to inflation, while future investments, reflecting choices to be made by the management, will generally have a greater degree of inflation protection. The authors term the ability of the firm to increase its cash flows in response to inflation the *inflation flow-through,* and show that high inflation flow-through lowers the duration of the market value of the stock. Of the two parts of the value of the firm, *TV* and *FV*, *FV* has a generally much higher rate of inflation flow-through and subsequently much lower duration. The duration of the sum of the two pieces is a weighted average of their respective durations. Leibowitz and Kogelman (1993) provide numerical examples showing that the Franchise Factor Model duration will be generally much lower than the one predicted by the classical Dividend Discount Model for shares valuation.

Panning (1993) applies a similar model to his hypothetical property-casualty company. The economic value of the firm is the sum of the value of the cash flows anticipated from existing business (tangible value) and the value of the future cash flows expected from the business yet to be written. $MV(FR)$ is the present value of future retentions. To determine it, the present value of future loss payments $MV(FL)$ is subtracted from $MV(FP)$, the present value of future premium payments, net expenses. A critical variable is the persistency rate p, which is defined as the proportion of policies that the company renews from year to year. This proportion is assumed to be constant for n years and then to become 0. Let us note two things here. As stated, the model created by Panning (1993) does not seem to include the franchise value. But this is only the first impression, as in fact the model does include *FV*. If future retentions include new business, and the retention rate p is allowed to exceed one, the resulting generalization naturally encompasses new business. Second, the model may appear simplistic, as it does not provide for the great uncertainty of future changes in the loss costs. If we allow for the firm's response to such changes in the changes of the future premium rates, we can arrive at a reasonable estimate of the difference between the two cash flow streams. And, as Redington (1952) stressed, an actuary knows his or her business by knowing its cash flows.

The present value of future loss payments is estimated as

$$MV(FL) = \sum_{t=1}^{n} Le^{-Ti} p^t e^{it} = Le^{-Ti} \frac{p}{e^i - p} \frac{e^{ni} - p^n}{e^{ni}}, \qquad (5.10)$$

and the present value of future premiums is

$$MV(FP) = N \frac{p}{e^i - p} \frac{e^{ni} - p^n}{e^{ni}}. \qquad (5.11)$$

Note that this model makes the future retentions asset into a contingent annuity of the same nature as life annuities considered in traditional life contingencies. The resulting present value of future retentions is

$$MV(FR) = (N - Le^{-Ti}) \frac{p}{e^i - p} \frac{e^{ni} - p^n}{e^{ni}}. \qquad (5.12)$$

Given this result, one can estimate the ratio of the firm's economic value to its book value as a function of loss payment delay T and retention rate p. The results of such estimates by Panning (1993) are given in Table 1. The analysis assumes a firm with $n = 10$ years time horizon, $k = 25\%$, ratio of surplus to loss at the time of loss payment, and the required return on surplus given by the formula $r = a + bi$, with $a = 0.15$ and $b = 1$, and $i = 0.06$.

The numerical estimates of Panning (1993) reveal that the economic value of a property-casualty insurance firm may indeed greatly differ from its book value. The objective of ALM is maximization of the economic value and, given the dramatically high ratios in Table 1, one must indeed pay attention to the going-concern model of the business.

Let us now proceed to the analysis of the interest-rate sensitivity of the whole company model, as proposed by Panning (1993). As indicated in Chapter 3, there are some reservations about the value of duration, and even duration and convexity, as measures of interest rate risk. These do, however, provide a useful initial benchmark in the process of ALM; alternative benchmarks will be discussed in Chapter 7.

In the perspective of Panning's model, future retentions constitute an additional, but, unfortunately, hidden, in the world of traditional insurance accounting, asset of the firm. If the firm were to pursue Redington's (1952) immunization strategy, it should set the dollar duration of its economic assets (balance sheet assetS and the future retentions phantom asset) equal

TABLE 1
RATIO OF ECONOMIC VALUE TO BOOK VALUE

	Retention Rate (p)			
Loss Payment Delay (Years)	0%	85%	100%	110%
1	1.2	1.8	2.3	3.1
2	1.3	1.9	2.5	3.2
3	1.4	2.0	2.6	3.4
4	1.5	2.1	2.7	3.5
5	1.6	2.2	2.9	3.7

to the dollar duration of its liabilities, which consist of the reserve and the committed surplus. This gives

$$MV(A)D(A) + MV(FR)D(FR) = (1 + k)MV(R)D(R). \tag{5.13}$$

Thus, immunization leads to setting

$$D(A) = \frac{(1 + k)MV(R)D(R)}{MV(A)} - \frac{MV(FR)D(FR)}{MV(A)}. \tag{5.14}$$

Equation (5.14) implies that, if the duration of the future retentions phantom asset is positive, then the immunizing duration of invested assets should be set lower than the one implied by Equation (5.8).

Now examine the parameters of the present value of future losses as a security, noting that, in what follows, losses are assumed to be independent of interest rates. This may be an unreasonable assumption, but it is justified for this simple model. The duration of the future losses equals

$$D(MV(FL)) = T + \frac{pe^{-i} + 2p^2e^{-2i} + \ldots + np^ne^{-ni}}{pe^{-i} + p^2e^{-2i} + \ldots + p^ne^{-ni}}. \tag{5.15}$$

Let us introduce a new, temporary, discount factor $\nu = pe^{-i}$. Using the annuities formed with this new discount factor we have:

$$\begin{aligned} D(MV(FL)) &= T + \frac{\ddot{a}_{\overline{n}|} - ne^{-in}}{1 - \nu^n} \\ &= T + \frac{e^i}{e^i - p} - \frac{np^n}{e^{ni} - p^n}. \end{aligned} \tag{5.16}$$

The assumption of independence of future premiums of interest rates also is crucial for a similar calculation of duration of future premiums. However, it cannot be brushed off that easily. In fact, it is certain that the pricing strategy of the firm will determine whether such independence exists. In practice, future premiums flow generally behaves like an inverse floating security: It rises when rates fall, and falls when rates rise. Furthermore, the pricing strategy of the firm, representing pursuit of required rate of return on capital, will also affect the changes in premiums in response to changes in interest rates.

Following Panning (1993), assume that a portion ν, $0 < \nu < 1$, of future premiums varies with interest rates. The premiums are decomposed into those portions that vary with interest rates and those that do not. Therefore,

$$N = \upsilon N_\upsilon + (1 - \upsilon)N_f, \tag{5.17}$$

where N_υ and N_f are given the same initial value. The duration of fixed future premiums is then calculated just as in Equation (5.16), yielding

$$D(N_f) = \frac{e^i}{e^i - p} - \frac{np^n}{e^{ni} - p^n}. \tag{5.18}$$

For the future premiums that vary with interest rates, it is necessary to assume that the future pre-tax return on surplus is a linear function of i, i.e., $r = a + bi$. The duration of future variable premiums then is

$$\begin{aligned} D(N_\upsilon) &= \frac{e^i}{e^i - p} - \frac{np^n}{e^{ni} - p^n} \\ &\quad + T\left(1 + \frac{(1 - b)ke^{aT+(b-1)it}}{1 - k + ke^{aT+(b-1)it}}\right), \end{aligned} \tag{5.19}$$

which gives the duration of the combined premium stream portfolio of

$$\begin{aligned} D(FP) &= \frac{e^i}{e^i - p} - \frac{np^n}{e^{ni} - p^n} \\ &\quad + \upsilon T\left(1 + \frac{(1 - b)ke^{aT+(b-1)it}}{1 - k + ke^{aT+(b-1)it}}\right). \end{aligned} \tag{5.20}$$

Combining Equations (5.20) and (5.16) we arrive at the duration of future retentions:

$$\begin{aligned} D(FR) &= \frac{e^i}{e^i - p} - \frac{np^n}{e^{ni} - p^n} \\ &\quad + T\left(\frac{\upsilon N\left(1 + \frac{(1 - b)ke^{aT+(b-1)it}}{1 - k + ke^{aT+(b-1)it}}\right) - Le^{-iT}}{N - Le^{-iT}}\right). \end{aligned} \tag{5.22}$$

For a firm with the parameters, following set of $T = 2$, $k = 0.25$, $a = 0.15$, $b = 1$, $i = 0.06$, $r = 0.21$, Panning (1993) calculates that the immunizing duration of the existing asset portfolio, when there are no retentions, is 1.36. When retentions are 90% forever and all of the future premiums vary with interest rates, it is −0.12 (with duration of future retentions equal to 8.56), and when retentions are 90% forever and no future premiums vary with interest rates, it is 4.17 (with duration of future retentions equal to −16.31).

These results indicate that the firm has a long position in premiums cash flow, and a short position in losses cash flow. If both of these do not vary with interest rates, since future premiums are received before future losses are paid, future retentions have a negative duration, and an immunizing asset portfolio should have increased duration.

Panning (1993) goes on to analyze the impact of competition on the value of an insurance firm. He assumes that competitors have the same characteristics as the firm analyzed, with the sole exception of the pricing strategy, where the proportion λ of future premiums varies with interest rates for the firm, and the proportion ω varies with interest rates for the competitor (the model assumes one pattern of competition). Then, if N is the firm's premium and N_c is the competitor's premium (those premiums are assumed to be equal initially),

$$\frac{\frac{dN}{di}}{N} = -\lambda T\left(1 + \frac{(1-b)ke^{aT+(b-1)it}}{1-k+ke^{aT+(b-1)it}}\right) \quad (5.23)$$

and

$$\frac{\frac{dN_c}{di}}{N_c} = -\omega T\left(1 + \frac{(1-b)ke^{aT+(b-1)it}}{1-k+ke^{aT+(b-1)it}}\right). \quad (5.24)$$

The firm's premium change relative to its competitors, $N_{rel} = N - N_c$, has the following rate of change:

$$\frac{1}{N}\left(\frac{dN}{di} - \frac{dN_c}{di}\right) = (\omega - \lambda)T \left(1 + \frac{(1-b)ke^{aT+(b-1)it}}{1-k+ke^{aT+(b-1)it}}\right). \quad (5.25)$$

Let

$$q = -\frac{\frac{N}{p}}{\left(\frac{d(N_{rel})}{dp}\right)}. \quad (5.26)$$

Then we have

$$\frac{1}{MV(FR)}\frac{\partial MV(FR)}{\partial p} = \frac{e^i}{p(e^i - p)} - \frac{np^n}{p(e^{ni} - p^n)}. \quad (5.27)$$

The changes in interest rates will affect the market value of future retentions directly through the duration measure of future retentions already calculated in Equation (5.22) and, indirectly, through interactions in the relative changes in premiums streams. This is calculated as

$$-\frac{1}{MV(FR)}\frac{\partial MV(FR)}{\partial p}\frac{dp}{d(N_{rel})}\frac{N}{p}\frac{1}{N}\frac{d(N_{rel})}{di} = \left(\frac{e^i}{p(e^i - p)} - \frac{np^n}{p(e^{ni} - p^n)}\right) q(\omega - \lambda)T\left(1 + \frac{(1-b)ke^{aT+(b-1)it}}{1-k+ke^{aT+(b-1)it}}\right). \quad (5.28)$$

Therefore, the chain rule implies that the total duration of future retentions equals the sum of the two components:

$$D(FR) = \frac{e^i}{e^i - p} - \frac{np^n}{e^{ni} - p^n} + T\left(\frac{\lambda N\left(1 + \frac{(1-b)ke^{aT+(b-1)it}}{1-k+ke^{aT+(b-1)it}}\right) - Le^{-iT}}{N - Le^{-iT}}\right) + \left(\frac{e^i}{p(e^i - p)} - \frac{np^n}{p(e^{ni} - p^n)}\right) q(\omega - \lambda)T\left(1 + \frac{(1-b)ke^{aT+(b-1)it}}{1-k+ke^{aT+(b-1)it}}\right). \quad (5.29)$$

We can see now that the indirect effect of change in interest rates will be to increase the duration of future business when the firm adopts a fixed-premium strategy but its competitors do not, and to reduce the duration of future business when the firm's premiums are variable but competitors' premiums are not. Panning (1993) calculates that, for his model company (as presented above), the immunizing asset portfolio duration is 2.14 if the firm's premiums vary and competitors' premiums do not vary, whereas it is 1.91 if the firm's premiums are fixed, and competitors' premiums vary.

This observation should be viewed in the context of property-casualty companies' actual investment strategies. Only in the case of future premiums not being responsive to interest rates, for both the firm and the competitors, did the Panning's analysis imply that the immunizing asset portfolio should have duration significantly exceeding that of the existing reserve liability (valued on an economic, not statutory, basis). In contrast, Messmore (1990, 1992) indicates that the actual asset portfolios of property-casualty companies, estimated based on A.M. Best's On-Line data on Dec. 31, 1987, had an average duration of approximately 5.4. The estimate for the average duration of in-force reserves for the U.S. property-casualty industry was 1.9, which is consistent with Equation (5.4) and $T = 3$, a rather reasonable assumption. The actual duration mismatch practiced by the industry is generally much higher than the one that could be explained by the Panning model, and directly contradictory to immunization of the interest rate risk of in-force reserves with existing assets (excluding future retentions and new business). One popular explanation of this phenomenon is that the managers of property-casualty companies are ignorant about asset-liability management theory, but here are two alternative hypotheses for this behavior:

- Asset portfolios could be composed of asset classes in which property-casualty companies have a comparative advantage.
- The managers of those companies may reject the immunization paradigm and instead pursue other strategies in which duration mismatch is not an anathema.

Let us examine those hypotheses. Property-casualty companies in the United States generally hold large amounts of their assets in municipal bonds whose interest is exempt from federal income taxes. This is often explained by the tax advantage argument, as those insurers must pay taxes on their investment income (generally unlike life insurers, who can transfer a great portion of their investment gains into reserve increases). But rational investors seek after-tax return, after consideration of the level of risk. In a world with taxes, there is a question of whether true tax advantages exist when all differences in risk are properly accounted for (Derrig 1994). As discussed by Derrig (1990), Stone introduced the concept of a regulatory standard portfolio: that is, a portfolio of Treasury securities whose cash flows are matched to the expected loss payment patterns. If this regulatory standard portfolio is used, computation of the effective investment tax rate is simple. All income from Treasury securities is fully taxable at the 35% corporate tax rate. Furthermore, the short position in the tax liability is fully hedged by investing the portion of the policyholder premium covering the expected tax liability in Treasury securities.

Myers (1984) posed the question of whether some other portfolio with lower tax rates might actually be superior in all relevant aspects to the regulatory standard portfolio, and would yield additional value to the company holding such a portfolio. If such a portfolio exists, it must contain risky securities. In that case, the short position in the tax liability can be fully hedged provided that either (1) the effective tax rate of the portfolio is known with certainty, so that the tax portion of the policyholder premium will exactly cover the option price of the tax liability, or (2) the uncertainty in the effective tax rate of the portfolio can be hedged.

Cummins and Grace (1994) determined that insurers perceive a yield advantage for longer maturity tax exempt bonds, implying the existence of a portfolio with an effective tax rate lower than 35% (the current corporate income tax rate in the United States). This can be justified by the *tax clientele* effect: A marginal buyer with a marginal tax rate of less than the insurers' 35%, less their 5.1% minimum proration resulting from the 1986 Tax Reform Act (for more on this, see Derrig 1994, and Derrig and Ostaszewski 1996), alternative minimum tax rate, and capital gains income. Of course, the question of comparing risk characteristics of longer-maturity tax-exempt bonds with the regulatory standard portfolio, or any other portfolio, remains a complicated issue to resolve.

One must however, pose a question arising naturally from the combined results of Messmore (1992) and Cummins and Grace (1994). Is it possible that the investment practices of property-casualty insurance firms in the United States also are a result of a portfolio approach to their investment assets and the phantom future retentions asset? Is the comparative advantage of tax-exempt bonds perceived by the property-casualty industry sufficient compensation for accepting the duration mismatch? Finally, if the actual duration mismatch is a measure of risk accepted by the firm, could this risk pursuit be justified in view of two forms of government involvement:

- Federal income taxes are proportional to income and provide for loss carryforward and carryback, resulting in a reduction of riskiness of after-tax cash flows for the firm (Derrig 1994 and Derrig and Ostaszewski 1996).
- State guarantee programs assess the surviving insurers in the case of an insolvency, thus lowering the riskiness of cash flows to the policyholders.

Baesel (1977) points out that the duration measure itself may depend on taxes. His analysis applies mostly to property-casualty companies, because of the reserve increase deduction for life insurance companies. Income taxes paid by property-casualty companies cause the duration of the after-tax income stream to be longer than that of the before tax income stream, and the duration increases with the tax rate. However, capital gains taxes cause the after-tax cash flow stream to have a shorter duration than the before-tax stream. The overall effect on a portfolio with duration of approximately 5.5 (close to the estimate provided by Messmore 1992) is to increase the asset portfolio duration to nearly 6. This proposition again stresses that positive duration mismatch is a fact of life in property-casualty insurance company management.

Another interesting argument for the comparative advantage hypothesis has been put forth by Babbel (1993), in combination with the hypothesis of management ignorance of ALM theory. Property-casualty insurers have an insatiable appetite for tax-exempt securities and perceive a comparative advantage in that area. Life insurers, in contrast, have an appetite for corporate bonds and mortgages because they provide book yield, as specified in statutory accounting for their regulatory purposes. As Babbel points out, the securities purchased in such large amounts by the insurance industry, when valued by the investment industry, are not a good value. Those securities generally contain provisions allowing for prepayment or call of the bond by the issuer. This option is paid for in an incremental yield of the bonds. The difference in yield between such a security and an analogous security issued by the U.S. Treasury is called the *spread* of the security. As previously mentioned, a portion of the spread is attributable to the price of the call/prepayment option. There is also a portion of the spread attributable to the risk of default of the asset issuer. When these two portions are subtracted, the remaining spread over Treasuries is referred to as an *option-adjusted spread.*

Babbel (1993) points out that valuation models used by the investment industry show that corporate bonds of investment quality have negative spreads. One could hypothesize that the investment industry is wrong. This hypothesis is not justified by the efficiency exhibited by the industry in pricing mortgage-backed securities and derivatives. Rather than assuming that the managers of insurance firms are ignorant about pricing or buying corporate bonds, Babbel claims that pursuit of the book yield by the insurance industry is the most reasonable explanation as to why the insurance industry would be buying overpriced securities. The insurance industry is subject to state statutory regulations, which force preference for a high book yield portfolio. One could argue that following these regulations is indeed payment for participation in the state guarantee programs. It would seem that insurers pay through an assessment system in case of insolvency. However, assessments are often credited against premium tax payments and, if one can argue that premium tax costs are transferred on to the policyholders, the cost of the guaranty association is indeed paid in following the statutory requirements.

One common characteristic of investment practices in both the property-casualty and life insurance industries, nevertheless, seems to be greater acceptance of duration mismatch than is implied by the immunization paradigm. One could call this too risky, or one might ask, are insurance firms properly compensated for the risks they take, considering all possible future cash flows of the business? We believe that the second approach is by far superior. If insurance firms are indeed in the business of crafting and selling derivatives, should they sell them the way other producers sell their wares: in pursuit of profits, not necessarily in pursuit of a hedge?