Stochastic Management without Tears

This work has been striving to establish the thesis that the valuation of a financial intermediary's balance sheet is a problem essentially equivalent to the valuation of derivative securities. The methodology of valuation of derivatives, as presented in Chapter 7, calls for using stochastic processes in the probability space of scenarios of the future, originating mostly from interest rate scenarios. This represents a departure from traditional methods of valuation in insurance and may be a cause for concern for the management of an insurance firm. Is this abstract methodology truly applicable to real-life situations? Is implementation possible and realistic?

Forbes et al. (1993), in their study of ALM practices of the life insurance industry, reaffirm the thesis that ALM has been brought to the forefront of the insurance firm management process. ''The objectives of ALM are to measure and manage the investment and liability risks of the insurer in order to meet its marketing, solvency and profitability objectives,'' they said. ''The development of appropriate and integrated pricing, investment, and contractual design strategies is necessary in order to achieve these objectives.''

This changes the perspective on the role of an actuary in the insurance firm. Instead of a narrow focus on pricing noninvestment contingencies, all contingencies with financial impact are brought together in an integrated picture (hence, the title of this work), and the actuary is asked to consider the entire firm. The second half of the 20th century was not only the period when actuaries were asked to learn about mortgage-backed securities and interest-rate scenarios, but also the period when the economic perspective on the institution of a firm changed.

In the first half of the twentieth century, and as late as in the 1960s, the idea of a massive industrial conglomerate was triumphant in the practice of corporate finance. The Modigliani-Miller ''Irrelevance Theorem'' (see a discussion of it in Chew, 1993) was effectively interpreted as a license to grow the conglomerates. Since the form of corporate financing ''did not matter,'' management followed its natural incentive to increase the size of the firm in order to increase its power and control over resources.

What followed in the second half of the twentieth century, was a major change, which we are in the midst of now, in the outlook on the firm. Was the change propelled by practice or theory? It is our firm conviction that ''there is nothing more practical than a good theory.'' Note the theoretical economic underpinnings of the new world of corporate finance (as provided in far more detail by Chew 1993; see also Gwartney and Stroup 1995). The key question is: Why do firms exist? The answer, however obvious it might appear, is that the firm provides a nonmarket-based economic zone in the market-based economic reality. Thus, the size of the firm is no longer irrelevant, and neither are the internal relationships among its employees. The employees are not there to be ordered about by the management, to merely play the role of pieces of a big puzzle, or to compete with each other, but rather to work together to make the entity competitive. If, as a norm in a given firm, employees can't work together and must be ordered, then the firm is either too big or improperly structured in its financing, the management line, or the internal incentives. If one must view employees as pieces of a puzzle, then the pieces do not stay in place, but move around and communicate with other pieces.

Second, the Modigliani-Miller Theorem has been reexamined. It states that, if taxes or bankruptcy costs do not matter and if the information flow between principals and their agents in the firm is perfect and their incentives are aligned, then the form of financing of the firm is irrelevant to the value of the firm. The contraposition of this statement is that, if the form of

financing matters, then it is either taxes, bankruptcy costs, or the intricate world of information and incentives flow between the principals (the owners of resources, investors) and the agents (the users of resources, managers, and employees). Since the empirical experience clearly shows that financing does matter, one must continuously examine all the factors that cause it to matter.

This brought about changes for the entire corporate world, in which corporations became generally smaller and more concentrated on creating economic value. The major change for insurance firms has not necessarily been in the size of the firm (many insurance firms in the United States, in fact, appear to be too small), but in bringing the actuarial valuation to the process of creating economic value for the firm.

Forbes et al. (1993) examined changes in the economic and regulatory environment of the life insurance industry. They pointed out recent developments, such as Valuation Actuary Model Regulation (1991 Amendment to Standard Valuation Law), Asset Valuation Reserve and Interest Maintenance Reserve (1992), Risk-Based Capital Requirements (1993), planned comprehensive investment regulations, and the interest expressed by the SEC in market value accounting for banks and insurance companies. The common thread of these developments is integration of traditional liabilities valuation with the asset side of the balance sheet of the firm, and inclusion of actuarial valuation in the management process.

Forbes et al. (1993) suggest incorporation of the following measures of ALM results:

- Accounting measures, with considerable attention given to the divergence of such measures from the underlying economic value, in both statutory and GAAP.
- Cash flow testing, including scenarios beyond those prescribed in New York Regulation 126.
- Constraints imposed by the rating agencies.
- Constraints imposed by the state regulators.
- Organizational design considerations.

The authors suggest that an insurance firm should form an ALM working group to address contingencies embedded in liabilities, such as guarantees of minimum or index interest rate, surrender features, options to change policy features, reinsurance, etc., as well as asset-side contingencies, such as the baseline portfolio, reinvestment strategies, uses of derivatives and instruments with complex derivatives embedded in them. This working group should also be engaged in the pricing, investment, and contractual design strategies of the firm. The group also should be involved in the design of the overall capital management system of the firm.

Current accounting principles, especially as applied to insurance in the statutory form, in many ways refer to an environment that existed in the Golden Era of life insurance, the short-lived era of the 1950s and 1960s. These principles are the source of many paradoxical situations in the management of the industry, which appears to be the forefront for financial entrepreneurs utilizing the greater efficiency of modern technology to take advantage of arbitrages handed to them by the accounting paradoxes.

Davlin (1996) analyzed the structure of reinsurance contracts and shows how the traditional approaches to reinsurance fail when viewed from an integrated asset-liability framework. The established model for reinsurance revolves around the concept of indemnification as a vehicle for the transfer of risk or obligations from the ceding company to its reinsurer. In this approach, the ceding company is able to remove some of its liabilities from the balance sheet, while the reinsurer acquires considerations for the contract.

Compare this to a hedging transaction of buying an interest rate floor. In this transaction, a firm concerned about the risk of falling interest rates (the *ceding firm)* seeks another firm (the *reinsurer)* that would be willing, for a fee, to pay the difference between a fixed interest rate floor and a certain market index of current interest rates, should the index fall below the floor. If the ceding company writes financial products that provide minimum interest rate guarantees to customers, while simultaneously, following some index in the amounts credited to the clients, the company is quite concerned about the risk of falling interest rates. It can, for a price, purchase such protective contracts from investment firms. Such a transaction is referred to as a *hedge.* It can also enter into a similar transaction with another insurance company, a reinsurer. Interestingly, such a transaction does not change any part of the liability side of the statutory balance sheet for the company purchasing a hedge if that company (ceding company) is an insurer, and the firm providing the hedge is reinsurer. This is peculiar because the treatment may be significantly different if the transaction were not structured as reinsurance.

Compare this to the following Davlin's (1996) example: A company, referred to as the *ceding company,* faces $10 million in noncontingent maturing endowments in five years' time. It has established a $7,835,262 statutory liability based upon a 5% rate of interest provided by the actuarial valuation. The company is considering three funding vehicles:

- Purchasing a Treasury bullet at a yield of 6% (at a cost of $7,472,582).
- Purchasing a senior debenture from the ABC Reinsurance Corporation available in the public market, yielding 8% (at a cost of $6,805,832).
- Purchasing a coinsurance contract from ABC in return for a single premium of $6,805,832.

Ignore for the time being the effects that tax laws and statutory reserves would have on the reinsurer's price, and ask the key question: How would these transactions be accounted for?

In the first case, the company would simply book an asset at cost, or $7,472,582. A municipality in an analogous position could place these liabilities and assets in an irrevocable trust, and argue that the $7,835,262 liability should be immediately defeased. Such a defeasance in the case of an insurance firm would create a gain to income and surplus of $362,680. However, the regulators would not allow the company to create what is essentially a preference for one block of policyholders.

In the second case, the company would again book the asset at cost. The debenture's price is discounted relative to the price of Treasuries to account for the risk of default. If there is no default, the ultimate cost of funding these liabilities is lower. However, one cannot argue for defeasance in this case. After all, the market does not believe that the liability is defeased by discounting ABC's promise by a risk premium of $667,050.

The third case is the most interesting one. The ceding company's assets would drop by the amount of the coinsurance premium, or $6,805,532. The company would also reduce its statutory liabilities by $7,835,262. This means an immediate gain to statutory income of $1,029,730. This is greater than even the $362,680 gain that might be produced by liability defeasance through Treasury purchases in trust. This $667,050 difference is attributable to the fact that statutory accounting essentially allows the company to immediately book the entire default premium as a gain to income and surplus.

Economically, the second and third alternatives are identical. Both contracts promise the same future cash flows from ABC at an identical price. Either transaction would affect the company's original obligations to its policyholders in the same manner. One transaction would create an immediate $1,029,730 gain, and the other none at all. This is similar to the situation in Chapter 6, where the government, creating future liabilities through open market borrowing, had to disclose the obligation in the nation's budget and debt figures, while an economically equivalent transaction of increasing future social insurance benefits need not be disclosed as long as the actuarial model put the long-term PAYGO system in balance. (That's assuming that a long-term actuarial model was indeed created, which is not the case in many social insurance systems worldwide.)

Davlin (1996) writes:

> ''We are more than 20 years past the need to replace the statutory accounting framework. The industry desperately needs a single accounting system which is internally consistent, which is consistent with external markets for traded assets, which provides both an accurate assessment of an institution's ongoing vitality and meaningful measures for its management, and which creates appropriate constraints on the growth and behavior of life insurance companies. Modern mathematical economics has given us the requisite concepts for such a financial framework, and modern computer technology has given us the means with which to implement it. All we actuaries seem to lack now is the necessary will to build it.'' (p. 7)

The key point is that valuation of financial instruments is determined by the cash flows produced by them, not by their official statutory or accounting names. If two instruments produce exactly the same cash flows in any future state of the world, then the only way they can have different prices is if they are separated to prevent arbitrage (and this is unlikely to persist given how the world is changing). If insurance products provide exactly the same cash flows as marketable securities, any divergence of prices from the market is unsustainable. But is every liability of an insurance firm a marketable security? The answer is clearly ''no,'' and the turbulent evolution of the insurance industry in the last 20 years is very much related to that ''no.''

To the degree that liabilities of insurance firms do contain marketable securities, the prices of these embedded securities to the customers have converged, or are near convergence, with their market prices. If prices were too high (e.g., crediting 4% in the late 1970s and early 1980s), customers refused to purchase such securities and arbitraged (either by selling their positions or borrowing against policies) to where market prices prevailed. If prices were too low (e.g., double-digit rates credited well into the 21st century by Executive Life), the insurance firms found themselves unable to find the long side to their unrealistic

short position. We should note that, although arbitrage is usually presented as a simultaneous short and long position in the same security but at different prices, to a person whose benchmark position is long, exchanging the current holding for the same security but obtained at a lower price in a different market is a riskless arbitrage as well, and will have the same effect on the market price of the security as the traditional concept of arbitrage. Clearly, as indicated in the discussion of human capital in Chapter 4, individual customers of insurance firms are naturally long financial instruments for most of their life.

Furthermore, new securities markets have developed, for example, in options, futures, swaps, and other derivatives. Many of these securities were previously, in one form or another, embedded in insurance contracts. Once they became marketable, similar arbitrage pressure developed for convergence of prices with the market.

Babbel and Santomero (1996) provide an overview of the risk management methodology utilized by insurers in the United States. Referring to the work of Oldfield and Santomero (1995), they segment risks facing a financial intermediary into three groups:

- Risks that can be eliminated or avoided by standard business practices.
- Risks that can be transferred to other participants.
- Risks that can be actively managed at the firm level.

It is important to notice that the same classification applies to an insurance company's customers. But the corresponding sets of the company and its customers do not coincide, and that is precisely why the transaction between them is affected. The benchmark position of consumers is to be long their human capital (and, as shown in Chapter 4, insurance and investment firms help them manage their personal balance sheets). Furthermore, what is nondiversifiable to the customers is diversifiable to the firm. Babbel and Santomero (1996) point out that the actuarial classification of risks (C-1, C-2, C-3, C-4) is increasingly considered in tandem with the financial view of risks, which they break into six generic types: actuarial, systematic, credit, liquidity, operational, and legal.

The key distinction, nevertheless, lies in diversification. Consumers pay insurers for diversification that is not available to them. All types of risks that cannot be diversified by the insurers, such as interest rate risk, inflation risk, credit risk to the degree that it is ''underlying'' in the overall economy, or catastrophes affecting entire insured populations, cannot be diversified away, and must be traded instead. Once markets for trading and hedging of such risks are available, it is pointless to price them actuarially within insurance policies, because they already have a price. Given the financial nature of insurance contracts, the existence of nondiversifiable market risks in policies is unavoidable. But as we have learned in Chapter 7, modern financial economics provides a dynamic methodology for valuation of such instruments.

A novel outlook on this distinction was provided by Chichilnisky (1996a, 1996b) and Cass, Chichilnisky and Wu (1996) with respect to property-casualty insurance. The decade of the 1999s brought about a major challenge to the property catastrophe insurance. Since 1989, climatic volatility has produced unprecedented insured losses of $43 billion, $18 billion of which were from Hurricane Andrew alone. The traditional view of such situations has been that one could diversify catastrophes over time, absorbing the losses when they occur, but recouping over time.

This already is in stark contrast with, for example, the pricing of human mortality, where it is expected that a properly diversified portfolio of policies will produce relatively stable cash flows of claims. But, if the magnitude of catastrophe losses becomes this large in relation to capital in the business, from the economic standpoint it begins to resemble interest rate risk (which affects everyone in large magnitude), inflation risk, or systematic credit risk related to the overall stability of the economy. After all, interest rate risk is fully diversifiable over time, if a sufficiently long time interval is available. (To deny this would be equivalent to believing either in the imminent demise of the national economy, with interest rates going to 0%, or in the demise of the national currency and the economy, with interest rates going to infinity). Even great national catastrophes in the United States, such as the Great Depression, World War II, or the September 11, 2001 attack, did not bring about such extreme outcomes.

Chichilnisky (1996a, 1996b) proposes separation of systematic catastrophic risk from the nonsystematic, and market pricing of the nondiversifiable portion, through the use of a *catastrophe bundle.* The bundle is defined as a two-part contract that combines a catastrophe future with a mutual reinsurance portfolio. The Chicago Board of Trade is the host for futures contracts known as *catastrophe futures* (CAT). A CAT contract entitles its holder to an agreed-upon amount that increases as the frequency of catastrophe claims in a given region increases. The second portion of the catastrophe bundle is a mutual reinsurance contract for insurers or reinsurers covering severity of the catastrophes insured. It provides shares in the catastrophe pool. Since the coverage for severity can be determined by examining the existing real property, it can

be diversified among all decision makers accepting the risk of coverage for the property.

The idea of Chichilnisky (1996a, 199b) is, in fact, a catastrophe analogue of a hedging strategy for a life insurance company. Given the nonforfeiture laws, a life insurance company may be required to guarantee a minimum interest rate on the accumulation portion of its products. If the mortality portion of the product is properly diversified, the life insurance company has created a mutual reinsurance portfolio for its customers. To manage the nondiversifiable interest rate risk created by the minimum interest rate guarantee, the company can purchase a portfolio of calls on long-term bond futures with the strike prices corresponding to the minimum interest rate guarantee.

We see that either a futures purchase, be it an interest rate hedge or a catastrophe hedge, is economically equivalent to covering a short position from the liabilities side with the hedge on the asset side. Ironically, statutory and GAAP balance sheets will show these transactions as an exchange of cash, a riskless asset, for a futures contract, not viewed as a riskless asset. The liabilities side under these accounting regimes will remain unchanged. This reinforces the point made by Davlin (1996)—that statutory accounting rules may indeed endanger the creation of economic value by the insurance firm. Of course, this is very closely related to the current debate on the use of market value accounting, because the central premise of the proposals for use of market value accounting by financial intermediaries is to show the true economic value of both assets and liabilities.

Messmore (1992) suggests that regulators should allow a somewhat radical, but realistic transaction—the *obligatory asset/liability swap* (OAL)—which could bring about proper management of the economic value of a financial intermediary. This proposal would allow one firm (firm A) to take a short position in another firm's (firm B) assets, at a price at least 5% below that reported if firm A believes the assets to be overpriced by at least 10%, in a transaction with firm B. And firm B would be *required* to accept the trade. Similarly, firm A could take a long position at least 5% below that reported by firm B in firm B liabilities, if firm A believes these to be at least 10% overpriced. Although this proposition does address the problem of unrealistic valuation, because of the private placement nature of liabilities and the large portion of assets, it could suffer from abuse. Even though objective mathematical methodology for valuation does exist, it does not substitute for objective valuation by the market. Given this, any such proposal would require careful analysis before being put into the existing legal framework. Note that OAL, despite this inherent danger, has the following advantages:

- It does not affect the customers because it is a private issue between firms.
- It forces companies to address unrealistic valuation early, not during a crisis, thereby avoiding political ramifications.
- It forces economic valuation of liabilities; that is, it requires market, or near market, values, and indirectly provides liquid reinsurance markets, and that would cause no-arbitrage pricing of insurance liabilities (as discussed in Chapter 7).

Messmore (1992) points out that most of the arguments brought against market value accounting in financial intermediation are very weak. Even though market values may not be directly observable, economic decision makers demonstrably do not act based on reported values, but on market values; reported values merely play the role of constraints imposed by a regulatory and legal framework (which does not make them irrelevant, but it does make them secondary, merely constraints, in the optimization process). Market values may require complicated models, change often, and are outside of management's control. But these undersirable features are shared by currently used statutory and GAAP values. Market values, nevertheless, do provide true information about the values of financial instruments, and their risks, and the process of management is impossible without them.

Chalke (1991) points out that traditional insurance pricing was based on the economic ''cost-plus'' pricing; that is, the price of the product has been determined to be the expected cost of the product, including expenses plus a contingency and profit margin. In contrast, modern economic thinking dictates that the firm should pursue profit maximization, given the constraints it has to deal with. Chalke (1991) points out that the key feature of economic pursuit of profits is a different perspective on *cost.* This perspective can be traced to the tradition of the Austrian School of Economics and the London School of Economics, as presented by Buchanan (1969) and Shackle (1972). It defines the *marginal cost* of an economic activity as that cost which can be avoided by choosing some alternative course of action (thus, the fixed cost, or ''overhead,'' is the cost common to all existing alternatives).

Similarly, *marginal revenue* can be defined as revenue that is available in a given course of action, but not available in some other course of action. The definition of *marginal profit* is analogous. The standard process of optimization shows that profit is maximized when the marginal profit is zero, in the economic

meaning of profit, that is, including the cost of capital as a properly accounted cost. This work is built on the premise that ALM should be an integral part of an insurance company management process. Traditionally, the management of financial intermediaries has fallen into one of two conceptual frameworks: spread management or asset management.

Banks and insurance companies are, thus, perceived as managing (maximizing it for a given degree of risk) spread between the yield on their assets, while mutual funds are asset managers who merely diversify their customers' portfolios. Spread management is, in fact, a methodology analogous to Markowitz's Efficient Frontier: It perceives the long assets/short liabilities portfolio as a capital asset and seeks to maximize its return (i.e., return to the providers of owner's capital in the financial intermediary), given the degree of risk accepted.

The methodology of risk-neutral valuation allows for a clearer economic perspective. It calls for what one might call ''management with stochastics.'' Given a risk-neutral stochastic process model providing valuation in the time horizon of the firm, we can view the firm activity as the acquisition of capital assets in capital markets and the resale of them to customers in the form of derivative securities crafted to meet customers' needs. Given competitive complete markets, and diversification of customers' diversifiable risks, risk-neutral valuation is consistent across assets and liabilities. The company must then consider the factors shaping the derivatives issued, such as:

- Liabilities contingencies (lapses, premium flow, policy loans, partial withdrawals, renewals, and new business production).
- Assets contingencies (bond calls, mortgage prepayments, sinking funds, credit quality, and hedges used, e.g., swaps, caps and floors, options and futures, etc.).
- Firm strategy contingencies (capital strategy, investment baseline, disinvestment strategy, crediting strategy, pursuit of new business).

Each of these factors becomes an element of the space over which the maximization of profits is performed. Regulatory requirements provide constraints for the optimization process. The optimal decision is the one for which marginal profit is zero, that is, the choice for which no other choice produces a higher profit. Given risk-neutral valuation, no consideration of risk is necessary. This approach, by combining assets and liabilities cash flows, can also provide an instant recognition of the firm's own value.

Most management models incorporating the Short Straddle Model show the results as the relationship between interest rates and the economic value of the firm (e.g., *price behavior curves),* or between two parameters (e.g., interest rates and a parameter describing the shape of the yield curve) and the economic value of the firm. This often serves as the basis for adjusting the firm's risk or return profile. However, the variable, with respect to which the company should act, has as its domain the set of all combinations of factors affecting assets, liabilities, and internal corporate contingencies. The maximization of profit should be performed over that space, under regulatory solvency constraints, and with possible consideration for accounting constraints. Thus, actions suggested by, for example, price behavior curves, are, in fact, changes in this parameter space and should be evaluated on the risk-neutral basis with respect to profits attained. Even though this procedure calls for a change in perspective and an increase in the complexity of the process (that is, continuous management with stochastics) it is the procedure implied naturally by the economic meaning of the activity of the firm.

Cummins (1989) discusses the relationship of insurance company management and product pricing in relation to modern financial asset pricing models. He points out that momentum for applying financial models to insurance (implying viewing insurance products as capital assets) exists in the marketplace because such models are designed to estimate the insurance prices that would pertain in a competitive market. Cummins said that ''an objective of research in this area is to develop a unified theory of insurance pricing that combines elements of actuarial and financial theory.'' He provides a review of various financial models in insurance pricing, including a host of equilibrium models, arbitrage-free models, and their variations. Ars and Janssen (1994) created a stochastic process for a whole company model and showed its use in ALM. A similar procedure, specifically for managing a property-casualty company, was developed by Correnti and Sweeney (1994).

These works illustrate practical procedures using the perspective on the management of a financial intermediary presented in this work. The approach calls for such management to be a continuous optimization process: optimization of the economic value of the firm, subject to regulatory constraints, with the use of financial valuation of the firm's balance sheet, perceived effectively as a derivative security. As the insurance industry approaches the state of perfect competition, such an approach becomes a necessity for all industry participants. This work, one hopes, will contribute to a better understanding of this process.

About the Author

Krzysztof M. Ostaszewski received his master's degree in mathematics in 1980 from the University of Lodz in Lodz, Poland, and a Ph.D. in mathematics in 1985 from the University of Washington in Seattle. Dr. Ostaszewski has worked at Hartford Life Insurance Companies and Providian Capital Management in the area of ALM. He is now the Actuarial Program Director at Illinois State University, Normal. He is a 1999 Fellow of the Society of Actuaries and a 1994 Member of the American Academy of Actuaries. He is also a Chartered Financial Analyst (1991).

Dr. Ostaszewski has published research in monographs by the Society of Actuaries and the American Mathematical Society, and in papers appearing in *North American Actuarial Journal, Proceedings of the Casualty Actuarial Society, Proceedings of the American Mathematical Society, Journal of Risk and Insurance, American Economic Review, Journal of Business,* and many other scholarly and professional journals. In 1995, he was named a Fulbright Research Fellow, studying actuarial aspects of free market reforms in Poland. He can be reached at the Department of Mathematics, Illinois State University, Normal, IL 61790-4520, e-mail: krzysio@ilstu.edu.