J.I.A. **121**, II, 363–440

VALUATION AND CORPORATE MANAGEMENT IN A NON-LIFE INSURANCE COMPANY

BY M. BRIDE, M.A., F.I.A. AND M. W. LOMAX, M.A., F.I.A.

[Presented to the Institute of Actuaries, 28 February 1994]

ABSTRACT

This paper explores the benefits and limitations of a valuation framework as a management tool within a general insurance operation. Two models are presented, one a model of the firm and the other an option valuation model, which together create a robust framework that enables management to analyse how different decisions would affect both the overall firm value and its distribution amongst investors. The model of the firm assists in understanding how key factors such as the momentum of a general insurance portfolio and the allocation of scarce resources affect the value of the firm. The second model, an option framework for corporate liabilities, highlights the critical distinction between the value of the firm and the value of investors' claims on the firm.

KEYWORDS

Appraised Value; Corporate Strategy; Finance; General Insurance

1. INTRODUCTION

1.1 *A Framework for Management Decisions*

1.1.1 The United Kingdom actuarial profession's contribution to non-life insurance will be enhanced if its members become involved in the management decision process. Since this process is concerned with selecting actions that maximise the value of investors' claims on a firm, a robust framework that can explain the effect of operational and financial decisions on the payoffs to investors in the firm would be an important tool for members of the profession.

1.1.2 The most obvious candidate for this framework, the actuarial appraised value of a non-life insurance company, arose to prominence primarily as the result of the need to calculate a value for shareholders' equity in connection with an acquisition or merger. Over time actuaries, amongst others, have started to discuss the appraised value in the context of a management tool, and this is evident in the most recent actuarial literature on the subject. Indeed, it is often mentioned in the same breath as Shareholder Value Added (SVA) analysis, a well-documented general management tool.

1.1.3 However, in our opinion, this model fails to capture the operational dynamics of non-life insurance business and obscures the issues surrounding the nature of shareholders', policyholders' and other creditors' claims on the assets of the firm.

1.1.4 In this paper we put forward a different framework which, whilst consistent with the appraised value model, is more structured, and aimed towards understanding the effect of management decisions on the value of investors' claims on the firm.

1.1.5 The framework that we put forward is conceptual and is not intended to replace conventional appraised value methodology in a practical context, when calculating the value of shareholders' equity in a firm, for example. However, being consistent with the traditional appraised value model, it throws much-needed light on many questions that are difficult to answer within this model, such as the selection of risk-adjusted discount rates and adjustments for locked-in capital.

1.2 *The Value of the Firm versus the Value of Investors' Claims on the Firm*

1.2.1 A fundamental distinction made by financial economists, and ourselves in this paper, is the difference between the value of the firm and the value of investors' claims on the firm.

1.2.2 We consider both shareholders and policyholders to be investors in the firm, in the sense that both have claims on the assets of the firm. Looking from the point of view of the insurer, an insurance policy is, in essence, a form of debt—the premiums represent the amount of debt raised and the claims and associated expenses constitute capital repayments and interest. Taking this view, an insurance company resembles a geared investment trust. However, notice that insurance 'debt' is quite unlike conventional debt, since it has an uncertain repayment schedule and may have an unknown mean. The following market value balance sheet should make the point clear (for simplicity, we ignore other creditors' claims on the firm).

Market Value Balance Sheet of a Non-Life Insurance Firm

Value of claims on the firm		Value of the firm	
Equity	E	Assets	V
Policyholders' claims	D	(including intangibles)	
Total	$E + D$	Total	V

1.2.3 The market value of equity is therefore given by $V - D$, that is the market value of the firm's assets (including intangible assets) less the market value of policyholders' claims on the firm.

1.3 *Financial versus Operational Decisions*

1.3.1 Consistent with this distinction between the firm and the financing of projects that constitute the firm, we make a distinction in this paper between operational decisions and financial decisions.

1.3.2 In a non-life insurance firm, operational decisions should be concerned with the management of the non-life insurance portfolio to maximise the value of the firm, V, given a certain capacity to write business.

1.3.3 Financial decisions are really 'enabling' decisions, and are concerned with preserving the capacity to exploit future insurance opportunities. The financial objective is two-fold. On the supply side, the financial decision is about maintaining access to capital to support the risks accepted, both present and planned. On the demand side, the financial decision is concerned with controlling the aggregate level of risk that the firm takes.

1.3.4 The identification of a robust financial decision framework is our main focus in this paper. We seek a model in which we can explain the effect of project riskiness, investment strategy and capital adequacy on the value of the non-life insurance firm and on the value of investors' claims on the firm.

1.3.5 However, since financial decisions are concerned with enabling operational opportunities to be exploited, we must also consider the nature of operational decisions in some detail, including some analysis of the effect of the firm's financial structure on these decisions.

1.4 *The Plan of the Paper*

1.4.1 In Section 2 we consider the usefulness of the traditional appraised value model in a financial decision-making context. We describe what we call the actuarial paradigm of general insurance management. This comprises a number of far-reaching assertions made in the appraised value literature that concern the effect of managers' financial decisions on the value of investors' claims on the firm.

1.4.2 In Sections 3, 4 and 5 we set out the main theoretical building blocks of an alternative framework which, while consistent with the appraised value model, has more structure and, therefore, more explanatory power.

1.4.3 In Section 3 we begin at the operational level of a firm. We start by considering the 'net present value (NPV) rule' as a management decision rule for project evaluation—i.e. accept all projects that have a non-negative NPV. We conclude that this has important implications for the way in which we define a 'project' in a non-life context. In particular, we find that the actuarial profit test of a single block of business cannot be considered to be a 'project' if we want to use the NPV rule. Instead, we consider an alternative approach in which the capital budgeting decision is viewed as a decision to capture future growth opportunities. We emphasise the distinction between available growth opportunities and the capacity of a firm to exploit these growth opportunities.

1.4.4 In Section 4 we build on Section 3 and discuss the insights that a simple option pricing model can offer in the valuation of investors' claims on a firm. We

observe that an implication of this model is that an increase in volatility of the firm can in fact increase the value of shareholders' interests in a firm. However, there may be offsetting influences, such as a reduction in the value of the firm itself.

1.4.5 In Section 5 we discuss how managers' desire to maintain corporate control and avoid negative signals to shareholders might also explain their unwillingness to increase the riskiness of the firm.

1.4.6 In Section 6 we consider the application of the framework that we have built in the three previous sections. We begin by addressing the implications of this framework for a practical model of corporate management decisions and we go on to investigate strategies for investing assets.

1.4.7 In Section 7 we return to the appraised value model. We discuss why, in practice, we believe that the appraised value is often misused as a result of unrealistic parameter assumptions and suggest how these problems could be avoided. Using our analysis of earlier sections, we examine critically the actuarial paradigm of non-life insurance management. We find that certain elements of the paradigm cannot be substantiated within the traditional appraised value model, and we conclude that more structure must be given to this model in order to assess their validity.

1.4.8 We also consider the two main technical areas of controversy in a non-life valuation context, namely the ability of the appraised value model to cope with skewed payoffs and the value that should be placed on locked-in assets. We put forward an explanation of the conventional locked-in asset adjustment that is far more innocent than the various justifications that we find in the literature.

1.4.9 Finally, we make some brief concluding remarks in Section 8.

2. Actuarial Appraised Values

2.1 *The Application of Appraised Value Methodology*

2.1.1 Our starting point is the actuarial appraised value framework. This is currently the only accepted model in the actuarial literature that purports to link managers' actions to the value of investors' claims on the firm. There are two main reasons why one might wish to perform calculations in an appraised value framework: either one is interested in the value of the firm if there were to be a change of control situation; or one believes that the framework can provide information that improves management decisions.

2.1.2 If the appraised value model is to assist actuaries in becoming involved in the financial decision-making process within a firm, it must be able to explain the cause and effect relationship between managers' actions and the value of equity in the firm. However, before we can assess the usefulness of the appraised value model in this context, we first need to be clear about the precise nature of an appraised value calculation.

2.1.3 Currently accepted appraised value methodology puts a value E on the equity in an insurance firm as follows:

$$E = MVF + \sum_{j=1}^{\infty} K(j) \tag{1}$$

where:

$K(j)$ is the present market value of the future notional capital flows projected under an actuarial profit test of the j^{th} generation of insurance business, under some chronological ordering of business written, both past (thus including any surplus in technical reserves) and future; and

MVF is the market value of those assets of the firm that are not notionally 'locked-in' to support insurance business within a profit test at the assessment date. Here, and throughout the paper, we define market value to mean discounted cash flow value at a risk-adjusted discount rate that reflects the price of risk in a market.

2.1.4 In Appendix A we justify equation (1) by considering a simple example from which the result is easily extended. Also in this appendix, we explain in detail the basic building block of an appraised value calculation—the profit test—together with the meaning of 'locked-in' assets.

2.1.5 The appraised value framework views the shareholders' claim on the firm as a collection of actuarial profit tests, or 'mini-firms'; some are already in place, relating to business on the books, others are in the future and relate to new business. If the stock of a 'mini-firm' were traded we would know its market value. Of course, profit-tested blocks of business are not separately traded and a discounted cash flow model is used.

2.2 *The Limitations of an Inert, Discounted Cash Flow Valuation Framework*

2.2.1 We find that, as a management tool, the appraised value model conveys limited explanatory power. It represents little more that an inert, passive, discounted cash flow framework. This is evident from equation (1). The only structure to the model is provided by the allocation of capital using profit tests, but this plays a superficial role in the valuation.

2.2.2 One can show that the profit test is a redundant construction for the purpose of calculating value. It is the Principle of Value Additivity (see Appendix A, A.4) that yields this result. This principle implies that discounting the individual premium, expense and claim cash flows at appropriate risk-adjusted discount rates is equivalent to evaluating the composite capital flows from the profit test at a composite risk-adjusted discount rate. Since none of the cash flows of a non-life firm are altered as a result of different capital allocation philosophies, our conclusion concerning capital allocation follows intuitively.

2.2.3 It is perhaps surprising, therefore, that the actuarial literature contains a number of far-reaching statements which have developed into a body of commonly shared views, that we call the actuarial paradigm for non-life

insurance management. This paradigm covers such matters as the influence of capital adequacy, investment strategy and project riskiness on the value of the shareholders' interest in a non-life insurance firm. In particular, we note the following:

(i) The value of capital that is locked in to support insurance business is, in principle, worth less than market value because:
   —there is a cost associated with the restricted investment strategy that a prudently managed non-life insurer must follow (see Sturgis, 1981), and
   —the capital is exposed to the risk of loss from insurance (see Ryan & Larner, 1990).

(ii) Only cash flows that could be distributed to shareholders without impairing solvency should be valued (see Whitehead, 1987).

(iii) For given expected payoffs, shareholders put a greater value on a low-risk insurance project than a high-risk project, where risk is summarised by the variability and negative skew of the payoffs themselves.

(iv) Accounting flows, and not cash flows, may be discounted to calculate an appraised value.

2.2.4 To assess the validity of these statements, we must give more structure and content to the conventional appraised value model. We return to these statements in Section 7, after we have first laid the groundwork for a more structured framework in Sections 3, 4 and 5. There we also discuss the other areas of the appraised value methodology that we believe can be enhanced by a more structured methodology. To give the reader an idea of what we have in mind, we set out below the general nature of the enhancements to the conventional appraised value framework that we believe are required.

2.3 *Re-orienting the Appraised Value Framework towards Management Decisions*

2.3.1 As a first stage, we need to make an explicit distinction between the value of the firm and the value of policyholders' and shareholders' claims on the firm. This is an important distinction if we are to understand fully the effect of financial decisions on different investors' claims on a firm's assets. For example, management's actions may leave a firm's value unchanged, but may result in a transfer of wealth between policyholders and shareholders.

2.3.2 Secondly, we need a framework that links operational decisions to financial decisions by recognising that scarce management and capital resources must be deployed in order to exploit future growth opportunities. Furthermore, the inter-temporal and inter-dependent nature of these operational opportunities must be recognised. We must consider:

(i) sequential dependencies between generations of insurance business as a result of pricing inelasticities, exit and entry barriers and limited capital and management resources,

(ii) cross-sectional dependencies between different business sectors due to limited resources and the fixed expense base of the company, and

(iii) the extent to which the appraised value assumes that additional resources are injected into the company in the future. In particular, where the appraised value assumes increased management and capital resources, attention must be given to whether or not these resources are available and at what price.

2.3.3 Thirdly, we need a sound financial economic framework. The problem of how to value a future stream of cash flows from a skewed distribution must be addressed. Finally, the question of what assumptions are reasonable for the long-term risk-adjusted return from non-life insurance must be answered.

2.3.4 In the following section, Section 3, we begin at the level of the firm. We consider how managers can maximise the value of the firm by evaluating the available projects. We use a 'growth opportunity' framework to explain the link between managers' actions and the value of the firm. We complete the framework in Section 4, where the link is made between the value of the firm and the value of investors' claims upon it.

3. Operational Decisions and the Value of the Firm

3.1 *Maximising the Value of the Firm*

3.1.1 Well-established financial economic theory demonstrates that it is in society's wider interests for managers to maximise the value of the firm, V. This fact is ingrained in current economic thought and dates back to Irving Fisher's classic 1930 work, *The Theory of Interest*. Fisher's fundamental result separates project evaluation from an individual's preferences for current versus future consumption. This means that a manager need not know what are the individual preferences of the investors in his firm in order to make optimal decisions.

3.1.2 Fisher's result is the foundation of the so-called 'NPV rule', which most actuaries accept unquestioningly. This rule states that managers should accept all projects with non-negative NPV. However, we must be careful what we call a project if we are to use this decision rule, since one must allow for sequential and cross-sectional dependencies between discretionary investment opportunities. For the NPV rule to be valid, a project must be something that can be entered or abandoned without affecting other discretionary investment opportunities.

3.1.3 A key consequence of this in non-life insurance is that an individual year of business, as commonly defined in the actuarial profit test, cannot be considered to be a project. This is because, in most insurance markets, a company's ability to underwrite a given volume of a particular class of business is dependent upon its presence in that class in previous years. Furthermore, the profitability of any business written may also depend upon the volume of business underwritten in previous years. We give our precise definition of a project in § 3.3.4, once we have developed some ideas further. As a precursor to the definition, we now consider a framework that recognises such dependencies.

3.2 *Assets in Place and Growth Opportunities*

3.2.1 Myers (1977) suggests that we should adopt a perspective that splits the value of the firm into two parts: the value of assets in place, V_A, and the value of future growth opportunities, V_{GO}. Symbolically we have:

$$V = V_A + V_{GO} \tag{2}$$

3.2.2 Assets in place are those assets, or projects, whose value does not depend upon further discretionary investment by the firm. On the other hand, growth opportunities do depend on future discretionary investment and are available as a result of a firm's access to markets, brand names, skilled work force and surplus capacity.

3.2.3 We value all of the firm's assets at market value. For many non-life insurers the market value of their assets in place will be readily available. Alternatively, a conventional discounted cash flow approach can be used to estimate their market value, using risk-adjusted discount rates that reflect the systematic risk of each project's cash payoffs in a market context.

3.2.4 The distinction between assets in place and future growth opportunities is only loosely related to the distinction between embedded value and goodwill in the actuarial appraised value calculation. We can rearrange equation (1) (see §2.1.3) for the appraised value of the equity in an insurance company as follows:

$$E = MVF + \sum_{j=1}^{m-1} K(j) + \sum_{j=m}^{\infty} K(j) \tag{3}$$

where m is the first generation of business written after the assessment date and all other symbols have the same definitions as before.

3.2.5 The first two terms on the right side of equation (3) are the embedded value and the last term is the goodwill component of the actuarial appraised value. V_A is not equal to the goodwill element of the appraised value for two reasons:

(i) The goodwill element of the appraised value evaluates all business to be underwritten after the valuation date. Some of this business, in fact the majority in early periods, will result from renewals and new business that occur 'naturally', that is, with no further management action. Under Myers' definition, this business is part of V_A.

(ii) It is also possible for the value of business in-force to be altered by future discretionary actions by management, such as new claims and expense control initiatives. This change in the embedded value falls within Myers' definition of V_A.

3.2.6 Myers' framework for V_{GO} is more useful than the goodwill element of the actuarial appraised value because it identifies those projects that are

dependent upon discretionary management action. Normally, the appraised value does not divide V_A and V_{GO} and considers the whole goodwill element as a chronological sequence of blocks of insurance—that is, profit tests—purely for computational simplicity. Myers' framework, on the other hand, demands that the sequential dependencies between discretionary investment opportunities are recognised.

3.3 *A Growth Opportunity Framework for Capital Budgeting using the Net Present Value Rule*

3.3.1 Subsequent authors have developed Myers' growth opportunity idea at the capital budgeting level (including Trigeorgis, 1988, and Pindyck, 1988). We find that we can split the NPV of any project that a firm undertakes into two parts:

$$\text{NPV} = \text{'Static' NPV} + \text{Increment in future growth opportunities.} \quad (4)$$

3.3.2 When a project is undertaken, part of its value, the 'static' NPV, increases V_A and the remainder represents an incremental increase in V_{GO}. Note that the increment in V_{GO} must allow for the opportunity cost of future opportunities forgone as a result of undertaking the particular project. Once again, within this framework, the manager should undertake all projects that have non-negative NPV in order to maximise the value of the firm.

3.3.3 We shall consider the acquisition of a portfolio to demonstrate these ideas in the non-life insurance context. The acquisition would increase the static NPV by the value of current policies plus any 'natural' renewals and new business. The value of future growth opportunities would change to the extent that the acquisition opened up previously non-existent portfolio opportunities to management.

3.3.4 In a non-life context, a 'project' is commonly viewed as a block of written business, defined according to some common period of origin such as an inception month, underwriting year or rating series. In our valuation model for non-life insurance, we define a project as the decision to be in a particular class of business over an underwriting cycle. Thus, the premium, claim and expense flows which we envisage resulting from a project may occur over much longer periods than those from the conventional actuarial profit test.

3.3.5 The static NPV of such an insurance project is equal to the present value of premiums actually written, including 'natural' renewals and new business, less the present value of associated claims and expenses, discounting each expected cash flow stream at a risk-adjusted rate reflecting its riskiness in a market context (which may vary by class of business), that is, at the return required by investors. The growth opportunities associated with writing a block of insurance business arise from the momentum of a non-life portfolio over time, which is a function of price elasticity and barriers to entry and exit in the insurance market. Management have the possibility of altering the volume of business, either up or

down, from the 'natural' volume. The evaluation of a growth opportunity follows the static NPV with the cash flows including the costs of the management actions required to realise it.

3.4 *The Actuarial Profit Test and Net Present Values*

3.4.1 We have seen that the total NPV of a project has two components—the static NPV and the increment in future growth opportunities. We suggest that under conventional actuarial methodology, all NPV is recognised as it emerges, and not as it is created. Taking a sum over an infinite, or very long, future time period, the appraised value, on the one hand, and the sum of the static NPVs and growth opportunities, on the other, converge fairly rapidly. However, when searching for a valuation framework to be used as part of a management process, it is important that the correct correspondence is achieved between the management decision and the creation of NPV.

3.4.2 The cyclical nature of non-life insurance markets gives the clearest illustration of this last point. At the bottom of the cycle, many insurance policies yield a negative static NPV. A simplistic one-year profit test analysis of such a policy, based upon current parameters, would indicate a 'do not underwrite' strategy. The next level of sophistication would be a single-year profit test using parameters averaged over the cycle. A further level of sophistication would be a sequence of profit tests over the cycle, yielding, it is hoped, a similar average result as the previous approach. In practice, either of these last two might be used as the basis for a decision.

3.4.3 Using our project definition, the static NPV, being the NPV of current business plus 'natural' renewals, includes some of the individual policy year positive NPVs that arise at the top of the cycle. The cash flows constituting the static NPV are a subset of those underlying the most sophisticated form of the profit test mentioned above. Growth opportunities in this situation arise from management's ability to manage the cycle by trimming the portfolio at the bottom and expanding it at the peak. Adding the selected growth opportunity strategy to the current business plus 'natural' renewals and new business should replicate the portfolio projected by the most sophisticated profit test.

3.4.4 The most sophisticated profit testing approach is the only one that explicitly calculates the magnitude of the positive NPVs that emerge at the top of the cycle, and provides year-on-year figures that could form the basis of a monitoring system. However, even using this approach, the positive NPVs are not related to the management decisions which create them, namely decisions on how to adjust the portfolio volume in each prior year in order to have the projected market presence at the peak of the cycle. By contrast, the framework we are proposing highlights for management:

(i) what is expected to happen in the future if they take no further action at this time (the static NPV), and
(ii) what is the expected outcome of management actions (the growth opportunities).

3.4.5 As we said in §2.2.2, capital allocation only plays a superficial role in a valuation since it does not affect the value. However, in defence of the actuarial profit test, we do believe that it represents a robust framework for modelling the capital requirements of a block of business over its lifetime. As we shall describe in Section 5, there are many instances where management find themselves effectively working in a limited capital environment. From a dynamic solvency perspective, therefore, the actuarial profit test can be a useful construction for projecting the capital consumption of different non-life portfolio strategies. The advantage of constructing a profit test for each block of business, rather than just looking at a snapshot of solvency, is that one is able to 'explain' changes in capital consumption over time.

3.5 *The Interaction of Operational Decisions and Financial Decisions*

3.5.1 Given available resources, we believe that a growth opportunity framework is necessary to make value-maximising decisions at the operational level of a firm.

3.5.2 However, our main reason for exploring this framework is to understand the interaction between operational and financial decisions. In practice, the key constraints on a company's ability to exploit available growth opportunities are limited capital and management resources. It is the role of the finance manager to ensure that sufficient capital resources are available to support the chosen strategy.

3.5.3 In the following section, Section 4, we turn our attention to the financing of the firm and look at an option model of investors' claims on the firm. This provides valuable insights into the effect of risk on the value of these claims. This is a separate issue from the effect of capital strength on the value of the firm, which is reflected in the value of future growth opportunities, V_{GO}, and is assessed using the framework just described in this section.

3.5.4 In Section 5, we discuss the extent to which managers of general insurance companies find themselves effectively operating with scarce capital resources, despite financial economic arguments that suggest that capital will always be available to finance positive NPV projects. This discussion is crucial, since the appropriate management strategies for the two environments, scarce versus 'unlimited' capital, are quite different. A clear grasp of the issues surrounding capital scarcity is also instrumental in understanding the actuarial paradigm.

4. Financial Decisions and the Value of Investors' Claims on the Firm

4.1 *Overview*

4.1.1 The non-life actuarial literature does not explicitly recognise the interrelationship of different investors' claims on a firm's assets. On the one hand, the

appraised value takes the shareholder perspective and is concerned with putting a value on the equity in an insurance firm, making no clear distinction between the value of the firm and the value of equityholders' claims on that firm. On the other hand, as D'Arcy & Doherty (1988) point out, the various actuarial theories of non-life insurance pricing are dominated by the policyholder perspective and use the probability of ruin as a pricing adequacy benchmark.

4.1.2 We believe that a framework that explicitly recognises the value of the firm and the inter-relationship of policyholders', shareholders' and other creditors' claims on that firm's assets, in states of solvency and ruin, is desirable in all situations, and essential in a management valuation model.

4.1.3 In Sections 4.2 and 4.3 we consider the implications for management of a simple option pricing model of corporate liabilities in which bankruptcy costs and taxes are ignored and there is a perfect capital market and perfect information. In these sections we suppose that we are in an 'MM' world (see Modigliani & Miller, 1958) in which 'financing has no influence on the value of the firm'. The option model allows us to consider policyholders' and shareholders' claims on the firm in one unified framework in future states of solvency and ruin.

4.1.4 In Sections 4.4 *et seq.* we consider the implications of this idealised option model for management decisions in the real world.

4.2 *An Option Pricing Framework for Corporate Liabilities*

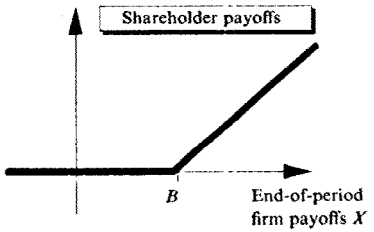
4.2.1 In their seminal 1973 paper 'The Pricing of Options and Corporate Liabilities', Black & Scholes were the first to suggest that option pricing theory could be used to value corporate liabilities, that is, to value investors' claims on the assets of the firm. The key point is that corporate liabilities have option-like payoffs owing to the limited liability of shareholders. In Appendix B, by way of background, we give a brief review of the principal intuitions behind option pricing.

4.2.2 We consider a very simple example here in a non-life insurance context. Consider a company trading for just one period. Suppose that the initial value of the firm's assets is V, and that these assets generate end-of-period payoffs X. Suppose there are outstanding policyholders' claims due at the end of the period, with total settlement cost B.

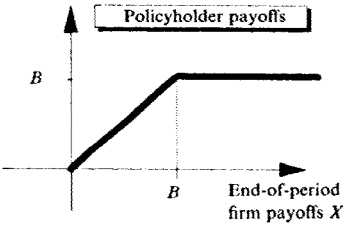
4.2.3 What are the respective values of the policyholders' and shareholders' claims? We know from financial economics that the value of the firm must be equal to the sum of the values of the debt (policyholders' claims, as described in Section 1.2) and equity, but what is the division?

4.2.4 We first consider the cash payoffs to shareholders and policyholders at the end of the period. The option-payoff diagram, Figure 4.1, shows the possible outcomes.

4.2.5 If the end-of-period assets have a value greater than B, then the equity is worth $X-B$, otherwise it is worth zero. Similarly, the policyholders receive B if the assets are worth more than this or X if the assets are worth less. The equity



State of nature	Shareholder payoff
$X>B$	$X-B$
$X<B$	0
All	$\max(X-B,0)$



State of nature	Policyholder payoff
$X>B$	B
$X<B$	X
All	$\min(X,B)$

Figure 4.1. End-of-period shareholder and policyholder payoffs.

holders have the same pay-off as a call option on the underlying assets with exercise price B (see Appendix B, B.1). The policyholders' interest in the firm is equivalent to a risk-free insurance 'debt' obligation of B less the price of a put option on the assets of the firm with exercise price B. We can *see* this by observing the value of the policyholders' claims at maturity:

$$\min(X,B)=B-\max(B-X,0) \tag{5}$$

where $\max(B-X,0)$ is the payoff at maturity for a put option on an asset that has value X at maturity, with exercise price B. We can think of this put option as a debt guarantee.

4.2.6 Note that in a real, multi-period situation, a firm would not necessarily be liquidated if $X<B$. It might continue as a going concern so long as it has access to valuable growth opportunities. The decision whether to liquidate or not is a capital budgeting decision.

4.2.7 We now turn to the value of shareholders' and policyholders' claims on the firm at the start of the period. Let O_C denote the current value of the shareholders' call option, $\bar{D}$ the value of zero default-risk insurance 'debt' and O_P the current price of the put option. We can rewrite the equation for the value of the firm, $V=E+D$, as follows:

$$V=O_C+(\bar{D}-O_P). \tag{6}$$

This relationship is known as put-call parity (see Appendix B, B.2).

4.2.8 We, therefore, have two equivalent views of the shareholders' interest in a firm. On the one hand, they own a call option on the firm's assets with exercise price B. Equally, they own the entire firm, less the value of guaranteed payments

to policyholders, plus an option to put the entire firm to the policyholders if the value of the firm is less than B at maturity.

4.3 *The Sensitivity of Shareholders' Equity to Risk within the Firm*

4.3.1 If we ignore bankruptcy costs and taxes, we can use the comparative statics (these are the partial derivatives) of the Black–Scholes option formula (see Appendix B, B.4) to give us some indication of the sensitivity of the value of shareholders' equity to key parameters that are of interest. This is not to say that the Black–Scholes formula holds even in this simplified world—indeed many of the assumptions are violated (see Black, 1989). However, we are interested only in the broad implications of the model and we can extract useful information from the Black–Scholes formula, provided that we interpret the results with care.

4.3.2 The key comparative static that we are interested in is vega, the rate of change of an option's value as the volatility of the underlying asset increases (see Appendix B, B.4). This gives us two fundamental implications for the value of shareholders' equity in a firm:

(i) the value of equity increases as the volatility of the firm increases, and
(ii) this effect is strongest when the shareholders' call option is 'at the money'.

4.3.3 Both of these are a direct function of the existence of limited liability for shareholders—the shareholder enjoys all the upside of a rise in value of the firm, but has limited downside.

4.3.4 In the following section we consider the implication of these two results for the management of risk and the maximisation of shareholder value in an insurer in the real world.

4.4 *Risk Substitution and the Expropriation of Wealth*

4.4.1 We have seen that the value of a call option increases as the volatility of the returns of the underlying asset increases. Consequently, in an MM world that excludes market imperfections such as bankruptcy costs, taxes and so on, there is an incentive for shareholders, whose holding in equity represents a call on the assets of the firm, to increase the volatility of the firm's returns. Let us assume for now that the interests of most managers are aligned with those of their shareholders. Given this working assumption, we examine more closely the implication of the simple option framework for managers' decisions concerning risk in an insurer in a real world.

4.4.2 To understand fully the motivation to increase risk, consider the following example. In buying a policy, a new policyholder decides that a premium charged for a product is 'fair', given the risk strategy that the insurer has historically adopted. Having received this premium, however, the shareholders of the insurer now have an incentive to increase the volatility of future business written or the volatility of the firm's investment strategy, provided that this action does not, in itself, result in an offsetting reduction in the value of future growth opportunities. This causes the policyholders to finance part of the

increased downside, whilst giving the shareholders an exclusive right to the upside.

4.4.3 In the case of a non-life insurance firm, the effect of volatility needs to be considered with some care, since we have the added complexity of a stochastic option strike price—the settlement cost of policyholders' claims. The probability of option exercise is then a function of the degree of mismatch between assets and liabilities. However, the intuition still holds; the shareholders' interest in the firm is maximised by optimising the trade-off between the riskiness of shareholders' claims and the effect that project riskiness might have on the value of the firm.

4.4.4 In addition to the possibility of expropriating wealth from a policyholder by increasing the volatility of the firm after the sale of a policy, managers also have the opportunity to benefit from the market rating structure and the difficulty an insured faces in assessing whether a 'fair' premium is being charged. We discuss this further in Section 6.3, when we consider the investment policy of a non-life insurer.

4.4.5 The intuition developed above may be seen to be equally applicable in cases where there is an ultimate guarantor of a firm's business. Whenever there are asymmetric claims on an asset, altering the variability of these claims or the variability of the underlying asset will result in transfers of wealth between different claimants. Any form of guarantee results in an asymmetric claim. Therefore, the ultimate guarantor of the insurance industry faces similar expropriation risks to policyholders within a firm. In particular, the guarantor meets the risk that the market as a whole will fail to charge a 'fair' premium, in aggregate, in the context of the level of security that this guarantor provides to the non-life insurance market.

4.5 *The Temptation to Expropriate Wealth*

4.5.1 The second result from the analysis of the comparative static, vega, is that the rate of increase in the value of a call for a given change in the volatility of the underlying asset is at its greatest when the call is 'at the money'. This may be seen from Appendix B, Figure B.2. This result presents us with a sense of when the 'temptation' to expropriate wealth from policyholders is at its greatest. When the total value of the firm is close to the value of the firm's debt (as in the case of a highly geared firm), any increase in the volatility of the returns of the firm will result in a relatively large increase in the value of a shareholder's claim on that firm.

4.5.2 We suggest that for many small London Market companies, the volatility of their insurance debt (given their levels of capital) means that the shareholders' call options may be only just 'in the money'. Perhaps this may also become the case for much larger companies, depending upon how the various potential latent claim 'problems' are resolved.

4.5.3 When the shareholders' call option is 'far in the money' (when the value of equity is high relative to the value of policyholders' claims), an increase in the volatility in returns by shareholders would not, in this framework, result in a

large increase in the value of the shareholders' call option. Thus, the benefits of shifting risk onto the policyholders might easily be outweighed by factors not considered under the simple model, but which we address briefly in Section 5.

4.5.4 It is important to note that we have so far considered only the incentives within the option framework to change the risk profile of the business. These incentives for shareholders and, by assumption, for managers, do not necessarily affect the overall value of the firm. At its simplest level, our analysis represents merely a way of changing how the whole is to be carved.

4.5.5 The implication of the option-like nature of investors' payoffs for operational decisions, and thus the value of the firm, is addressed in the next two subsections.

4.6 *Some Implications of the Option Framework for the Management of the Firm*

4.6.1 We noted in § 3.1.1, that it is in the wider interests of society for managers to maximise the value of the firm, V, by maximising the NPV of projects in place plus future growth opportunities. However, managers' incentive contracts usually motivate them to maximise the value of equity in a firm, E.

4.6.2 We saw in Section 4.4, that managers' actions can result in transfers of wealth between investors with different claims on a firm's assets. If a manager's objective is to maximise E, and many of today's managers do receive a significant part of their remuneration in the form of options on the firm's equity, we find that decisions may be made that are inconsistent with maximising the value of the firm.

4.6.3 Suppose that a manager is considering an internally financed incremental project that has NPV equal to ΔV, which will increase overall firm value from V to $V+\Delta V$. Using the same symbols as previously, assume that acceptance of the new project instantaneously increases the value of the put option from O_P to $O_P+\Delta O_P$. Note that if ΔO_P is negative, the value of the put option falls and policyholders' claims on the firm are worth more.

4.6.4 The value of investors' claims on the firm with and without the project are as follows:

	Without	With
Shareholder	$V-\{\bar{D}-O_P\}$	$V+\Delta V-\{\bar{D}-(O_P+\Delta O_P)\}$
Policyholder	$\bar{D}-O_P$	$\bar{D}-(O_P+\Delta O_P)$
Total	V	$V+\Delta V$

4.6.5 The value of shareholders' equity increases with acceptance of the project only if $\Delta V+\Delta O_P>0$. In other words, if the manager's objective is to maximise E, then the project is accepted only if the value of the firm increases by more than the increase in value of the policyholders' claims on the firm's assets.

4.6.6 The different scenarios in which $\Delta V+\Delta O_P>0$ can be summarised as follows:

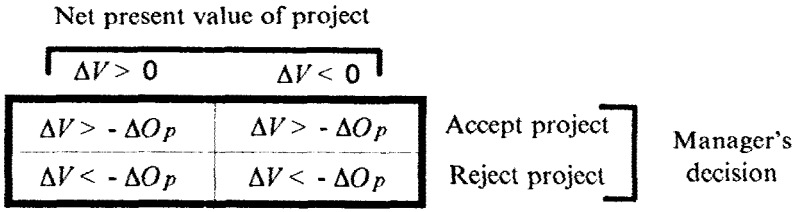


Figure 4.2. The risk substitution and debt overhang problems.

4.6.7 The bottom left box is what Myers (1977) calls the 'debt overhang' problem. A project with a positive NPV can reduce the value of equity, and so is ignored by managers. Jensen & Meckling's (1976) 'risk substitution' problem, whereby a negative NPV project can represent a good deal for shareholders because the increase in overall riskiness of the firm more than compensates shareholders by reducing the value of the debt holders' (in our case the policyholders') claims on the firm, is described by the top right box.

4.7 *The Economic Fundamentals of an Equity Injection into a Non-Life Insurer from the Shareholders' Perspective*

4.7.1 Consider the following example. A non-life insurance firm is about to announce that it is seeking to raise fresh equity capital. Its market value balance sheet is as follows:

Market Value Balance Sheet pre Equity Injection			
Value of claims on the firm		Value of the firm	
Equity	E	Assets in place	V_A
Policyholders' claims	$\overline{D} - O_P$	Growth opportunities	V_{GO}
Total	V	Total	V

4.7.2 Suppose that the firm successfully raises an amount I of equity capital. There are incremental changes in E, O_P, V_A and V_{GO}. Ignoring taxation effects, we suggest that assets in place increase by amount I. The new market value balance sheet is then as follows:

Market Value Balance Sheet post Equity Injection of *I*			
Value of claims on the firm		Value of the firm	
Equity	$E + \Delta E$	Assets in place	$V_A + I$
Policyholders' claims	$\bar{D} - (O_P + \Delta O_P)$	Growth opportunities	$V_{GO} + \Delta V_{GO}$
Total	$V + \Delta V$	Total	$V + \Delta V$

4.7.3 V_{GO} changes in the event of a capital injection for two reasons. First, the universe of future growth opportunities expands as more insureds are willing to do business with the firm. Secondly, the firm's capacity to exploit available growth opportunities is enhanced.

4.7.4 If the firm's valuable growth opportunities previously outstripped its capital resources, then V_{GO} will increase substantially when a capital injection is announced. On the other hand, some would argue that if a firm is already well capitalised then V_{GO} might very well be negative (see Jensen, 1986). Indeed, the U.K. non-life insurance industry has a reputation for squandering free cash flow (see Riley, B., *Financial Times*, London, 27 June 1992, 'Botching the Insurance Job').

4.7.5 From the two market value balance sheets, we get the following expressions for the value of shareholders' equity before and after the new capital is raised:

$$E = V_A + V_{GO} - \bar{D} + O_P \tag{7}$$

$$E + \Delta E = V_A + I + V_{GO} + \Delta V_{GO} - \bar{D} + O_P + \Delta O_P. \tag{8}$$

The increase in total shareholder wealth as a result of the equity injection is given by:

$$\text{Total increase in shareholder wealth} = E + \Delta E - (E + I). \tag{9}$$

Using equations (7) and (8) we can express this as:

$$\text{Total increase in shareholder wealth} = \Delta V_{GO} + \Delta O_P. \tag{10}$$

4.7.6 This is identical to the expression we derived in Section 4.6 when considering the 'debt-overhang' and 'risk substitution' problems . We can draw very similar conclusions as before. Adjusting for the face value of the capital injection, the value of equity increases only if the increase in value of future growth opportunities outweighs the costs to shareholders of the increased

security of policyholders' claims. Furthermore, managers acting to maximise E may choose to ignore positive NPV projects that require external financing or, equally, may raise capital to invest in negative NPV projects.

4.8 *Summary of the Option Model Insights*

The simple option model provides a framework within which one can understand the relationship between the firm's value and the value the investors' claims on the firm. We find that the management incentives implied by the model may be overpowered by other influences. In particular, whereas the option model ought to motivate managers to increase the level of risk within the firm, we find that a lower-risk strategy might be preferred in order to maximise the value of growth opportunities.

5. The Management of Capital in Practice

5.1 *The Story so Far . . .*

5.1.1 By considering the interaction of the various claims on the value of the firm rather than simply the value of the firm itself, we have described a framework that explains, first, how managers' actions may result in a redistribution of total wealth between claimants and, secondly, how they may be motivated to ignore positive NPV projects and accept negative NPV projects. These are problems faced by all types of company and not solely by non-life insurers.

5.1.2 In this section we highlight a number of counterbalancing influences which, whilst not eliminating these incentives, do offset them to some degree.

5.1.3 It should be reiterated, at this stage, that the incentive to engage in wealth expropriation and in non-value-maximising decisions is strongest when the value of equity relative to the value of debt is very low. It is therefore instructive to consider the relevance of each offsetting factor in this particular situation.

5.2 *Sanity Restored . . .*

5.2.1 The reader is, by now, likely to be thinking that, although interesting as a theory, the intuitions of the option framework bear little resemblance to the 'real world'. Managers of 'normal' insurers simply do not go around deliberately expropriating wealth from policyholders, and it is not our intention to suggest that. However, we believe that the incentives under the option framework are always present and, although they may be outweighed by other factors, they provide a foundation on which a theory of corporate financial decisions can be built.

5.2.2 We believe that there are a number of reasons why managers usually adopt a low-risk strategy rather than a high-risk strategy, contrary to the incentives under an option model of corporate liabilities in an MM world. First, as we mentioned in Section 4, managers act as though capital were a truly limited resource and attempt to preserve their capacity to exploit future growth

opportunities. Secondly, managers' actions are consistent with a desire to maintain corporate control and, in particular, to avoid any negative signals to shareholders. We discuss these points in detail in the rest of this section.

5.3 *Capital Availability*

5.3.1 Financial economics argues that fresh capital is always available, but at a cost. Therefore, from a theoretical perspective, new capacity should always be available to finance positive NPV future growth opportunities.

5.3.2 However, shareholders face considerable information shortfalls (see Section 5.5), which impair their ability to assess investment opportunities. Furthermore, the signalling costs (see Section 5.6) associated with a capital raising exercise may be unacceptable to managers. In practice, therefore, from time to time managers may behave as if capital is limited. This causes them to be very concerned about the riskiness of their strategies, since this affects their capacity to exploit future growth opportunities, and hence the value of V_{GO}. Managers might follow low-risk strategies, pursuing only the better NPV positive projects and forgoing the others, rather than raise further capital.

5.3.3 In the period since the end of the tariff structure in the U.K. insurance market, there are many examples of under performing, or even failed, non-life insurers. This under performance, when combined with the acute information and signalling problems of the industry, has created capital markets that are wary of further investment in the sector. As a result, we believe that most non-life insurance companies have limited opportunities to raise further capital and must manage themselves accordingly.

5.3.4 Our conclusion concerning capital in U.K. non-life insurers might seem somewhat counter-intuitive, given the amount of capital raising activity that the market has seen in recent months. However, at the time of writing, it would appear that attempts by Lloyd's to stem the exodus of capital, using corporate membership, has met with only moderate success. Furthermore, a substantial proportion of the new capital is going into new, off shore operations, and not to existing companies or management. This inflow of capital is seeking to benefit from the very 'hard' premium rates that the market is able to enforce owing to the withdrawal of capacity—presumably by insurers who are unable to convince their shareholders of the expediency of further investment.

5.4 *Corporate Control*

5.4.1 Theories of corporate control are based entirely on the premise that managers act to preserve control over their empires. Proponents of such theories argue that managers are reluctant to make divestments, are reluctant to return surplus cash to shareholders and are reluctant to put their own jobs at risk (see Jensen, 1986).

5.4.2 Until now we have assumed that managers can be incentivised to align their interests with those of the shareholders. However, as managers do not have a diversified portfolio of assets (a disproportionate amount of their wealth is tied into the firm that employs them), they have a strong incentive to avoid the loss of

employment that may well accompany either bankruptcy or a take-over. The implications of the desire of managers to maintain their corporate position have been analysed by researchers from the 'Corporate Control' school.

5.4.3 The desire to maintain control may be thought of as offsetting the incentive to increase volatility at a time when the value of equity is low relative to that of debt.

5.4.4 However, when in financial distress, this incentive is once again reversed, as the manager realises that corporate control has, barring a miracle, been lost. In such a situation, a very negative NPV project can look like the only possible source of that miracle, even though the project's likely outcome would result in a further fall in the value of the firm (the cost being borne by the policyholders).

5.4.5 The desire to avoid take-over will increase the motivation of managers to maintain positive signals of the company's strength and quality, and thus will tend to reinforce the incentive to influence the stability of results.

5.4.6 Theories of corporate control are, however, more ambiguous when considering the incentive of managers to accept only positive NPV projects. Although the threats of take-over and bankruptcy provide some control on the quality of projects undertaken, the more extreme theorist will argue that, when threatened explicitly by neither, managers care more about the size of the company than earning an adequate return for shareholders.

5.5 *Information Shortfalls*

5.5.1 In many companies there is a separation between ownership and control. Such a delegation of decision-making power becomes problematic when the shareholders are unable to observe the actions of the managers or are unable to observe the state of nature that is obtained. We refer to the information asymmetry between managers and shareholders, and the information uncertainties faced by both, collectively as information shortfalls. These shortfalls leave the shareholders unable to tell whether the results achieved are a function of mediocre management in an excellent environment or of excellent management in a mediocre environment. The more volatile the cash flow of a firm, the harder it is to differentiate between bad luck and bad management.

5.5.2 In non-life insurance, the information shortfalls faced by managers and shareholders are quite acute. First, few managers choose to communicate to shareholders the nature of the risks that they underwrite (an information asymmetry). Secondly, the very business itself is founded on the fact that the state of nature cannot be observed (an information uncertainty). This means that managers will often be uncertain about the true financial outcome of an insurance project. What confidence do managers have in their estimates of the distribution parameters underlying a catastrophe event? In an era of latent claims, at what point can it safely be decided that there will be no further movement on a contract? The shareholders' problem is all the more acute depending upon the extent to which management choose to provide them with information.

5.5.3 The costs that accompany such uncertainty are mitigated through a variety of explicit and implicit measures: the adoption of incentive contracts tie managers' pay, in part, to company performance; the inclusion of bond covenants is explicitly designed to control some of the risk-shifting problems previously mentioned. These methods of control, however, can be costly to monitor and implement.

5.6 *Signalling Costs*

5.6.1 To reduce further the costs associated with information shortfalls, therefore, managers use well-recognised signals which convey to the market an impression of the quality and sustainability of the results achieved. In the U.K. Stock Market in general, and certainly in the composite insurance sector, the most obvious example of such a signal is the dividend. Without a signal that requires cash flow stability the costs associated with the informational uncertainty increase.

5.6.2 'Dividends are cut only when things go wrong'. This is a message that is widely accepted by the market, but the pressure to sustain adequate cash flow to maintain this payment seems to fly against the intuition provided by the option framework—that shareholders want volatile returns. We would argue that the costs of information shortfalls can explain this.

5.6.3 A second, and perhaps more negative, signal is associated with the decision to raise capital through the equity market. Will shareholders think that capital has been depleted owing to poor management? Is a request for more capital communicating a new weakness to shareholders? Will the share price become depressed and make the firm vulnerable to take-over? Smith (1986) presents well-documented evidence that, on average, the issuance of equity is taken to imply 'bad' news. The explanation of this phenomenon, however, is less certain.

5.6.4 In practice, the economic fundamentals of a capital-raising exercise may be unobservable, or may only be observed by management. Shareholders, therefore, base their investment decision on management signals—the published track record of the company, adherence to implicit bonding contracts such as increasing the dividend and management's stated use for the capital.

5.6.5 Managers will weigh the potential costs of signals against the economic benefits of additional capital. If managers judge that the signalling costs outweigh the economic benefits, they will choose to delay an approach to the stock market for more capital. As a result, second best solutions, namely solutions that do not maximise value, may ensue.

5.6.6 In non-life insurance, we believe that the signals associated with an approach to the stock market can easily be misread, owing to the particular difficulties for shareholders in differentiating between bad luck and bad management in an industry that makes its living out of the unpredictable forces of nature.

5.6.7 In summary, therefore, we argue that managers act to preserve their

explicit, positive signals and to avoid negative, implicit signals, even if this, in a world without information shortfalls, would not be in the interests of shareholders. Thus, the benefit of volatile returns is at least partially counterbalanced by the need to be able to make positive, explicit signals in the form of monotonic dividend pay outs and growth financed from retained earnings.

5.7 *Summary*

5.7.1 We have established a framework that allows one to consider the effect of management decisions on all classes of investor. The simple option theory that we highlight provides a useful starting point for this analysis. We find that the incentives that the model predicts are at their strongest when the company has a high debt to equity ratio and that this coincides with the time when offsetting influences are at their weakest.

5.7.2 When the shareholders' option is far 'in the money', we have argued that other factors, in particular signalling issues, become highly significant and thus should be considered when analysing the decision process. We suggest that capital scarcity is a dominant influence on management actions in the non-life industry, particularly in light of the acute information shortfalls faced by managers and shareholders and the poor historical performance of the sector. We consider the effect of capital scarcity further in Section 6.

6. Corporate Management

6.1. *Overview*

6.1.1 We now have the platform from which we can launch our hypotheses concerning corporate management in a non-life insurance company. Section 3 gave us a definition of a project which can be used to assess the value creation resulting from different management actions. In Section 4, we developed a model that describes the principles of interaction between the value of the firm's assets and the value of each investor's claim upon those assets, and discussed how these interactions can influence managers' actions. To complete the picture, in Section 5 we investigated how managers' actions deviate from those suggested by classical economic theory as a result of the real world influences. In particular, we hypothesised that many managers operate as though capital is a scarce resource.

6.1.2 We begin by briefly outlining the type of insurance company model that we believe can contribute significantly to the management of a non-life insurer. The model can be used at two levels:

(i) to evaluate alternative operational strategies, given the fixed short-term supply of scarce resources (capital and skilled management), and
(ii) to evaluate the additional operational strategies that would be open to the company in the longer term with a different level of scarce resources and, hence, whether or not a change in the level of resources should be considered.

6.1.3 To complete the discussion of corporate management in a non-life insurer, we then examine the firm's strategy for investing assets in place. The findings of Sections 4 and 5 are once again instrumental in developing our ideas.

6.2.1 *A corporate management framework*

6.2.1.1 At the centre of the framework is a corporate model. The model consists of separate 'mini firms', each one of which represents a class of insurance projected over one complete underwriting cycle (similar to an extended profit test). The sum of these 'mini firms' represents the total firm.

6.2.1.2 The logic behind the underwriting cycle project is to recognise the dependencies between each generation of business. It is not our objective to collapse the individual years of business that form the underwriting cycle project into a 'black box'. At a macro-decision level the value over the underwriting cycle may be adequate for management to take their portfolio decisions. However, at the micro level, when the company comes to implement its selected strategy, detailed analysis of each year of each class of business will be necessary to optimise the portfolio.

6.2.1.3 Each 'mini firm' models the premium, claim and variable expense flows arising from the class of business, both on a cash flow and on an accounting recognition basis. The volumes of premium assumed to be underwritten in consecutive years must respect the sequential dependencies between generations of business and anticipate the insurance cycle. The fixed expenses of the firm over the ensuing underwriting cycle are projected separately.

6.2.1.4 The cash flows of each 'mini firm' plus the opening asset position are combined with the appropriate investment yield assumptions to project forward the total asset position through the underwriting cycle. This allows the projection of the company's financial statements, and hence verification that adequate capital is available to support the business projections. In practice, maintaining adequate capital strength, as measured by published information, places only a lower bound on capital requirements. Management may stipulate more stringent levels of capital than the external market indicates is required, perhaps, for example, to pursue a more risky investment strategy, or in preparation for a phase of growth.

6.2.1.5 The value of the firm is the sum of the market value of the assets in place plus the NPV of the growth opportunities. This latter amount is represented by the future premium, claim and expense flows discounted at interest rates that reflect the systematic, or market, risk implicit in each cash flow (see Mehta, 1992, for a discussion of risk-adjusted discount rates).

6.2.2 *The framework in use*

6.2.2.1 As we have discussed, we believe that the objective of management should be to maximise the value of the firm. This is a two-stage process: first, to maximise the value of the firm given the current planned capital and management resources; secondly, to investigate whether the value can be increased by changing the level of either resource in the medium term. During both stages,

management must have a clear understanding, at the project level, of what is the 'natural' renewal and new business rate, so that they can identify the components of V_A, and V_{GO}.

6.2.2.2 In the first stage of the analysis, management must ensure that the volumes of business assumed are consistent with the resources available. This is straightforward for capital, since explicit requirements can be stipulated and monitored against the projected levels. The classic actuarial profit test can be used to project the capital requirements. In doing this, management will usually wish to experiment with various scenarios for the level of claims and movements in the market values of assets. Estimating the level of business that a specified management resource can sustain is difficult, but nevertheless essential.

6.2.2.3 At the second level of analysis, management can assess the potential change in the value of the firm should they increase or decrease the levels of either or both scarce resources in the future. If the company achieves a situation where capital is to all intents and purposes unlimited, at a cost, then the capital projection takes secondary importance and the management resource dominates. However, the capital resource should still be monitored so that any further capital calls can be properly planned.

6.2.2.4 The two key factors to the successful use of this framework are knowledge of how much business the company's management can undertake and an understanding of the inter-temporal aspects of the insurance portfolio.

6.3 *The Effect of Investment Strategy on the Value of a Non-Life Company*

6.3.1 *Introduction*

6.3.1.1 We have not yet discussed the effect that the investment strategy has on the value of an insurance company. We begin by returning to the market value of a non-life insurance company using the growth opportunity and option models of Sections 3 and 4:

Market Value Balance Sheet of a Non-Life Insurance Firm

Value of claims on the firm		Value of the firm	
Equity	E	Assets in place	V_A
Policyholders' claims	$\overline{D} - O_P$	Growth opportunities	V_{GO}
Total	V	Total	V

6.3.1.2 When we talk about investment strategy in this context, we mean the strategy for investing real assets, that comprise part of total assets. The question we ask is this: what effect does this strategy have on the value of shareholders' equity, E?

6.3.1.3 We consider this problem one step at a time. First, at a fundamental economic level we consider the effect of investment strategy on V_A, then on V_{GO} and finally on E. We then consider why information asymmetries between managers and shareholders might motivate managers to take actions that represent a second-best solution for shareholders, even if they are incentivised to act in shareholders' best interests.

6.3.2 *The effect of investment strategy on V_A*

6.3.2.1 We contend that, ignoring taxation and transaction costs, investment strategy has no effect on V_A. The principal asset pricing models of financial economics tell us that the yield on a particular asset precisely compensates investors for its risk. Thus, an investment in gilts and an investment in equities have equal risk-adjusted total yields from the perspective of a shareholder with a diversified portfolio of assets.

6.3.2.2 The only situation in which we can envisage a company accepting an inadequate risk-adjusted yield on an asset is when there is no choice but to do so; in other words, when asset strategy is directed by a regulatory authority or certain asset classes are unauthorised, so that the investor has no option but to hold an inefficient portfolio. We are of the opinion that any such cost is likely to be of second-order magnitude in the major insurance markets of the world.

6.3.2.3 If investment restrictions are voluntary, in the interests of prudent management, we can see no reason why an insurer cannot hold an efficient portfolio of investments with the desired level of risk, which is a costless strategy in terms of its effect on V_A.

6.3.3 *The effect of investment strategy on V_{GO}*

6.3.3.1 Our starting position is, again, that investment strategy has no effect on V_{GO}. However, we need to be explicit about the assumptions we are making. If there is sufficient capacity to finance future growth opportunities and maintain the external perception of financial strength, then we argue that the investment strategy for V_A has no effect on the value of V_{GO}.

6.3.3.2 If capital is limited, however, we have a different story. Investment risk is itself a consumer of capacity, and the amount consumed increases with the riskiness of the strategy (in the sense of mismatching between assets and liabilities). It is possible, therefore, that the strategy for investing V_A could affect V_{GO} by altering the capacity available to exploit operational insurance opportunities. Equally, since investment risk might influence the external perception of capital strength, V_{GO} might change as the premium policyholders are willing to pay changes. The effect of this can be assessed using the sensitivity analysis as described in Section 6.2.

6.3.4 *The implications of investment strategy for the value of equity*

6.3.4.1 Let us reconsider the expression for the value of equity that we developed in Section 4.7, namely:

$$E = V_A + V_{GO} - \bar{D} + O_P. \tag{11}$$

6.3.4.2 We have argued that investment strategy does not affect the value of assets in place, V_A, but that it can affect the value of growth opportunities, V_{GO}. Clearly it also affects the security of policyholders' claims, which affects the value of the put option O_P. $\bar{D}$ is unaffected by the firm's investment strategy. The overall effect on E depends on the trade-off between V_{GO} and O_P.

6.3.4.3 We saw in Section 4, using a simple option model of corporate liabilities, that suddenly and unexpectedly increasing the volatility of returns in the firm results in an instantaneous expropriation of wealth from policyholders to shareholders. However, this is not to say that a permanently high-risk investment strategy is in the interests of shareholders, since the premium that policyholders are willing to pay should reflect the riskiness of the insurer.

6.3.4.4 In practice some, but not all, purchasers of insurance (usually, but not exclusively the commercial policyholders) actively consider the security of an insurance company as part of their decision when they purchase a contract. The market uses a fairly simple system for security rating, in which the major insurance broking houses play an important role. An insurer may be graded as suitable for all risks, suitable for certain risks or unsuitable for any risks. Within a particular grade, the premium paid for a policy does not vary with the individual insurer—in a typical commercial coinsurance the lead insurer(s) sets the rate for the policy in negotiation with the broker. It is, therefore, in the shareholders' interests for their company to be the riskiest within its security category, since it is then expropriating more wealth from its policyholders than its peer group. Of course, all companies can play this expropriation game, which might alter the premium charged for the entire group.

6.3.5 *Signalling and investment strategy*

6.3.5.1 The question of what comprises a 'low-risk' investment strategy is itself non-trivial. Analysts and shareholders are compelled to rely on comparative measures of performance within the sector as a whole because of an almost total lack of published information on risk levels within insurance companies. A company that underperforms its peer group may find that there is a short-term pressure on its share price, even if this is due to a different risk retention strategy.

6.3.5.2 Managers will, therefore, be concerned about risk relative to competitors. The signals generated relative to the peer group are very important. Thus from a management perspective, a low-risk strategy might mean following a risk strategy in line with those of competitors.

6.3.5.3 When risk relative to competitors dominates, companies may find that they are, in fact, following quite high-risk strategies when considered in the sense of mismatching between assets and liabilities, particularly when true insurance

liabilities are fully recognised. We believe that this has been the case in the U.K. in the recent past. During the decade of the 1980s, the average equity weighting of the quoted non-life insurance sector (including composites) was in excess of 100% of shareholders' funds. Whilst we acknowledge that the U.K. composite insurers do have some liabilities which could be considered to be matched by equity type investments, in principle such an investment strategy represents a mismatch of assets and liabilities.

6.3.5.4 One possible explanation of this is suggested by the simple option model of Section 4. One could argue that by retaining high levels of risk, the sector as a whole is maximising its expropriation against the ultimate guarantor. Whilst this may not be a serious situation in the U.K. non-life insurance industry, there are genuine concerns over the position in the banking sector, created by the increasing volumes of derivative instruments that are being traded.

6.3.5.5 If non-life insurance managers are concerned about avoiding negative signals to shareholders and maintaining corporate control, then a high equity investment/ high solvency strategy would probably be considered the best 'low-risk' strategy. This strategy maximises internally generated capital in the long term (which avoids the risk of negative signals when fresh equity is sought) while at the same time providing protection against loss of control in bankruptcy in the short term.

6.3.6 *Summary of investment strategy arguments*

6.3.6.1 For a well-capitalised insurance company with access to new capital at an acceptable cost, investment strategy does not affect the value of the firm. Shareholders can expropriate wealth from policyholders by increasing the level of investment risk (in the sense of mismatching), but a permanently high-risk strategy will eventually influence the premiums policyholders are willing to pay, and so will not benefit shareholders.

6.3.6.2 However, a manager may choose to adopt a low-risk investment strategy in order to preserve the value of signals to shareholders. In this context, risk relative to competitors is very important and can dominate managers decisions. It is possible that such a strategy might result in value-creating opportunities' being forgone, but it does not affect the value of assets in place.

6.3.6.3 A high equity/ high solvency strategy may be favoured by all managers within the non-life industry in order to maximise internal capital generation over the long term, and hence reduce the possibility of going to the market for further capital.

7. The Actuarial Paradigm and Appraised Value Revisited

7.1 *Overview*

7.1.1 The implication of much of this paper for the appraised value model is straightforward: more economic content needs to be given to it, in order for it to provide useful management information. We have already presented our

proposed improvements in previous sections. In this section we view these proposals from another perspective—by examining what we see as the key problems that arise when using current appraised value methodology.

7.1.2 First, there is some disquiet in the actuarial literature about the ability of a valuation framework that discounts expected cash flows to handle skewed payoffs. This point—the limitations of a conventional discounted expected cash flow model—has some foundation. We begin this section with a discussion of this issue, with reference to the models presented earlier in the paper. However, by casting more light on a problem, its true complexity is often revealed. Indeed, we find that some of the valuation issues raised by the growth opportunity and option frameworks of Sections 3 and 4 are particularly testing.

7.1.3 Secondly, we believe that the practical interpretation of the appraised value model is often ambiguous and unhelpful. The emphasis is far too much on calculating a final number, rather on how one gets to it and what it means. This will stand in the way of the profession if it wishes to progress its involvement in management.

7.1.4 Thirdly, we do not believe that the actuarial views on non-life insurance company management, which we have referred to as the actuarial paradigm, are robust.

7.1.5 In particular, there is the controversial issue of the value that shareholders should place on assets that are 'locked in' to support insurance business. This point—the value of locked-in assets—has been described by Salmon & Fine (1991) as the 'most important technical question' in an appraised value calculation. It is certainly the most controversial question in the actuarial literature on this subject. In the authors' opinion, this controversy has been fuelled by the lack of a clear economic framework in the previous actuarial literature.

7.1.6 Instead, the arguments hinge on the 'cost' of the firm's investment strategy and—a separate point—the 'cost' of exposing assets to the risk of loss from insurance (see Sturgis, 1981, and Ryan & Larner, 1990, amongst others). Despite the lack of clarity in these arguments, there is a consensus opinion in the actuarial literature that locked-in assets are worth less than market value to shareholders.

7.1.7 We look at each of these arguments for a locked-in asset adjustment in turn. We find that an option model of corporate liabilities can justify an adjustment arising from the asymmetric nature of the payoffs from insurance. However, this adjustment is a positive addition to the expected value of the payoffs, reflecting the protection from the severe downside payoffs that limited liability affords shareholders.

7.1.8 We are still left with one major loose end. Although we reject the actuarial arguments for a locked-in asset adjustment, we still find that it features as an explicitly defined element in practical appraised value calculations (although it is hard to glean its content from the actuarial literature). So what does this adjustment represent? Why is it included?

7.1.9 In answer to these questions, we derive a simple result within the appraised value framework that we believe lies at the root of the locked-in asset issue. The result provides an explanation for a 'locked-in asset adjustment', although it has nothing to do with the economic arguments in the actuarial literature. We go on to present a closely related result that perhaps explains another part of the paradigm—the continuing ambiguity over whether cash flows or accounting flows should be discounted in an appraised value calculation (see Sturgis, 1981, and Rothman & Deutsch, 1982, for the origins of this debate).

7.2 *Risky Payoffs and the Discounted Cash Flow Framework*

7.2.1 *Introduction*

7.2.1.1 In this section we consider the appraised value model from a valuation perspective. We consider how well it is suited to valuing the skewed option-like payoffs to investors that arise from their asymmetric claims on the firm, and the negatively skewed payoffs on insurance projects that are an intrinsic feature of non-life business.

7.2.2 *The actuarial application of the discounted cash flow valuation framework*

7.2.2.1 The discounted cash flow framework used by many practitioners—actuarial or not—attempts to put a present market value on a risky cash flow stream $\{C_t\}$, as follows:

$$PV = \sum_t \frac{\mathrm{E}(C_t)}{(1+r)^t} \tag{12}$$

where r is the return required by investors to compensate them for the riskiness of the cash flow stream in the context of their diversified portfolios.

7.2.2.2 However, actuaries are uncomfortable applying equation (12) to the valuation of non-life insurance projects. The argument is that it incorrectly values projects that have downwardly skewed payoffs, because discounting an expectation gives inadequate weight to 'bad' states of the world. Is there a point here? We answer this question by considering the 'solutions' that actuaries have proposed to this 'problem'.

7.2.2.3 Three reactions to perceived limitations of equation (12) are put forward in the actuarial literature, namely:

(i) apply an arbitrary loading to the risk-adjusted discount rate, or
(ii) discount non-mean cash flows, or
(iii) adopt a stochastic approach.

7.2.2.4 The suggestion that one should adjust for the risk of insurance by discounting cash flows at a rate that exceeds the 'normal' discount rate indicates a propensity by the profession to consider risk from the point of view of an owner-

manager rather than a diversified investor—perhaps because of the profession's tendency to look at problems from the policyholder perspective. This distinction is critical to understanding risk discount rates. The firm is not an individual, it is a 'legal fiction', a 'nexus of contracting relations' (see Jensen & Meckling, 1976).

7.2.2.5 If one were the owner-manager of a firm in which all one's wealth is invested, then one would be concerned about the total variability of returns from any project accepted. The rate at which future cash flows from the said project would be discounted would reflect this concern. Hence, an above-normal discount rate may be appropriate.

7.2.2.6 However, given the separation of ownership from control that typifies the U.K. quoted insurance sector, it is safe to assume that the firm is owned by a large group of shareholders (such as pension funds or insurance company funds), each of whom owns a well-diversified portfolio of assets.

7.2.2.7 The most significant, and least controversial, result to have arisen from mainstream research in financial economics over the past forty years is that investors will pay only for that risk which they cannot costlessly diversify away. Admittedly there have been some major debates concerning the appropriate definition of 'risk'. However, whether the researcher uses just the beta of the asset (the Capital Asset Pricing Model, CAPM) or multiple factors (the Intertemporal CAPM, ICAPM, and the Arbitrage Pricing Theory, APT), the intuition remains intact.

7.2.2.8 The importance of diversification for the valuation of insurance projects is immediately apparent. Many causes of insurance losses represent risk that is virtually entirely diversifiable by investors. Examples are losses arising from natural catastrophes. A risk-free discount rate should be used to value future losses arising from such business. When the cause of insurance losses is highly correlated with variables that influence the overall value of the investor's portfolio, we have non-diversifiable risk. Mortgage indemnity is an example of a class of insurance business that exposes investors to systematic risk.

7.2.2.9 Another possible explanation for loading the risk discount rate rests on the implicit assumption, often made in the actuarial literature, that firms operate in a limited capital environment. If capital is truly limited, a substantial cost could be associated with any negative fluctuations in cash flow, irrespective of the size of the systematic component of the risk, since capacity may not be available to exploit future growth opportunities. The reduced value that the actuarial appraised value often places on these skewed cash flows, as a result of the risk loading, could be considered compensation for this opportunity cost. However, we believe that it is important to separate the questions of capital availability, the value of future growth opportunities and the appropriate risk-adjusted discount rate.

7.2.2.10 In summary, therefore, any 'loading' on to the discount rate used in equation (12) can only be described as arbitrary and without economic justification. The result of any such approach to project evaluation will be the rejection of a band of positive NPV projects (where the parameters of the band

are given by the market and arbitrary discount rates). This is to the detriment of the firm and thus the value of shareholder equity.

7.2.2.11 The second suggestion is that non-mean cash flows should be discounted. We have already highlighted the importance of non-diversifiable risk; this means that investors are concerned about the expected value of the cash payoffs on a firm's projects and the covariance of these payoffs with the assets in their portfolios. Although the application of the discounted expected value model can be problematic, the model does have a sound economic foundation (see Dybvig & Ross, 1989). Expected payoffs are discounted, and the covariance of payoffs with investors' portfolios is reflected in the risk-adjusted discount rate.

7.2.2.12 It is interesting to note that if one were using an option model to price corporate liabilities, then the discounting of non-mean cash flows could be justified, provided that a consistent discount rate is chosen. Indeed, the Black–Scholes equation (see Appendix B, equation B.3) is best understood as the discounting of non-mean cash flows at risk-free rates. In fact, the cash flows that are discounted in the Black-Scholes equation are the mean cash flows that would prevail in the 'shadow' probability space that is consistent with the investors being risk neutral, rather than risk averse. However, the traditional appraised value is not an option pricing model, and we suggest that, unless an option structure for corporate liabilities is explicitly included within conventional appraised value methodology, then arbitrary adjustments to mean cash flows should not be made.

7.2.2.13 The third actuarial solution is to consider the total distribution of cash payoffs of a project using a stochastic model and to use an expected utility approach to put a value on it. This sounds fine in theory, but it relies on the identification of appropriate, quantifiable (von Neumann-Morgenstern) utility functions. In practice, utility functions are not so obliging (see Tversky & Kahneman, 1986).

7.2.2.14 Continuing on the theme of utility, investors who are normally risk averse may be willing to stake a small amount in a risky project to gain even a minute chance of a massive payoff, despite the negative NPV of the mean cash flows. Hence the success of national lotteries and other similar organisations. This behaviour can be explained by these investors' utility curves. The possibility of finding investors wishing to purchase an interest in a non-life insurance company for these reasons exists, but is remote in the authors' opinions. However, a valuation on this basis could be considered for a manager in the situation of § 5.4.4, who has become risk seeking in the search for the miracle that would save the firm.

7.2.2.15 In a similar vein to the stochastic approach suggested by actuaries, Hertz (1964) suggested that the capital budgeting problem could be solved by calculating the distribution of internal rates of return of a project, but this approach has since been challenged on many occasions by financial economists. The problem is determining the hurdle for project acceptance or rejection.

7.2.2.16 However, we do think that there is merit in considering how the

fortunes of a project might unfold over time and the cash flows obtaining in different future states of the world. Advocates of decision tree analysis have suggested this for many years. Indeed, this brings us on to what we consider to be the real problem with discounted cash flow methods.

7.2.3 *The real problem*

7.2.3.1 The problem with the discounted cash flow valuation framework lies in its application, not the valuation framework itself. The practitioner will encounter the problem whether using the traditional appraised value or a model similar to the one we have defined. Equation (12) represents a somewhat crude interpretation of the framework. Actuaries generally make no allowance for the changing expectation of C_t over time, and the risk-adjusted discount rate r is assumed to be constant over time.

7.2.3.2 The implicit assumption in equation (12) is that risk unfolds evenly over time (see Trigeorgis, 1988). However, very often this is not the case. Consider, for example, a project that generates asymmetric payoffs because it has intrinsic option characteristics. In this case, the asymmetry means that both the appropriate risk-adjusted discount rate and the expected payoffs will vary over time. This can make the application of the conventional discounted cash flow model extremely difficult in practice (see Bogue & Roll, 1974).

7.2.3.4 Returning to our previous distinction between assets in place, V_A, and the value of growth opportunities, V_{GO} (see Section 3), we suggest that the conventional discounted cash flow valuation framework is well suited to valuing V_A, but often has problems handling V_{GO}. In particular, the discounted cash flow valuation framework can experience difficulties in valuing the incremental effect ΔV_{GO} that a project may have on V_{GO}.

7.2.3.5 The reason for this is that interdependencies between projects often have a very significant effect on V_{GO}. In contrast, the value of assets constituting V_A does not depend on future discretionary investment by the firm, so they can be valued on a 'stand alone' basis. We contend that the discounted cash flow framework finds easy application only in situations where such an assumption of mutual exclusivity is valid.

7.2.3.6 Take for example the decision of an insurer to write a new line of business. The expected value of the outcome of the decision will ignore the value of the new options that the business will create and the cost of the options that can no longer be exercised. If by making a decision to invest one creates a future option to expand, then the value of that option should be considered when evaluating the opportunity.

7.2.3.7 Such sequential interdependencies are critical for understanding 'real world' investment decisions; the decision to write business at a loss in order to maintain market share, for example, can be understood only in an inter-temporal framework.

7.2.3.8 In the conventional appraised value model, the complexity of option-like payoffs is reduced to the question of the appropriate risk-adjusted rate for

discounting the capital flows projected under profit tests of past and future business. However, the search for the 'right' discount rate is misguided. Instead we should question the limitations of the valuation framework. This is a rewarding area for future research within the profession.

7.3 *The Appraised Value as a Management Tool*

7.3.1 *Introduction*

7.3.1.1 The emphasis in the actuarial literature on appraised values has been on the value of the shareholders' interest in the firm in a change of control situation. This emphasis has been at the expense of developing a framework that can assist the strategic management of a company. Instead, questions such as the justification of different appraised values from the buyer's and seller's perspectives in a take-over have dominated the literature.

7.3.1.2 As a management tool, we have already criticised the appraised value framework for lacking economic content, and we have outlined—in Sections 3 and 4—the improvements that we believe are necessary. However, we also believe that a change of perspective is required within the profession.

7.3.1.3 An appraised value calculation is often viewed by actuaries as a somewhat hypothetical exercise: "if future business is written as assumed and if shareholders demanded such and such a return on their capital then this would be the value of equity". This is an exercise in arithmetic, not corporate management. The danger is that an appraised value can become divorced from market value. For strategic management purposes, this distorts the value-maximisation decision.

7.3.1.4 Members of the profession need to examine critically and justify the assumptions that are used in an appraised value calculation. Given current resources, what assumptions about the future are realistic? In particular, consideration must be given to:

(i) the need for future additional capital and management resources,
(ii) the availability and cost of obtaining additional capital and management resources, and
(iii) the existence of competitive advantage.

7.3.2 *Capital and management resources*

7.3.2.1 As we have discussed already in this paper, the management of the financial 'supply side' of a non-life insurance company is of critical importance, since it determines the ability of a company to exploit its opportunities for future growth. Ignoring this issue in the appraised value inevitably renders it of limited use in management.

7.3.2.2 Appraised values often neglect the question of management resources. Frequently, the assumptions in the profit test assume a volume and profitability of business in the future that could be achieved only with an enhanced quality and quantity of management, which may or may not be available. The costs of

obtaining such management resources, if it is indeed possible to do so, are generally not identified. If additional management resources are required to achieve the levels of profitability projected and such costs are not included in the calculation, then the appraised value will exceed the market value by the costs of acquiring these resources, ignoring any other sources of differences. Equally, if the management resources are unavailable at any cost, then the projections themselves must be questioned.

7.3.2.3 The lack of explicit modelling of capital and management resources is a major stumbling block to the use of appraised values as a management tool. Increases in an appraised value may be read as good progress. In fact, they may just reflect a widening gap between market value and the appraised value, arising from the unaccounted costs of additional resources. This leaves management none the wiser as to how they should act in order to improve the company's value. In all situations, and particularly a sale, the additional resources (capital and management) required to be added to the current company in order to attain the appraised value should be clearly stated. This poses a problem for actuaries in calculating appraised values, since they are often not in possession of the information necessary to assess the management resources.

7.3.3 *Competitive advantage*

7.3.3.1 Financial economics suggests that, without any artificial restrictions on the industry, all projects should be NPV zero since capital will flow either in or out as necessary to maintain this equilibrium. We are inclined to agree with this view. However, owing to lack of information, an inadequate supply of expert management and barriers to entry and exit, at any time, most insurance markets will have insurers with positive NPV projects and insurers with negative NPV projects.

7.3.3.2 Many appraised value calculations assume that a company can write positive NPV projects in perpetuity. This seems impossible to justify for the majority of companies. The reason for the positive NPV could be unrealistic assumptions on the long-term prospects for the insurance market. The alternative possibility is that the assumptions for the long-term are inconsistent, in other words that continued above average performance is assumed without allowing properly for the costs of the resources necessary to maintain that performance.

7.3.3.3 In the rest of this section, we consider the controversial question of the value of locked-in assets.

7.4 *The Actuarial Arguments on the Value of Locked-In Assets*

7.4.1 *Introduction*

7.4.1.1 We begin by considering the two actuarial arguments for valuing locked-in assets value below market in an appraisal of the value of shareholders' equity.

7.4.2 *The effect of investment strategy on the value of locked-in assets*

7.4.2.1 In Appendix A we define the 'locked-in' assets of an insurance company as those assets in place that are required to meet the run-off of current outstanding insurance liabilities with a given, subjective, level of confidence. The value that shareholders should place on such assets has been a matter of controversy in the literature on appraised values.

7.4.2.2 Sturgis (1981) argues that the prudent investment strategies followed by insurers incur a cost for shareholders and, therefore, locked-in assets must be valued below market when appraising the shareholders' interest in the firm. The most naïve reading of this statement is that the worth of an asset is being measured by its total yield, ignoring risk; but risk can be ignored only in a risk-neutral world, and investors are not risk neutral, they are risk averse. Alternatively, the author may feel that a restriction of assets to certain classes must necessarily result in an inadequate risk-adjusted return.

7.4.2.3 We argued in Section 6.3.2 that there are no costs inherent in any investment strategy *per se*, provided that an insurer is able to hold an efficient portfolio, since returns are judged on a risk-adjusted basis. Of course, there may be some instances when a firm is unable to hold an efficient portfolio because this conflicts with prudent investment management from a risk standpoint. For example, a firm may be committed to holding tax-inefficient investments.

7.4.2.4 If the riskiness of an investment strategy affects the perceived capital strength of an insurer, then the value of future growth opportunities may suffer as a result of a loss of confidence. However, we suggest that when valuing the equity of an insurer, this 'cost' is allowed for explicitly by making realistic assumptions about the volume of risk that the firm is able to accept in future, given available capital resources.

7.4.2.5 Because of the information shortfalls that face managers and shareholders, we concluded in Section 6.3.6 that managers would seek to follow low-risk strategies, where risk relative to competitors is particularly important, in order to transmit the desired signals to the market. It is possible that following such a low-risk strategy could cause managers to make value-destroying decisions. However, again, this 'cost' is allowed for explicitly in the valuation of equity by a realistic assessment of the value of future projects.

7.4.2.6 The only situation in which we believe investment risk *per se* might affect the value of equity is when a firm is near bankruptcy, and shareholders' limited liability is of significance. In such cases, the shareholders' option to put the assets of the firm onto the policyholders if there are insufficient assets to pay their claims can be significant. The implications of an option model of corporate liabilities are that increasing investment risk would increase the value of equity in such circumstances. Equally, lowering risk reduces the value of equity. Although this is consistent with the intuitions suggested in the actuarial literature (see Sturgis, 1981), by providing an economic framework which justifies these results, managerial decision-making in these situations can be better understood.

7.4.3 *The cost of exposing assets to the risk of loss from insurance*

7.4.3.1 The second actuarial argument for valuing locked-in assets below market value in an appraised value context is based on the argument that shareholders' capital is exposed to future losses from insurance.

7.4.3.2 Ryan & Larner (1990), amongst others, have introduced this idea. In their paper, they describe two different scenarios for a capital injection into a non-life insurance company. In § 3.4.3 of their paper they describe a situation where a capital injection of £10m will not increase the company's value by £10m, except under a set of circumstances which, from reading § 4.5.3, we assume they consider to occur infrequently. In Section 4.7, they define an under-capitalised insurer as one in which an increase in capital causes the value of the company to increase at a faster rate than £1 for £1.

7.4.3.3 We can make little sense of this actuarial argument. If a fair premium is charged, then the value destroyed by insurance in the bad years will presumably be offset by the value created in the good years. Indeed, an option model of corporate liabilities would imply that shareholders' limited liability protects them from the downside (although this might be factored into pricing).

7.4.3.4 If we return to the market value balance sheet of an insurer once more (using the same symbols as before), we find that we can express the value of equity as follows:

$$E=\{V_A-\tilde{D}\}+O_P+V_{GO}. \tag{13}$$

7.4.3.5 V_{GO} is the value of future business. O_P is an adjustment term reflecting the value of shareholders' limited liability (and it is always positive). We can see no economic rationale for a negative adjustment term.

7.4.3.6 Using the framework developed in Sections 3 and 4, we would explain the two different effects that Ryan & Larner noted in the following terms:

(i) The value of the firm does in fact increase by the face value of the capital injected plus any change in value of the growth opportunities. However, the value of the firm is not the same as the value of the shareholders' interest.

(ii) A capital injection into the firm gives rise to a change in the shareholders' put option value ΔO_P and a change in the value of the firm ΔV. In the first situation they describe, the reduction in the option value exceeds the change in value, and vice-versa in the second.

7.4.3.7 We contend that if ΔO_P is negative, then it represents a true cost to shareholders as a result of exposing their capital to outstanding insurance liabilities. Our simple option model tells us that it is an expropriation of wealth from shareholders due to debt overhang. Ryan & Larner's implicit view is that ΔO_P is normally both negative and significant in the context of the firm's overall value. However, we are of the opinion that this is not so, and that the origin of the adjustment lies in a combination of the appreciation of the existence of the debt overhang problem and the factors we discuss in Section 7.5.

7.4.3.8 Some actuaries go further and suggest that capital that is locked-in to an insurer in perpetuity to support insurance has no value. If this is the case, then

surely shareholders should be willing to give up the ownership of locked-in capital without compensation. However, it seems to us that if the capital did not exist, then either new capital must be raised (and serviced) or future growth opportunities must be forgone. In either case there is a cost involved, so locked-in capital obviously has value, even if it is locked-in in perpetuity.

7.4.3.9 This extreme (actuarial) argument on locked-in capital is based on the assumption that only distributable earnings matter in a valuation of shareholders' equity. At the other extreme, an extension of the MM irrelevancy proposition that we considered in Section 4 (see Modigliani & Miller, 1958) suggests that dividend philosophy has no effect on the value of the firm. They use an arbitrage argument, based on the idea that shareholders can 'manufacture' their own 'dividends' by selling shares.

7.4.3.10 From a fundamental economic perspective, we believe that distributable earnings are unimportant. On the other hand, from an agency perspective, distributable earnings can play a critical role and may affect management behaviour. We have already discussed how the quoted U.K. non-life insurance sector uses the dividend as a key signalling tool. Furthermore, the dividend represents a useful management discipline for any industry that might be tempted to squander free cash flow (see Jensen, 1986). In industries that enjoy closer agency relationships between managers and shareholders, the dividend may not be important at all (for example, the German and Japanese non-life sectors).

7.4.3.11 In summary, we cannot see why exposing locked-in assets to the risk of future insurance losses should necessarily imply valuing them at a discount to market value, from a shareholder perspective. We argue that distributable earnings do affect management behaviour, but do not affect the calculation of economic value, given management actions. In an appraised value calculation, we suggest that adjustments on the grounds of distributability of earnings are unwarranted.

7.5.1 *Locked-in asset adjustments in practical appraised value calculations*

7.5.1.1 In Section 2 we put forward the following expression for the appraised value of the equity in an insurer:

$$E = MVF + \sum_{j=1}^{\infty} K(j) \tag{14}$$

where:

$K(j)$ is the present market value of the future notional capital flows projected under an actuarial profit test of the j^{th} generation of insurance business, under some chronological ordering of business written, both past and future, and MVF is the present market value of those assets of the firm that are not notionally 'locked in' to support insurance business within a profit test at the assessment date.

7.5.1.2 This expression for E is entirely consistent with equation (13) that we have just considered in §7.4.3.4. However, in this section we stay within the appraised value framework.

7.5.1.3 Conventional actuarial methodology usually includes a specific 'locked-in' asset adjustment term in the appraised value calculation, which we do not see in equation (14). Sometimes, rather confusingly, this adjustment is referred to as the 'cost of capital'. We have already put our case in the previous sections that the economic arguments for such an adjustment in the actuarial literature are unsatisfactory, so what does it represent?

7.5.1.4 In very simple terms, an adjustment is often included because the wrong risk discount rate is used. For example, if positive risk-free cash flows are erroneously discounted at a greater, risk-adjusted discount rate, the answer will be too low and a positive adjustment must be added back to get the right answer.

7.5.1.5 In the next section, 7.5.2, we explain why such an error adjustment is often included in practical appraised value calculations. This error adjustment term is rather deep-rooted in conventional appraised value methodology, but it is not recognised for what it is and has given birth to a number of potentially damaging ideas. One such idea is that accounting flows, not cash flows, should be discounted in an appraised value calculation. In Section 7.5.3, we explain how this particular misconception has arisen.

7.5.2 *Practical interpretations of locked-in asset criteria in appraised value calculations*

7.5.2.1 Our ensuing argument in this section hinges on the irrelevance of capital allocation to the value of equity in a non-life insurance firm (which we justified in §2.2.2).

7.5.2.2 The allocation of capital is an internal, notional procedure that does not in itself affect the company. To an extent it is arbitrary. In particular, while an actuary may choose to align the locked-in assets criterion defining a profit test with required accounting provisions, the influence of this procedure on the value of equity must not be confused with the influence of published earnings on that value.

7.5.2.3 We develop our argument using a simple appraised value example. We have already introduced this example in Appendix A in order to justify equation (1) in Section 2. However, we describe it again very briefly. Suppose that an all-equity financed firm has a pot of assets and writes just a single block of insurance business. We wish to put a value on the equity in the firm. Following conventional methodology for appraised values, we construct a profit test of the block of business using a locked-in asset criterion that we call C, say, and we discount the notional capital flows projected under the profit test at the rate of return required by shareholders, r_C, say.

7.5.2.4 We can express the market value of the equity in the firm as follows:

$$E = MVF(C) + \mathbf{DCF}(\mathbf{N\tilde{C}F}(C), r_C) \tag{15}$$

where the symbols are defined as follows:

$MVF(C)$ is the market value of the free assets under the locked-in assets criterion C, and
$\mathbf{DCF}(\mathbf{N\check{C}F}(C),r_C)$ is the discounted cash flow operator that discounts the expected future stream of notional capital flows $\mathbf{N\check{C}F}(C)$ projected in the profit test at the return required by shareholders, r_C.

7.5.2.5 Now suppose that we change the locked-in asset criterion from C to D, say, but use an unchanged risk-adjusted rate r_C to discount the new capital flows. Since capital allocation or, equivalently, the locked-in assets criterion does not affect the value of equity, we now need an additional adjustment term in equation (15). This is because the risk discount rate r_C no longer reflects the return required by shareholders to compensate for the riskiness of the new capital flows. Calling the adjustment term $COCA$, and using the same notation as above, the equation for the equity in the firm, E, becomes:

$$E = MVF(D) + \mathbf{DCF}(\mathbf{N\check{C}F}(D),r_C) + COCA. \tag{16}$$

7.5.2.6 In Appendix C, we show that we can write the $COCA$ term in equation (16) as follows:

$$COCA = -(r_C - i)\sum_{j=1}^{n}\left\{\frac{MVLIA(j-1,C) - MVLIA(j-1,D)}{(1+r_C)^j}\right\} \tag{17}$$

where:

$MVLIA(j,C)$ is the market value of locked-in assets at time j using locked-in assets criterion C (and similarly for $MVLIA(j,D)$),
i is the assumed market investment return per unit time period on assets within the profit test, and
n is some future point beyond which there are no further cash flows arising from the business underwritten.

7.5.2.7 In practice, most actuaries define C by equating locked-in assets to the insurance funds required under standard accounting conventions, plus a fixed percentage of written premiums to provide an additional margin for solvency. Under this assumption, r_C is usually assumed to be a rate that reflects the overall cost of equity for the company, which is estimated from historical stock market returns. D, on the other hand, is usually defined like C, but ignoring the additional margin for solvency over and above the accounted insurance funds.

7.5.2.8 In Appendix D we calculate each element of the value of equity in equation (16) for our simple example, using the practical interpretations of C and D just described.

7.5.2.9 The formula for *COCA*, the adjustment term, takes the following form (see Appendix D, D.4):

$$COCA = -(r_C - i)a\sum_{j=1}\left\{\frac{WP(j-1)}{(1+r_C)^j}\right\} \tag{18}$$

where the difference between locked-in asset criteria C and D at time j is an additional margin for solvency $aWP(j-1)$, where a is a constant and $WP(j-1)$ is the premium written in time period $(j-1, j)$.

7.5.2.10 It is straightforward to extend the simple example to more complex situations. Suppose that future blocks of business are written at discrete times $t=0,1,2, \ldots$ etc. Suppose further, that for each block written at time t, the difference between the locked-in asset criteria C and D is an amount equal to $aWP(t)$ at time t, which is released at time $t+1$.

7.5.2.11 If we assume that premiums increase at rate g per unit time period, we find that we can express the locked-in asset adjustment in a particularly simple form (see Appendix D, D.5), namely:

$$\text{Locked-in asset adjustment} = \frac{-(r_C - i)aWP(0)}{(r_C - g)}. \tag{19}$$

7.5.3 *Discounted cash flows or discounted accounting flows?*

7.5.3.1 Rather conveniently for actuaries restricted to external, published information, the notional capital flows projected under the profit test using locked-in asset criterion D are exactly the same as the accounted insurance profit flows of the company (see Appendix D, D.3 for a demonstration of this point).

7.5.3.2 However, care should be taken not to draw the wrong conclusions from this result. All it says is that under this particular definition of the locked-in asset criterion D, the notional capital flows projected under the profit test have the same magnitude as the insurance profit earned in the previous time period. The notional capital flows are still notional cash flows. The result does not imply that a valuation model based on accounted earnings should be used in place of a discounted cash flow model.

7.5.3.3 From an economic perspective, the validity of discounting cash flows to calculate market values rests on a 'no-arbitrage' argument. This is most easily seen if we are valuing certain cash flows. In this case the discount rates are current risk-free interest rates. If market value were different from the discounted cash flow value, then it would be possible for an investor to make an arbitrage profit for no risk. We can extend this argument to an uncertain world. In an uncertain world we need stronger assumptions, such as the spanning of investors' opportunity sets by available investments (see LeRoy, 1989).

7.5.3.4 We suggest that the allocation of cash flows to accounting periods generally has no effect on the economic value of a project or a firm, except in so far as the cash tax liability is concerned. If capital availability restricts the firm's ability to exploit further growth opportunities and capital adequacy is driven by

external perceptions of strength, then one might further argue that the accounting basis influences the value of the firm.

7.5.3.5 Certainly, published accounted results are a source of financial information for external investors, but this does not in itself justify a valuation model based on accounted earnings. There is empirical evidence to support the view that investors do look through to the underlying cash flow economics of a business, when they are in a position to do so (see Ricks, 1982). To a certain degree, the allocation of cash flows to accounting periods is arbitrary and may not reflect underlying economic fundamentals (see Griffiths, 1986).

8. Conclusion

8.1 In this paper, we have drawn on the intuitions provided by option pricing and signalling theories to establish a framework for understanding the effect of financial decision making upon the values of the stakes of the various claimants of an insurer. Although the model described is shown to be consistent with the current appraised value methodology, we believe that option theory provides a more powerful framework for assisting management with decisions than the relatively inert discounted cash flow valuation tool traditionally employed by actuaries when calculating the value of shareholders' interests.

8.2 The distinction between the value of the firm and the value of shareholders' claims on the firm helps to clarify some of the more difficult areas of the appraised value. In particular, the framework sheds new light on the role of investment strategy in an insurance company and the effect of both systematic and non-systematic risk on the operation.

8.3 Our aim is to enhance the contribution that actuaries can make to the non-life insurance industry, and this is the rationale behind the model that we have proposed. In essentially ignoring the issues surrounding the use of management resources and the management of the financial 'supply side' of the company, the appraised value as it is used currently will not, in the authors' opinion, prove to be of long-term value to managers.

8.4 In order to demonstrate our case clearly, it has been necessary to address both the methodology and frequently-cited conclusions of the appraised value literature. Here we believe that our most significant contribution lies in the interpretation that we offer for the locked-in asset adjustment.

8.5 From the analysis of current practice that is presented, the need to identify a richer framework becomes apparent. Although we believe that option theory looks promising as a candidate for this newly perceived role, we recognise the need for more research in this area within the profession.

8.6 We hope that this paper has opened up fertile new areas for future research. The framework that we have put forward can be applied to many industries outside non-life insurance, in particular banking and life assurance. Similarly, there is much research in other fields that can throw light on the problems in non-life insurance. As a starting point, we have included a

comprehensive list of references, many elements of which, we realise, will be unfamiliar to a number of readers. Some of our references to these texts have been quite vague. Usually, this is because we are referring to a major theme presented in the text rather than to a specific page or paragraph.

8.7 Finally, we would like to express our thanks to Alison Thomas, who shaped many of the ideas that we have borrowed from financial economics, and to our employer Commercial Union, who supported us in a variety of ways during the writing of this paper. We are also grateful to our scrutineers—both official and unofficial—for their helpful comments and suggestions, many of which have been incorporated in the final text.

References

AKERLOF, G. (1970). Market for Lemons: Qualitative Uncertainty and the Market Mechanism. *Quarterly Journal of Economics*, **89,** 488.

ALLINGHAM, M. (1991). *Arbitrage: Elements Of Financial Economics*. Macmillan.

ANDERSON, J. C. H. (1959). Gross Premium Calculations and Profit Measurement for Non-Participating Insurance. *Transactions of the Society of Actuaries (USA)*. **XI,** 357.

BLACK, F. (1989). How To Use The Holes in Black-Scholes. *Journal of Applied Corporate Finance*, **1**.

BLACK, F. & SCHOLES, M. (1973). The Pricing of Options and Corporate Liabilities. *Journal of Political Economy*, **81,** 637.

BOGUE, M.C. & ROLL, R.R. (1974). Capital Budgeting of Risky Projects With 'Imperfect' Markets for Physical Capital. *Journal Of Finance*, **May,** 601.

BREALEY, R. A. & MYERS, S. C. (1991). *The Principles of Corporate Finance* (4th Edition). McGraw-Hill.

BREEDEN, D. T. (1989). Intertemporal Portfolio Theory and Asset Pricing. *Finance, The New Palgrave*. Macmillan.

BRENNAN, M. J. & SCHWARTZ, E. S. (1985). Evaluating Natural Resource Investments. *Journal of Business*, **58,** 135.

BRENNAN, M. J. & SCHWARTZ, E. S. (1978). Corporate Income Taxes, Valuation and the Problem of Optimum Capital Structure. *Journal of Business*, **51,** 103.

BURROWS, R. P. & WHITEHEAD, G. H. (1987). The Determination of Life Office Appraisal Values. *J.I.A.* **114,** 411.

COPELAND, T. E. & WESTON, J. F. (1988). *Financial Theory and Corporate Policy*. Addison Wesley.

COX, J. & RUBENSTEIN, M. V. (1985). *Options Markets*. Englewood Cliffs, Prentice Hall.

CUMMINS, J. D. (1990). Asset Pricing Models and Insurance Ratemaking. *ASTIN Bulletin*, **20, No. 2**.

CUMMINS, J. D. (1991). Statistical and Financial Models of Insurance Pricing and The Insurance Firm. *The Journal of Risk and Insurance*.

CUMMINS, J. D. (1988). Capital Structure and Fair Profits in Property-Liability Insurance. *Second International Conference on Insurance Solvency*.

D'ARCY, S. P. & DOHERTY, N. A. (1988). The Financial Theory of Pricing Property-Liability Insurance Contracts. *Huebner Foundation*, **Monograph 15**.

DIXIT, A. (1989). Entry and Exit Decisions Under Uncertainty. *Journal of Political Economy*, **97,** 620.

DOHERTY, N. A. & GARVEN, J. R. (1986). Price Regulation in Property Liability Insurance: A Contingent Claims Approach. *Journal of Finance*, **41,** 1031.

DYBVIG, P. H. & ROSS, S. A. (1989). Arbitrage. *Finance, The New Palgrave*. Macmillan.

FAIRLEY, W. B. (1979). Investment Income and Profit Margins in Property Liability Insurance: Theory and Empirical Results, *Bell Journal of Economics*, **10,** 192.

FISHER, I. (1930). *The Theory of Interest* (reprinted 1965). Augustus M. Kelley.

FRIEDMAN, M. *Oligopoly Theory*.

GALAI, D. & MASULIS, R. W. (1976). The Option Pricing Model and The Risk Factor of Stock. *Journal of Financial Economics*, **3,** 53.

GRIFFITHS, I. (1986). *Creative Accounting — How to Make Your Profits What You Want Them To Be.* Unwin Hyman Ltd.

HAYES, R. H. & GARVIN, D. A. (1982). Managing as if Tomorrow Mattered. *Harvard Business Review*, **50, No. 3,** 70.

HERTZ, D. B. (1964). Risk Analysis in Capital Investment. *Harvard Business Review*, **42, No. 1.**

HUANG, C. & LITZENBERGER, R. (1988). *Foundations for Financial Economics.* North-Holland.

HULL, J. C. (1993). *Options, Futures, and Other Derivative Securities* (2nd Edition). Prentice-Hall International.

JENSEN, M. (1986). Agency Costs of Free Cash Flow, Corporate Finance and Takeovers. *American Economic Review*, **76,** 323.

JENSEN, M. & MECKLING, W. (1976). Theory of the Firm : Managerial Behaviour, Agency Costs and Ownership Structure. *Journal of Financial Economics*, **3,** 305.

KESTER, W. C. (1984). Today's Options for Tomorrow's Growth. *Harvard Business Review*, **No. 2,** 153.

KRAUS, A. & ROSS, S. A. (1982). The Determination of Fair Profits for the Property-Liability Insurance Firm. *Journal of Finance*, **37,** 1015.

LEE, R. E. (1984). A Prophet Of Profits. *J.I.A.S.S*, **28,** 1.

LEROY, S. F. (1989). Present Value. *Finance, The New Palgrave.* Macmillan.

LOWE, S. P. (1981). Discussion of Sturgis, R.W. (1981), Actuarial Valuation of Property-Liability Insurance Companies. *Proceedings of the Casualty Actuarial Society*, **LXIX.**

MARKOWITZ, H. (1959). *Portfolio Selection : Efficient Diversification of Investment.* John Wiley & Sons.

MASON, S. P. & MERTON, R. C. (1985). The Role of Contingent Claims Analysis in Corporate Finance. *Recent Advances in Corporate Finance.* Richard D Irwin, Inc.

MCDONALD, R. & SIEGEL, D. (1985). Investment and The Valuation of Firms When There is an Option to Shut Down. *International Economic Review*, **26, June,** 331.

MCDONALD, R. & SIEGEL, D. (1986). The Value of Waiting to Invest. *Quarterly Journal of Economics*, **101, Nov.,** 707.

MEHTA, S. J. B. (1992). Allowing For Asset, Liability & Business Risk In The Valuation Of A Life Office. *J.I.A.*, **119,** 385.

MERTON, R. C. (1973). Theory of Rational Option Pricing. *Bell Journal of Economics and Management Science*, **4, Spring,** 141.

MERTON, R. C. (1990). *Continuous Time Finance.* Blackwell.

MICCOLIS, R. S. (1987). An Investigation of Methods, Assumptions and Risk Modelling for the Valuation of Property-Casualty Insurance Companies. *Financial Analysis of Insurance Companies.*

MILLER, M. H. (1977). Debt and Taxes. *Journal of Finance*, **32,** 261.

MODIGLIANI, F. & MILLER, M. H. (1963). Corporate Income Taxes and The Cost of Capital: A Correction. *Amercian Economic Review*, **53, June,** 433.

MODIGLIANI, F. & MILLER, M. H. (1958). The Costs of Capital, Corporation Finance, and the Theory of Investment. *Amercian Economic Review*, **48, June,** 261.

MYERS, S. C. (1977). Determinants of Corporate Borrowing. *Journal of Financial Economics*, **5,** 147.

MYERS, S. C. (1984). Finance Theory and Financial Strategy. *Interfaces*, **14, Jan–Feb,** 126; also *Midland Corporate Finance Journal*, **5, No. 1 Spring 1987.**

MYERS, S. C. & COHN, R. A. (1981). A Discounted Cash Flow Approach to Property-Liability Insurance Rate Regulation. *Fair Rate of Return in Property-Liability Insurance.* Kluwer 1987.

PINDYCK, R. (1988). Irreversible Investment, Capacity Choice & The Value of the Firm. *American Economic Review*, **78, Dec,** 969.

RICKS, W. (1982). The Market's Response To The 1974 LIFO Adoptions. *Journal of Accounting Research*, **Autumn.**

RITCHKEN, P. & RABINOWITZ, G. (1988). Capital Budgeting Using Contingent Claims Analysis: A Tutorial. *Advances in Futures & Options Research*, **3,** 119.

ROCK, K. (1986). Why New Issues Are Underpriced. *Journal of Financial Economics.*

ROSS, S. A. (1978). A Simple Approach to the Valuation of Risky Streams. *Journal of Business*, **51, No. 3,** 453.

ROSS, S. A. (1989). Finance. *Finance, The New Palgrave*. Macmillan.

ROTHMAN & DEUTSCH (1982). Discussion of 'Actuarial Vaulation of Property/Casualty Insurance Companies' By Sturgis, R.W. *Proceedings of the Casualty Actuarial Society*, **LXIX**.

RUBENSTEIN, M. (1976). The Valuation of Uncertain Income Streams and The Pricing of Options. *The Bell Journal Of Economics and Management Science*, 7, 407.

RYAN, J. P. & LARNER, K. P. W. (1990). The Valuation of General Insurance Companies. *J.I.A.*, **117,** 597.

SALMON, I. L. & FINE, A. E. M. (1991). Reflections on a Takeover of a United Kingdom Insurer: A Case Study. *J.I.A.*, **118,** 59.

SHARPE, W. F. (1964). Capital Asset Prices : A Theory of Market Equilibrium Under Conditions of Risk. *Journal of Finance*, **19,** 425.

SIEGEL, D. R., SMITH, J. L. & PADDOCK, J. L. (1987). Valuing Offshore Oil Properties with Option Pricing Models. *Midland Corporate Finance Journal*, **5, No. 1, Spring.**

SMART, I. C. (1977). Pricing and Profitability in a Life Office. *J.I.A.*, **104,** 125.

SMITH JR., C. W. (1986). Raising Capital: Theory and Evidence. *Midland Corporate Finance Journal.*

SMITH JR., C. W. (1984). Applications of Option Pricing Analysis. *The Modern Theory of Corporate Finance*. McGraw-Hill Inc.

STURGIS, R. W. (1981). Actuarial Valuation of Property/ Casualty Insurance Companies. *Proceedings of the Casualty Actuarial Society*, **LXVIII**.

TOBIN, J. (1989). Financial Intermediaries. *Finance, The New Palgrave*. Macmillan.

TRIGEORGIS, L. (1988). A Conceptual Options Framework for Capital Budgeting. *Advances in Futures & Options Research*, **3,** 145.

TRIGEORGIS, L. & MASON, S. P. (1987). Valuing Managerial Flexibility. *Midland Corporate Finance Journal*, **5, No. 1, Spring.**

TVERSKY. A. & KAHNEMAN, D. (1986). Rational Choice and the Framing of Decisions. *Journal of Business*, **Oct,** 251.

WHITEHEAD, G. H. (1987). Appraisal Values for Property and Casualty Insurance Companies for Merger or Acquisition. *Casualty Actuarial Society Valuation Issues.*

APPENDIX A

PROFIT TESTING AND THE APPRAISED VALUE MODEL

A.1 *Introduction*

A.1.1 In this Appendix we justify the equation for the value of equity in an insurance firm that was put forward in Section 2 (see equation (2)), using conventional appraised value methodology. We consider a very simple example here. The results are easily generalised. First, we review the actuarial profit test, since this is the key construction in the appraised value model.

A.2 *Anderson's Profit Test*

A.2.1 Anderson (1959) was the first to make a link between the incremental capital flows accruing to the shareholders of an insurance firm and the insurance business written.

A.2.2 The link was made by constructing a profit test of the block of business under consideration, whereby capital required to back the outstanding liability to policyholders is notionally allocated to the block of business over its lifetime.

A.2.3 More precisely, the profit test of a block of business is defined by a bundle of assets and liabilities that changes over the lifetime of the business. At each future date, the liabilities are those created by the sale of the policies that remain outstanding; the assets are those that are locked-in to these outstanding liabilities, in order to provide a given level of confidence that the liabilities can be met without recourse to further capital.

A.2.4 Cash flows specifically associated with the sale of the policies — namely, the sale proceeds, payments extinguishing the firm's liability and associated expenses— stream in and out of the profit test. Notional capital injections and releases flow in and out from a central pool of the firm's capital, in order to maintain the locked-in assets at the desired level over the lifetime of the policies. This desired level is defined by what we shall call a locked-in assets criterion.

A.2.5 The construction of a profit test is shown in Figure A.1, together with an illustration of the pattern of expected notional capital flows over the lifetime of a block of insurance business.

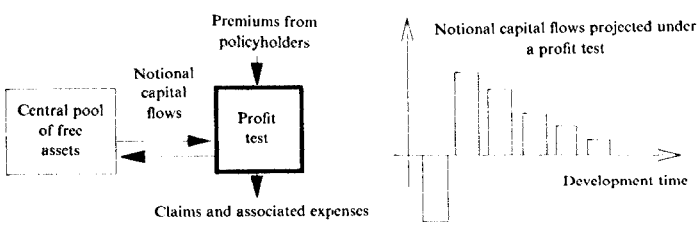


Figure A.1. Profit testing.

A.2.6 We refer to those assets that are not notionally locked-in to the profit test to support outstanding insurance liabilites as free assets. These are therefore a function of the locked-in asset criterion that defines the profit test. Note that the notional capital flows projected under the profit test are notional cash flows whose profile will vary by product and according to the locked-in asset criterion.

A.3 *A Simple Example: Building the Appraised Value from the Profit Test*

A.3.1 Suppose that an all-equity financed firm has a pot of assets and writes just a single block of insurance business. We wish to put a value on the equity in the firm. Following conventional appraised value methodology, we construct a profit test of the block of business using a locked-in assets criterion that we call C, say, and we discount the the notional capital flows projected under the profit test at the return required by shareholders, r_C, say.

A.3.2 In general, the return required by investors on a project is that which compensates them for the riskiness of the future stream of cash flows generated by the project, viewed in the context of their overall investment portfolios. From the investors' perspectives, the risk that is priced is the systematic risk, which cannot be diversified away in their portfolios. This intuition is key and is shared by all well-known asset pricing models in financial economics, such as the single-period CAPM and its multi-period versions the Consumption CAPM (CCAPM) and ICAPM, and APT. The required return is the equilibrium expected rate of return on securities equivalent in risk to the project being valued. It depends primarily on the use of funds—that is the projects in which a firm invests—not the source of funds (although financing can have a second-order effect).

A.3.3 In this instance, the required return r_C, reflects the riskiness of the stream of future notional capital flows projected under the profit test. r_C is therefore a function of the locked-in assets criterion C, defining the profit test, since this impacts the systematic variability of the notional capital flows.

We can express the economic value of the equity in the firm as follows:

$$E = MVF(C) + \mathbf{DCF}(\mathbf{N\check{C}F}(C), r_C) \qquad \text{(A.1)}$$

where the symbols are defined as follows:

$MVF(C)$ is the market value of the free assets under the locked-in assets criterion C,

$\mathbf{DCF}(\mathbf{N\check{C}F}(C), r_C)$ is the discounted cash flow operator that discounts the expected future stream of notional capital flows $\mathbf{N\check{C}F}(C)$ projected in the profit test at the return required by shareholders, r_C.

A.3.4 Equation (A.1) can obviously be generalised to more complex situations in which the value of equity is given by equation (2) in Section 2 (ignoring conventional debt).

A.4 *The Principle of Value Additivity*

A.4.1 The justification for equation (A.1) rests on the 'Principle Of Value Additivity'—that is, the present value of projects A and B combined equals the

present value of *A* plus the present value of *B*. This is probably accepted without question by most actuaries, but, in fact, it is more subtle than it appears and has interesting implications (see Brealey & Myers, 1991). It means that the cash flows associated with any project can be 'unbundled' and valued separately, each discounted at its own required return to put a present 'market' value on it.

A.4.2 An interesting corollary of the Principle Of Value Additivity is that the profit test is a redundant construction for the purpose of calculating value. Instead of allocating capital to a block of business over its lifetime and discounting the composite notional capital flows at a composite risk-adjusted discount rate, the individual policy cash flows can be discounted directly at their own risk-adjusted rates. The process of allocating capital, or assets, to the block of business does not affect value, assuming investment markets are efficient.

A.4.3 Myers & Cohn (1981) recommended such an 'unbundled' discounted cash flow framework for the purpose of rate regulation in non-life insurance.

APPENDIX B

AN INTRODUCTION TO OPTION PRICING THEORY

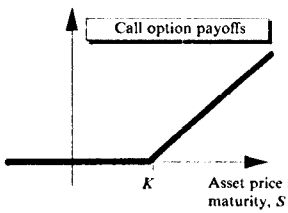
B.1 *Definitions*

B.1.1 An option grants the purchaser the right **but not the obligation** either to buy (here the option is known as a call) or to sell (a put) a pre-specified asset at a pre-determined price (the strike price) on (in the case of a European option) or before (in the case of an American option) a pre-agreed date (the maturity date).

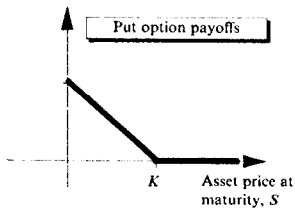
B.1.2 The purchaser of a call will exercise the right to buy the underlying asset at the strike price only if the current traded price of the underlying asset is greater than the strike price. If the current price of the underlying asset is less than the price at which the option allows one to participate, then it is clearly rational not to exercise one's option, but to purchase the asset directly in the market.

B.1.3 As a put provides the purchaser with the right, but not the obligation, to sell the pre-specified asset at the strike price, it is clear that a put will be exercised only if the strike price is above the current market price.

B.1.4 If the price of the underlying asset at maturity is S and the strike price is K, then the payoffs to a call and a put at maturity are as follows:



State of nature	Call option payoffs
$S>K$	$S-K$
$S<K$	0
All	$\max(S-K,0)$



State of nature	Put option payoffs
$S>K$	0
$S<K$	$K-S$
All	$\max(K-S,0)$

Figure B.1. Payoffs at maturity of calls and puts.

B.1.5 An option is referred to as being 'in the money', 'at the money' or 'out of the money' depending on whether $S>K$, $S=K$ or $S<K$, respectively.

B.2 *Put-Call Parity*

B.2.1 It can be demonstrated using simple no-arbitrage arguments that the prices of non-dividend-paying European (a European option may be exercised only on the expiry date of the contract) puts and calls are linked through a relation known as 'put-call parity' (see Hull, 1993):

$$O_C + Ke^{-rT} = S_0 + O_P \tag{B.1}$$

where O_C is the price of the call, O_P is the price of the put, r is the risk-free interest rate (continuously compounded), T is the time to maturity and S_0 is the current price of the (non dividend-paying) underlying asset.

B.2.2 This is easily seen by considering the combinations of payoffs at maturity given above, since:

$$\max(S-K,0) - \max(K-S,0) = S-K. \tag{B.2}$$

B.3 *The Black–Scholes Option Pricing Formula*

B.3.1 By assuming that stock prices follow a continuous time diffusion process, Black & Scholes (1973) provided an exact option pricing valuation formula. The model they generate has several interesting features. In construction, it depends upon the ability of an option holder to mimic, instantaneously, the payoff on an option through a combination of holdings in the underlying asset and the risk-free bond. As the return on an option can be replicated without risk over any instant, the return on that option must be the risk-free rate (otherwise riskless arbitrage could occur). This allows one to value an option in a risk-neutral environment, that is, without reference to investors' subjective beliefs on asset returns. Both of these features may be seen in the Black–Scholes pricing formula, which for a call is given by:

$$O_C = S_0 \mathrm{N}(d_1) - Ke^{-rT}\mathrm{N}(d_2) \tag{B.3}$$

where the symbols are defined as before, plus:

$d_1 = (\ln(S_0/K) + (r + (\sigma^2/2)T))/\sigma\sqrt{T}$

$d_2 = d_1 - \sigma\sqrt{T}$

σ is the standard deviation of the return on the underlying asset (i.e. the volatility)

$\mathrm{N}(\bullet)$ is the cumulative normal distribution function.

B.3.2 Merton (1973) showed that the option payoffs at maturity could be replicated by following a self-financing dynamic portfolio strategy using risk-free bonds (with maturity coinciding with the option exercise date) and shares in the underlying asset. The Black–Scholes formula tells us that the initial portfolio contains $\mathrm{N}(d_1)$ shares in the underlying asset and a nominal amount $K\mathrm{N}(d_2)$ invested in bonds yielding r, with term T.

B.4 *Comparative Statics of the Black–Scholes Formula*

B.4.1 As the replicating portfolio holds only instantaneously, it is instructive to consider the comparative statics of the pricing equation to understand how sensitive the price of the option is to a change in a given variable. Below is a table of the comparative statics that are of greatest interest to us.

Sensitivities of the Black-Scholes Option Formula					
Name and definition		Call option		Put option	
Delta	$\frac{\partial O}{\partial S}$	$N(d_1)$	+	$-N(-d_1)$	-
Vega	$\frac{\partial O}{\partial \sigma}$	$S_0\sqrt{T}\,N'(d_1)$	+	$S_0\sqrt{T}\,N'(d_1)$	+

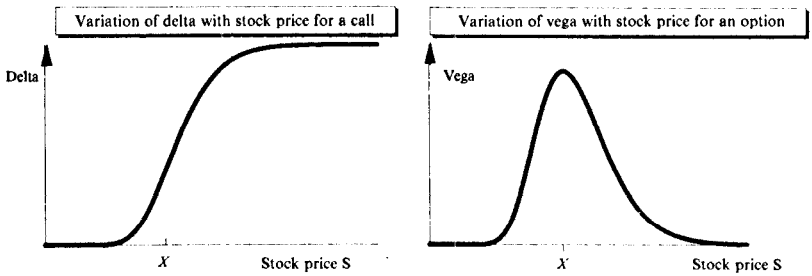


Figure B.2. Variation of Delta and Vega with the Underlying Stock Price.

APPENDIX C

LOCKED IN ASSET ADJUSTMENTS

C.1 *The Definition of the COCA*

C.1.1 In this appendix we derive the expression for the locked-in asset adjustment that we called *COCA* in equation (16), for the simplified appraised value example considered in Section 7 and Appendix A, A.3.

C.1.2 We use the following symbols:

t	time, $t \in \mathbb{N}$. Assume that the block of insurance business is written at $t=0$
$PC(t)$	policy cash flows at time t associated with the profit tested block of business, that is, premiums less claims and associated expenses. Assume $PC(t)=0$ for $t>n$
$MVA(t)$	market value of the firm's assets (i.e. securities) at time t
i	total market investment yield per unit time on the firm's assets
$E(t)$	market value of the equity in the firm at time t
$MVLIA(t,C)$	market value of locked-in assets at time t under the locked-in asset criterion C
$MVF(t,C)$	market value of assets that are not locked in to the profit test to support insurance business under the locked-in asset criterion C
$ACC(t,C)$	market value of accumulated assets within the profit test at time t under the locked-in assets criterion C, allowing for previous notional capital injections/(releases) into/(from) the profit test, as well as policy cash flows into and out of the profit test
$NCF(t,C)$	notional capital flows in/ (out) of the profit test at time t, under the locked-in asset criterion C. Put $\mathbf{N\tilde{C}F}(C,t+1)=\{NCF(j,C)\}^{j\in[t+1,n]}$
r_C	return required by shareholders to compensate them for the riskiness of the notional capital flows $\mathbf{N\tilde{C}F}(C,t+1)$, which we assume is constant $\forall t$ for simplicity

$\mathbf{DCF}(\tilde{\mathbf{X}}(t+1),r,t)$ the discounted cash flow operator $\sum_{j=t+1}^{n} \frac{-E(X(j))}{(1+r)^{j-t}}$.

C.1.3 From the definition of a profit test (see Section 2) we have that:

$$MVF(t,C)=MVA(t)-MVLIA(t,C) \tag{C.1}$$

$$NCF(t,C)=MVLIA(t,C)-ACC(t,C). \tag{C.2}$$

Note that $MVLIA(t,C)$ is calculated prospectively, whereas $ACC(t,C)$ is the accumulation of previous cash flows within the profit test.

C.1.4 Using the Principle of Value Additivity (see Appendix A, A.4), we can express $E(t)$ as follows:

$$E(t)=MVF(t,C)+\mathbf{DCF}(\mathbf{N\tilde{C}F}(C,t+1),r_C,t). \tag{C.3}$$

C.1.5 Now, if we construct a new profit test using the locked-in asset criterion D, we have:

$$MVF(t,D) = MVA(t) - MVLIA(t,D) \tag{C.4}$$

$$NCF(t,D) = MVLIA(t,D) - ACC(t,D). \tag{C.5}$$

Again, using the Principle of Value Additivity and discounting notional capital flows at r_D we have:

$$E(t) = MVF(t,D) + \mathbf{DCF}(\mathbf{N\check{C}F}(D,t+1),r_D,t). \tag{C.6}$$

C.1.6 However, if we use the same risk-adjusted rate r_C to discount the notional capital flows $\mathbf{N\check{C}F}(D,t+1)$, we need a balancing term in equation (C.6) which we call $COCA(t,C,D)$. In other words we have:

$$E(t) = MVF(t,D) + \mathbf{DCF}(\mathbf{N\check{C}F}(D,t+1),r_C,t) + COCA(t,C,D) \tag{C.7}$$

C.1.7 The proposition we seek to prove is that:

$$COCA(t,C,D) =$$

$$-(r_C - i)\sum_{j=t+1}^{n}\left\{\frac{MVLIA(j-1,C) - MVLIA(j-1,D)}{(1+r_C)^{j-t}}\right\} \qquad \forall t.$$

C.2 *Proof*

C.2.1 Putting $t = n-1$ and eliminating $MVF(t,C)$ and $MVA(t)$ from equation (C.3), using equations (C.1) and (C.4) gives:

$$\begin{aligned} E(n-1) &= MVF(n-1,D) + MVLIA(n-1,D) - MVLIA(n-1,C) \\ &\quad + \mathbf{DCF}(\mathbf{N\check{C}F}(C,n),r_C,n-1) \\ &= MVF(n-1,D) - \frac{NCF(n,C)}{1+r_C} \\ &\quad - (r_C - i)\left\{\frac{MVLIA(n-1,C) - MVLIA(n-1,D)}{1+r_C}\right\} \\ &\quad - \frac{(1+i)}{(1+r_C)}\{MVLIA(n-1,C) - MVLIA(n-1,D)\}. \end{aligned} \tag{C.8}$$

C.2.2 By definition, we know that:

$$MVLIA(t,C) = \sum_{j=0}^{t}(PC(j) + NCF(j,C))(1+i)^{t-j}$$

and similarly for the locked-in asset criterion D. Therefore:

$$NCF(t,D)-NCF(t,C)=MVLIA(t,D)-MVLIA(t,C)$$
$$-(1+i)(MVLIA(t-1,D)-MVLIA(t-1,C)). \quad \text{(C.9)}$$

C.2.3 Put $t=n$. Since $MVLIA(n,C)=MVLIA(n,D)=0$, we have:

$$NCF(n,D)-NCF(n,C)=(1+i)(MVLIA(n-1,C)-MVLIA(n-1,\mathrm{D})). \quad \text{(C.10)}$$

C.2.4 We can now substitute this expression into equation (C.8) to give:

$$E(n-1)=MVF(n-1,D)+\mathbf{DCF}(\mathbf{N\check{C}F}(D,n),r_C,n-1)+COCA(n-1,C,D). \quad \text{(C.11)}$$

C.2.5 We have therefore proved the result for $t=n-1$. We can prove the general result $\forall t$ by induction by assuming that it holds for t and proving it for $t-1$. First, we establish some preliminary results.

C.2.6 For any locked-in asset criterion D, we have:

$$MVF(t,D)+\mathbf{DCF}(\mathbf{N\check{C}F}(D,t+1),r_C,t)=MVA(0)(1+i)^t$$
$$-\sum_{j=0}^{t}NCF(j,D)(1+i)^{t-j}-\sum_{j=t+1}^{n}\frac{NCF(j,D)}{(1+r_C)^{j-t}}. \quad \text{(C.12)}$$

C.2.7 We can write the right hand side of equation (C.12) as follows:

$$(1+i)\left\{MVA(0)(1+i)^{t-1}-\sum_{j=0}^{t-1}NCF(t,D)(1+i)^{t-j-1}-\sum_{j=t}^{n}\frac{NCF(j,D)}{(1+r_C)^{j-t+1}}\right\}$$
$$-NCF(t,D)+NCF(t,D)\frac{(1+i)}{(1+r_C)}-(r_C-i)\sum_{j=t+1}^{n}\frac{NCF(j,D)}{(1+r_C)^{j-t+1}}.$$

Therefore equation (C.12) becomes:

$$MVF(t,D)+\mathbf{DCF}(\mathbf{N\check{C}F}(D,t+1),r_C,t)=-(r_C-i)\sum_{j=t}^{n}\frac{NCF(j,D)}{(1+r_C)^{j-t+1}}$$
$$+(1+i)\{MVF(t-1,D)+\mathbf{DCF}(\mathbf{N\check{C}F}(D,t),r_C,t-1)\}. \quad \text{(C.13)}$$

C.2.8 In particular, when $D\equiv C$, equation (C.13) gives us:

$$E(t)=(1+i)E(t-1)-(r_C-i)\sum_{j=t}^{n}\frac{NCF(j,C)}{(1+r_C)^{j-t+1}}. \quad \text{(C.14)}$$

C.2.9 Now we return to our inductive argument. Suppose that:

$$E(t) = MVF(t,D) + \mathbf{DCF}(\mathbf{N\check{C}F}(D,t+1),r_C,t) + COCA(t,C,D). \quad \text{(C.15)}$$

Substituting the left hand terms of equations (C.13) and (C.14) into equation (C.15) gives:

$$(1+i)E(t-1) = (1+i)\{MVF(t-1,D) + \mathbf{DCF}(\mathbf{N\check{C}F}(D,t),r_C,t-1)\}$$
$$+ COCA(t,C,D) - (r_C - i)\sum_{j=t}^{n} \frac{(NCF(j,D) - NCF(j,C))}{(1+r_C)^{j-t+1}}. \quad \text{(C.16)}$$

C.2.10 But from equation (C.9) we have:

$$-(r_C - i)\sum_{j=t}^{n} \frac{(NCF(j,D) - NCF(j,C))}{(1+r_C)^{j-t+1}} = -COCA(t,C,D)$$
$$+ (1+i)COCA(t-1,C,D). \quad \text{(C.17)}$$

We now substitute the left hand side of equation (C.17) into equation (C.16) to give:

$$(1+i)E(t-1) = (1+i)[MVF(t-1,D) + \mathbf{DCF}(\mathbf{N\check{C}F}(D,t),r_C,t-1)]$$
$$+ COCA(t,C,D) - COCA(t,C,D) + (1+i)COCA(t-1,C,D).$$

C.2.11 This gives us:

$$E(t-1) = MVF(t-1,D) + \mathbf{DCF}(\mathbf{N\check{C}F}(D,t),r_C,t-1) + COCA(t-1,C,D). \quad \text{(C.18)}$$

Q.E.D.

APPENDIX D

USING REQUIRED ACCOUNTING PROVISIONS TO DEFINE AN ACTUARIAL PROFIT TEST

D.1 Overview

D.1.1 This appendix considers the practical detail of an appraised value calculation when we use a locked-in asset criterion (see Appendix A, A.2) that is based on required accounting provisions. We consider the simple example that was introduced in Section 7 and Appendix A, A.3.

D.1.2 We define the locked-in asset criteria C and D as follows:

- D the locked-in assets are equal to accounted insurance funds (that is, technical insurance provisions), and
- C the locked-in assets are the same as for criterion D, plus a fixed fraction a of written premium in the previous time period, for a period T.

D.1.3 We use the same symbols as Appendix C, plus the following:

$P(t)$	premium received at time t
$PR(t)$	premiums receivable at time t
$UPR(t)$	unearned premium reserve (gross of DACs) at time t
$WP(t)$	premium written during $(t,t+1)$
$EP(t)$	earned premium during $(t,t+1)$
$CM(t)$	claims paid at time t
$OS(t)$	outstanding claims at time t
$IC(t)$	claims incurred during $(t,t+1)$.

D.1.4 First, using these definitions of C and D, we interpret the three elements of the value of equity, $E(t)$, that we derived in Appendix C (see equation (C.7)), namely:

$$E(t) = MVF(t,D) + \mathbf{DCF}(\mathbf{N\check{C}F}(D,t+1), r_C, t) + COCA(t,C,D). \qquad \text{(D.1)}$$

D.1.5 The calculation of $E(t)$ uses the risk-adjusted rate r_C, which is the return required to compensate shareholders for the riskiness of the cash flow stream $\mathbf{N\check{C}F}(C,t+1)$. In practice, r_C is usually based on observed market returns on equity for quoted non-life insurers over a long time period and the fraction a of written premium reflects an acceptable 'normal' solvency ratio.

D.1.6 At the end of this appendix, in Section D.5, we consider how the simple example can be extended to more complex examples.

D.2 *The Market Value of Free Assets*

D.2.1 Using equation (C.4) from Appendix C, we get:

$$MVF(t,D) = MVA(t) - MVLIA(t,D). \qquad \text{(D.2)}$$

D.2.2 In other words, $MVF(t,D)$ is equal to accounted shareholders' funds, with assets adjusted to market value from their book values. Premiums receivable, taken at face value and assumed to be zero yielding, are considered as part of the locked-in assets $MVLIA(t,D)$.

D.3 *The Discounted Value of Notional Capital Flows*

D.3.1 Since r_C does not reflect the return required by investors to compensate for the riskiness of cash flows $\mathbf{N\check{C}F}(D,t+1)$, the term $\mathbf{DCF}(\mathbf{N\check{C}F}(D,t+1),r_C,t)$ does not have any economic meaning in a market context. We are, therefore, primarily interested in the nature of the notional cash flows $\mathbf{N\check{C}F}(D,t+1)$ in this section.

D.3.2 From the definition of $MVLIA(t,D)$ we have:

$$MVLIA(t,D)(1+i)-iPR(t)+NCF(t+1,D)+PC(t+1) \\ +(PR(t+1)-PR(t))=MVLIA(t+1,D). \quad \text{(D.3)}$$

$\forall t$, equation (D.3) gives us:

$$NCF(t+1,D)=-[(MVLIA(t,D)-PR(t))i+PC(t+1) \\ -(MVLIA(t+1,D)-MVLIA(t,D))+(PR(t+1)-PR(t))]. \quad \text{(D.4)}$$

D.3.3 This expression for the cash flows $NCF(t+1,D)$ at $t+1$ is the same as the insurance profit generated by the block of business during the interval $(t,t+1)$, with reversed sign (because $NCF(t+1,D)$ represents a cash flow into the profit test). The term $(MVLIA(t,D)-PR(t))i$ is the investment return on the acccounted insurance funds during $(t,t+1)$ and the term $PC(t)-(MVLIA(t+1,D)-MVLIA(t,D))+(PR(t+1)-PR(t))$ is the underwriting profit during $(t,t+1)$.

D.3.4 The equivalence of the right hand side of equation (D.4) to the insurance profit earned in $(t,t+1)$ may not be immediately obvious to the reader. We therefore demonstrate it for the separate premium and claim components of the underwriting result (each time ignoring all other elements), at which stage the result should become clear.

D.3.5.1 *The premium component of equation (D.4)*

D.3.5.1.1 For premiums, the unearned premium reserve is all that constitutes $MVLIA(t,D)$ (assuming there is no additional amount for unexpired risks). Therefore, ignoring all elements but premium, we can write:

$$MVLIA(t,D)=UPR(t). \quad \text{(D.5)}$$

The relevant policy cash flow $PC(t)$ is just the premium actually received at time t, therefore:

$$PC(t)=P(t). \quad \text{(D.6)}$$

D.3.5.1.2 From equations (D.5) and (D.6), including the premiums receivable from equation (D.4) in this section of the analysis, we have:

$$PC(t+1)-(MVLIA(t+1,D)-MVLIA(t,D))+(PR(t+1)-PR(t))$$
$$=P(t+1)-[UPR(t+1)-PR(t+1)-UPR(t)+PR(t)]$$
$$=[P(t+1)+(PR(t+1)-PR(t))]-[UPR(t+1)-UPR(t)]$$
$$=WP(t)-[UPR(t+1)-UPR(t)]$$
$$=EP(t). \qquad \text{(D.7)}$$

D.3.5.2 *The claim component of equation (D.4)*

D.3.5.2.1 Ignoring everything but claims in equation (D.4), $MVLIA(t,D)$ is the accounted provision for outstanding claims incurred in respect of the profit-tested block of business. Therefore:

$$PC(t+1)-(MVLIA(t+1,D)-MVLIA(t,D))=C(t+1)-[OS(t+1)-OS(t)]$$
$$=IC(t). \qquad \text{(D.8)}$$

D.4 *The Locked-In Asset Adjustment COCA(t,C,D)*

D.4.1 In Appendix C, we established that the $COCA$ term is given by:

$$COCA(t,C,D)=-(r_C-i)\sum_{j=t+1}^{n}\left\{\frac{MVLIA(j-1,C)-MVLIA(j-1,D)}{(1+r_C)^{j-t}}\right\}. \qquad \text{(D.9)}$$

D.4.2 In this case, we know that for all j such that $t+1 \leqslant j \leqslant t+T$:

$$MVLIA(j-1,C)-MVLIA(j-1,D)=aWP(j-1). \qquad \text{(D.10)}$$

D.4.3 Therefore, we can write the $COCA$ term as:

$$COCA(t,C,D)=-(r_C-i)a\sum_{j=t+1}^{t+T}\left\{\frac{WP(j-1)}{(1+r_C)^{j-t}}\right\}. \qquad \text{(D.11)}$$

D.5 *Extending the Simple Example*

D.5.1 In this final section, we consider how the simple example that we have considered can be extended to more complex, realistic cases. We assume that the goodwill component of the full appraised value calculation represents the value of all future written business.

D.5.2 Consider equation (D.11) in the case where premium is only written during one year commencing at time s, and where $T=1$. Suppose further that the difference between the locked-in asset criteria C and D is an amount equal to $aWP(s)$ at time s, which is released at time $s+1$, where a is a constant. Then we have:

$$COCA(s,C,D) = -(r_C - i)a\left\{\frac{WP(s)}{(1 + r_C)}\right\}$$

$$COCA(s + i,C,D) = 0 \; \forall i > 0. \tag{D.12}$$

This is precisely a one-year profit test with premium being underwritten for the first year of the profit test and with a fraction a of premium injected into the profit test during that one year.

D.5.3 The company can be considered as a series of past and future one-year profit tests of the type defined in Section D.5.2. The overall $COCA(t,C,D)$ is given by:

$$COCA(t,C,D) = \sum_{j=-\infty}^{j=\infty} COCA_j(t,C,D) \tag{D.13}$$

where the j subscripts on the right side refer to the j^{th} one-year cohort of business.

D.5.4 Equation (D.12) implies that $COCA_j(t,C,D) = 0$ for all past (before time t) years' business.

For future years' business, the same equation gives the value of $COCA_j(t,C,D)$ at the inception time of that year. Adjusting for the time value of money we can rewrite the expression for the $COCA(t,C,D)$ in equation (D.13) as:

$$COCA(t,C,D) = -(r_C - i)a\sum_{r=t}^{\infty}\left\{\frac{WP(r)}{(1 + r_C)^{(r+1)}}\right\}. \tag{D.14}$$

D.5.5 Suppose that the written premium increases at the constant rate g per year. Using equation (D.14) we can write:

$$COCA(t,C,D) = \frac{-(r_C - i)aWP(t)}{(1 + r_C)}\sum_{r=t}^{\infty}\left\{\frac{(1 + g)}{(1 + r_C)}\right\}^r. \tag{D.15}$$

D.5.6 Setting $t = 0$ in equation (D.14) we can rearrange the expression for $COCA(0,C,D)$ as follows:

$$COCA(0,C,D) = \frac{-(r_C - i)aWP(0)}{(1 + r_C)}\left\{\frac{1}{1 - \left\{\frac{1 + g}{1 + r_C}\right\}}\right\}$$

$$= \frac{-(r_C - i)aWP(0)}{(1 + r_C)}\left\{\frac{1 + r_C}{r_C - g}\right\}$$

$$= \frac{-(r_C - i)aWP(0)}{(r_C - g)}. \tag{D.16}$$

D.5.7 This simple expression is the locked-in asset adjustment for the full appraised value in this more complex example. It is sometimes called the 'cost of capital' adjustment.

ABSTRACT OF THE DISCUSSION

Mr M. W. Lomax (introducing the paper): In 1959 an American actuary called James Anderson was the first actuary to make the connection between shareholder value and operational decisions in an insurance company. This was achieved by constructing what we now call a profit test. In other words, rather than considering the individual policy cash flows associated with a block of insurance business, the notational capital flows accruing to shareholders are considered instead.

At about the same time as Anderson was devising the profit test, a golden era in financial economics was just beginning. From the mid-1950s to the late 1970s this era flourished. During that time, modern portfolio theory, the capital asset pricing model and option pricing theory were first discovered and then refined by others.

By the early 1980s, quite independent of the strides being made in financial economics, many actuaries in both the U.S.A. and the U.K. had realised that Anderson's profit test could be used as the building block for a valuation model of shareholders' equity in the firm. Indeed, this is the accepted methodology today for calculating shareholders' interest in an insurance company, for example in a change of control situation.

The logical extension of the appraised value model is this: if appraised values are a good way to calculate the value of shareholders' equity in a firm, and we suppose that managers act in shareholders' best interests, then is the appraised value a good decision framework for managers within a firm?

In a non-life context, we suggest that the answer is no, and there are two reasons for this. First, we argue that the appraised value misallocates value, recognising it when it is written rather than when it is created. Secondly, the appraised value does not explicitly identify the inter-relationship between policyholders' and shareholders' claims on the firm. This inter-relationship can become very significant, particularly for weakly-capitalised companies.

So we went back to the drawing board, and we asked ourselves the question: what makes the difference between a good management decision and a bad management decision? We turned to financial economics for the answer, and the framework that resulted from our endeavours has two key features. First, we make a distinction between the value of 'assets in place' in a firm and the value of future growth opportunities. Secondly, we make a distinction between the value of the firm and the value of investors' claims on the firm, including policyholders' claims. We believe that this throws useful light on key questions in non-life valuation, such as the impact of risk and the impact of limited capital resources.

Finally, I want to comment on the practical interpretation of the framework that we put forward. We do not describe how one calculates the change in value of future growth opportunities, or indeed the value of an option on that change. We make no apologies for this. The framework that we describe is not intended as a number crunching framework; it is meant as a conceptual framework. If management decisions could be reduced to numbers, there would be no such thing as a positive or a negative NPV project. Indeed, the ability to identify and exploit strategic opportunities is what separates good managers from bad.

We hope that the approach that we put forward starts to bridge the gap between the actuarial world and the management world. Ultimately this should lead to better management decisions, since the potential pitfalls of existing decision rules will be appreciated in advance, rather than after the fact.

Mr P. G. Duffy (opening the discussion): Actuarial involvement in non-life insurance in the U.K. is of relatively recent origin compared to life assurance. In non-life insurance firms that employ actuaries, claim reserving and, to a lesser extent, product pricing and reinsurance, are the principal areas of involvement of those actuaries. Although many non-life firms use consulting actuaries for a variety of purposes, including valuation, merger and takeover activities, and a number of actuaries are in the top echelon of non-life executive management, it is undeniable that the operational, financial and executive management of non-life firms is largely in the hands

of the underwriting and accountancy professions. The ethos permeating the operational and financial decision making in non-life firms is heavily influenced by an underwriting and accountancy perspective. Witness the existence of the underwriting cycle and present Companies Act reporting requirements.

The authors certainly want actuaries to become more involved in non-life decision making. With this aspiration in mind, § 1.3.4 contains the main aim of the paper, the identification of a robust financial decision framework. Two points come to mind:

(1) the decision framework developed in the paper, which is an enhanced appraised value model, can be applied to both operational and financial decision-making, and
(2) the word 'actuarial' could be profitably inserted into the aim of the paper, since the decision framework developed by the authors is dominated by an actuarial perspective, notwithstanding the influence of financial economic theory.

Let us consider further the aims and aspirations of the paper, while contrasting the actuarial involvement in life and non-life firms. The role of actuaries in executive management and all types of decision making in life assurance firms is well defined. Many papers have been written with the generic title of 'The Actuarial Management of a Life Assurance Firm'. Such papers have expounded the actuarial methodology and perspective and have found favour with the owners and management of life assurance firms. The same has been rarely true of actuarial involvement in non-life firms heretofore.

I suggest that this paper could be generically sub-titled 'The Actuarial Management of a Non-Life Firm', since it attempts to lay out, in a very incisive and challenging manner, an actuarial decision-making framework which seeks acceptance from fellow actuaries and, more importantly, from the owners and management of non-life firms. While we are here, principally, to debate the actuarial merits of this paper, we should also bear in mind the perspectives of our hard-nosed underwriting manager, our corporate financial planner, together with our more sceptical executive management and institutional shareholders, who are all interested in the relevance and applicability of this paper to their particular duties. I, therefore, feel that this paper should be judged by the criterion: "to what extent has this paper expounded an actuarial methodology for the management of a non-life firm that is acceptable for owners and management alike?"

The authors' starting point, in Section 2, is a critique of the contribution that the existing appraised value methodology makes to the financial decision-making process within a non-life firm. Although financial economic theory argues that managers should act to maximise the value of the firm, I feel that the decision-making process proposed by the authors is very much aligned with the interests of the owners, who are assumed to be shareholders, each of whom holds a well-diversified portfolio of assets as defined by financial economic theory, and whose behaviour is governed by that theory. It is questionable whether the shareholders, let alone the management, of the major U.K. composites and other non-life firms follow the percepts of financial economic theory. Daykin & Hey's paper 'Managing Uncertainty in a General Insurance Company' (*J.I.A.* **117**, 173) alludes to the shortcomings of CAPM models in § 15.23.

The authors state that the existing appraised value methodology is a discounted cash flow framework of little use in its present form. In particular, the authors argue that the capital allocation calculations contained in the existing appraised value framework do not alter the value of the shareholders' interest in a non-life firm at all, and hence the profit test is a redundant construction for calculating value.

The irrelevancy of capital allocation is, at first sight, a very disquieting notion, since it depends, as Appendix A.4.2 reminds us, on the critical assumption of the efficiency of investment markets, which assumption appears to be called into question in § 15.34 of the Daykin & Hey paper. It is, therefore, crucial to bear in mind that the appraised value model/decision making framework to be constructed in this paper is one that can always quantify the real changes in the value of the interests of the type of shareholder described above.

I wonder, if a statutory valuation basis was introduced in the U.K. for non-life firms along similar lines to the life assurance industry, and with an attendant control cycle and methodology for the

distribution of surplus in the technical reserves, would capital allocation be then so irrelevant to the shareholders?

As a first step in improving the decision-making framework, an explicit distinction is made between the value of the firm and the value of policyholders' and shareholders' claims on the firm. Myers's concept of future growth opportunities, V_{GO}, is then introduced in Section 3, and used to highlight the weakness of using a single underwriting year of business in the actuarial profit test, namely, the lack of recognition of the dependencies described in §2.3.2. The implication of V_{GO} is that only those valuation elements which depend on discretionary management action are included in V_{GO}, and the net present value results that follow from a profit test should include value as it is created, and not when it emerges. This idea of accelerating the recognition of certain cash flows is an interesting one, since the authors' revised profit test methodology implies that all possible future cash flows, including future renewals, that could flow from a block of business without recourse to further management action, should be included.

We can, therefore, see that the traditional actuarial concept of goodwill has a narrower meaning in the V_{GO} framework. We are still left, however, with the task of calculating the value of V_{GO} and its much more uncertain cash flows. The difficulties of valuing V_{GO} are alluded to in §7.2.3.4, but I would have liked the authors to expand on the calculation of V_{GO}, and of ΔV_{GO}, and to give some examples. It should be pointed out that the Daykin & Hey paper, in §15.33, appeared to question the helpfulness of financial economic theory to illuminate management decisions on the future development of non-life firms.

Section 4 deals with the inter-relationship of different investors' claims on a firm's assets, and asserts that liabilities to policyholders and shareholders have option-like payoffs. If this result from option pricing theory is applicable to shareholders in a non-life firm, it implies that the value of their equity increases as the volatility of the firm increases. One way of increasing volatility is by choosing a riskier investment strategy, which may benefit shareholders at the expense of policyholders.

I feel that there is an issue of great professional importance here, namely, whose side should the actuary be on: the policyholder or the shareholder? I think the authors are, in the main, on the side of the shareholders. If this paper can, indeed, be sub-titled 'The Actuarial Management of a Non-Life Firm', and if non-life actuaries do assume similar decision-making positions as their life assurance colleagues, then supervisory authorities such as the DTI may take more than a passing interest in the duties of an actuary in a non-life firm, particularly if a statutory role is given to them.

Section 4.6 yields the interesting result that a project with a positive NPV can reduce the value of equity, while certain negative NPV projects can increase the value of a shareholder's interest. What is being implied is that it is not enough to evaluate a project by considering merely the NPV result of a conventional discounted cash flow calculation. The change in the value of V_{GO}, together with the change in the value of the policyholder's notational put option, must be included. The link between option pricing theory and discounted cash flow calculations in project appraisal is, therefore, clearly asserted in this paper. The key questions are: "does this link hold in reality in a non-life environment?" and "how does one go about measuring both O_P and ΔO_P?" It would have been helpful to have seen a practical example of a positive NPV project reducing the value of shareholders' equity, if only to convince non-actuarial decision makers of the veracity of the authors' assertion.

The reasons adduced in Section 5 to explain how managers do not follow higher risk strategies are related to the perceived scarcity of capital and a desire to maintain corporate control. I have difficulties accepting that managers avoid increasing volatility just to maintain positive signals to shareholders. I think that managers are simply responding to a real requirement of owners of non-life firms, which is for non-volatile returns.

The underwriting cycle, which has contributed significantly to the volatility of returns to shareholders in the U.K., is used to define the length of the profit test in Section 6.2.1. While it is important to recognise the dependencies between each generation of business, it appears as though the authors are accepting the status quo of the underwriting cycle in the non-life market place. I think that they may be underestimating the power of their decision-making framework to dampen down the effects of the underwriting cycle, and hence smooth the returns of shareholders.

In this paper and in the papers of Ryan & Larner (*J.I.A.* **117,** 597) and Daykin & Hey (*J.I.A.* **117,** 173) there is the capacity to measure the returns on individual underwriting and accident year blocks of business. This paper also serves as a very useful dynamic solvency measurement tool, since it can monitor the capital and management resource consumption of non-life firms over a period of time. If the shareholders and the non-life market could see more clearly the returns accruing to, and the capital requirements of, their various projects on an inception month or accident year basis, and not on a trading year basis where the returns and capital requirements of several projects are bundled together, would the decision making alter so that pricing was done on a non-trading year basis, with the resultant damping down of both price movements and volatility of shareholders' returns? I feel that this paper contributes significantly towards enabling decision makers to recognise the emergence of positive value and profit more clearly and earlier than heretofore.

Section 7.2 is very important, as it highlights the problems with the discounted cash flow framework and application. A very lucid explanation of the inter-relationship between cash flow streams and risk-adjusted discount rates is given, in which the contribution of financial economic theory is clearly essential to a fuller understanding of risk.

The remainder of the paper deals with the value of locked-in assets, and the critical point is made in §7.5.2.5 that, if the locked-in asset criterion is changed from C to D, then the risk discount rate must also change from r_C to r_D, but, more crucially, the value of the shareholders' equity does not change, and so the adjustments of equations 17 and 19 are simply balancing items that maintain equity equilibrium. This would appear to make redundant the arguments of Sturgis and Ryan & Larner in Section 7.4.

Let us now consider to what extent this paper has met the judgement critierion suggested at the beginning of these remarks. If actuaries are to assume greater decision-making roles in non-life firms, clearly they have to persuade the existing management of the usefulness of their actuarial tools and the validity of the actuarial perspective. The enhanced discounted cash flow framework or appraised value model developed in this paper is one of these tools and an important building block of 'The Actuarial Management of a Non-Life Firm'.

Mr S. Lowe (a visitor): I am a visitor from the U.S.A. Overall, the paper is an excellent contribution to actuarial literature, and I hope that it gets read on both sides of the Atlantic. The paper seeks to merge modern financial theory and related economic principles with actuarial science, and I agree with the authors that this needs to be done, and that it can be done to the benefit of our clients and our employers.

In the U.S.A., the use of shareholder value concepts as a management tool for all businesses is gaining ground very rapidly, making its way into the popular business press. It is time for actuaries to join in those discussions and attempt to apply these tools in ways such as are presented in this paper. As a practicising actuary, I have used value added, based on profit testing, in several non-life insurer strategy studies. It is a concise way of expressing the costs and benefits of alternative strategies. In my experience, it is a powerful tool when used correctly, but is very susceptible to misuse by naive actuaries. I agree with the authors that a multi-year time horizon is essential to getting the right result and to getting a meaningful decision to flow from the analysis. We also need to recognise, in any multi-year model, the economic fact that in the long-term market equilibrium the returns could be just at the hurdle rate, producing no economic value to the firm.

I also agree with the authors that the first step in building assumptions must be to articulate the firm's competitive advantage: what are the sources of competitive advantage; how significant are they; and how sustainable are they? Too many actuaries view appraisals as extrapolations of past costs and volumes of businesses. Sometimes this leads to economic nonsense.

The authors seek to express the value of the firm in terms of option pricing theory—in essence, investors have the option of putting the firm to the policyholders if the liabilities exceed the resources of the firm. An interesting aside is that this same approach was taken by the American Academy of Actuaries Task Force on Risk Based Capital. In evaluating each type of risk: market, default of investments, underwriting, etc., we recommended that the risk-based capital charges should not be

based on simple confidence levels, but rather on the expected cost of the resulting deficit from the policyholders' perspective.

Where I think that the authors have it wrong is on the issue of the cost of capital adjustment. I agree with them that this has a long history of controversy; I believe the problem is one of poor articulation, not of faulty reasoning. The cost of capital adjustment is not, in my view, a downward adjustment to the value of assets; it is often characterised that way in appraisals and in the literature, but that is not what is taking place. Instead, it is an upward adjustment to the value—that is cost—of the liabilities, reflecting the need to tie up investor funds in the firm to support those liabilities.

The correct cash flow to be concerned with is the shareholders' cash flow, reflecting his or her investment into the firm and his or her returns out of the firm. I draw the distinction between internal and external cash flows here. The external cash flow is best measured by capital movement and earning patterns.

Mr A. E. M. Fine: I think back to the work of Sidney Benjamin, and regret that none of his papers is listed in the references. I know that he would have found this paper fascinating and stimulating, particularly regarding the dynamics of the appraised value and its use as a management tool, even if he might not have been in agreement with all of the conclusions. Benjamin was a strong supporter of locking in in appraised valuations. In his paper, "Profit and Other Financial Concepts in Insurance" (*J.I.A.* **103,** 233), Benjamin recognised that, while the problems—and indeed language—of non-life insurance are different to those of life insurance, the basic financial concepts are the same.

My own work is mainly in the life insurance field, and I went through this paper with the application to life insurance firmly in mind. The concepts in the paper are challenging, and to some extent new to me; but should be of applicability to life as well as non-life insurance.

In §2.2.3 there are four statements of shortcomings regarding appraisal methodology. These statements apply, or indeed originate from life appraisal values. Therefore, if there is any valid criticism of them, this criticism could apply equally to life appraisals.

In relation to the so-called NPV rule, in practice there may be few genuinely independent investment opportunities for an insurance company. In the life context, new business and in-force are certainly not independent. What would the authors consider to be a project for life business; a new distribution channel, perhaps? Also, might a corresponding phenomenon in life insurance to the non-life cycle be the bonus smoothing cycle?

The option pricing framework is interesting. Paragraph 4.2.5, for instance, analyses the change in interest for a change in the year end asset values and a given B. For a non-life company, surely B varies, probably by more than asset values for many companies? This suggests that one would have to integrate the expressions over the distribution of B. In terms of expected value, this may give a rather different picture. Indeed, it appears to create an incentive to mismatch. In the life context, it will be interesting to examine the effect of with profits. This could suggest a sharing of payoffs when V is in excess of B. The applicability or otherwise to mutual life companies is worthy of consideration. Perhaps here, instead of shareholders' and policyholders' values, we should be considering the estate and policyholders.

Section 7.3, which looks at the appraised value as a management tool, is particularly important, and the three items listed in §7.3.1.4, including the impact of the need for future additional capital and management resources, are extremely important. I certainly attempt to reflect these sort of items in the appraisal value process, either quantitatively or qualitatively. What Section 7.3 does omit is the valuable information which can be extracted from an analysis of change in appraised value from one year to the next. I find that management consider this the most important and useful part of the appraised value process.

I finally turn to the issue of locking in. The authors say that there are two actuarial arguments for locking in, which they subsequently demolish. These arguments are the effects of investment strategy and the cost of exposing assets to the risk of losses from insurance. As far as I am aware, these are not arguments used in life assurance appraisal values. The effect of investment strategy is accounted for in projected cash flows and the risk of loss is dealt with in the reserving basis. An appraised value

is no more than a projection of future distributable earnings under certain assumptions which are then discounted. Distributable earnings arising allow for establishing required reserves and solvency margins. Locked-in assets simply reflect the need for this solvency margin. The appropriate discount rate to use is a matter for debate, and indeed a matter for negotiation in a sale and purchase. The discount rate, in general, reflects the underlying return on investments, risk and lack of marketability—a point missing from the paper. Certainly in a willing buyer/willing seller situation, we have seen that the discount rate significantly exceeds the rate that can be earned on the underlying investments.

There are two controversial conclusions in the paper. First, the suggestion that adjustments on the grounds of distributability of earnings are unwarranted; secondly, that cash flows should be discounted ignoring accounting conventions or requirements. In my view, these statements do not correspond with the market place, as I understand it, or the requirements of my clients. I shall continue to lock in (but with an open mind on the subject).

Mr R. S. Clarkson, F.F.A.: I do not propose to repeat my criticisms of what I see as a Trojan Horse methodology of financial economics, except to ask three specific questions which are relevant to the paper:

(1) Why do the authors fail to point out that the central assumption of the Black-Scholes model—namely that, as stated in §B.3.1, an option can be replicated without risk over any instant—broke down quite spectacularly on 19 October 1987, when many financial institutions which have been sold the concept of portfolio insurance were, nevertheless, decimated by the 508 point fall on Wall Street that day?

(2) Why do the authors not point out that the main investment management implication of the Modigliani/Miller world, namely the dividends irrelevance proposition, is not only at odds with nearly all the U.K. literature on practical investment management, but it also at odds with many classic U.S. expositions on the subject?

(3) Do the authors seriously suggest, as seems to be the case from various statements throughout the paper, that their MPT world also includes the NPT assumption that managers always have access to unlimited amounts of capital at the risk-free rate of interest? This assumption, which in plain English is that there are always philanthropic bankers who will lend you unlimited amounts at a risk-free rate of interest, regardless of the financial health of your company, suggests to me another interpretation of the initials MM—Mickey Mouse, a fantasy world of financial make believe.

The authors, in formulating their framework, lay great stress on limited liability: Now, how do the shareholders of the Walt Disney Corporation fare with limited liability in terms of their troubled operation called Euro Disney? What is happening is that the bankers are suggesting that the company puts up half of the cost of the £1.5 billion restructuring—so much for the MM world and philanthropic bankers.

Euro Disney is in dire financial straits, as a combination of high gearing and low revenues as a result of the recession. If you want an acid test of what the authors are suggesting for a framework, not only for non-life companies, but also, as they say in their conclusions paragraph, for life insurance companies and banks, consider the financial turbulence caused by depressed asset values in December 1974. In an MM world, investors are indifferent as to whether a financial company is prudently managed with modest gearing and good solvency margins or highly geared with poor solvency margins.

If you look at the horrifying experience of that time, two events stand out, even after almost 20 years. One of the pillars of our U.K. financial system, one of the Big Four banks, and the one which was thought to have lost most in the debacle in the property market, was rumoured to be insolvent. Also, a composite insurance company had to have a crisis rights issue at a quite exorbitant dividend yield within a week or two of the bottom of the market.

My impression is that the framework suggested by the authors cannot possibly be the best way forward, as it bears no resemblance to the financial world in which I seem to have lived for the past

25 years. My suspicion is that, far from leading to better prudential management of financial companies, it will exacerbate, not just the frequency, but also the severity of financial accidents in a world that is already far too uncertain and dangerous.

Professor H. Meij (a visitor): The authors have tried to bring actuarial discussion and competence closer to management practice. This is not only laudable, but is also a stretching and difficult target. I quote from the *Journal of Financial Economics*:

> "There are, however, an infinite number of imperfect market theories corresponding to the limitless combinations of alternative assumptions.
> Unfortunately most of these theories are irrelevant to understanding the world. In this sense they are 'possibility theorems'—propositions that, while logically correct, have little or no probability of explaining any real phenomenon".

There are quite a number of theories and conclusions that are obvious examples of this statement, such as:

— some financial theory in which money does not matter,
— capital structure does not matter, or
— investment strategy does not matter.

One asks, what does matter? There are some points in the paper which fall into this category, but it is still worthwhile to have stated them.

The philosopher, Popper, stated that "The very refutation of a theory is always a step forward that takes us nearer to the truth". In order to come nearer to the truth, I will try to falsify the statement that management decisions should take account of the beneficial effect of the bankruptcy option. This point influences a number of the equations in the paper.

My view is that management decisions should be based on the principle of a going concern. In that perspective, it is the value of the firm that should be maximised over time. Anyhow, management should be kicked out before the bankruptcy option comes in, so management should not see this option as a positive value.

The question then is: how realistic is this assumption, and do managers have this broader objective, the value of the firm, instead of the narrower focus which is assumed in the paper? There has been some research on this point. In the Netherlands a recent investigation found that 80% of management had the objective of maximising the value of the firm. This would correspond to my own perception. Indeed, I would argue that, over time, the maximum value of the firm as an ongoing entity would equate to maximising the return to shareholders and management.

I do not want to leave you with this criticism of the paper without expressing strong support for option theory as such. I think that the recent contributions in this field, especially by Dixit & Pindyck, but also by the present authors, are of great value. They make hard and measurable one of the basic tenets of economic theory: the value of forgone opportunities and the value of existing opportunities. This will improve management decision making, and I am sure that actuaries can help in substantiating these effects. When actuaries take a more active part in management, this element in their competence will have considerable value for the firm.

Mr B. R. P. Joseph: The authors have exposed some of the limitations in the appraised value model as presented in the actuarial literature. The model, as designed, suffers principally from the fact that it is very dependent on the reporting actuary producing the relevant commentary, one which attempts to place the numerical results into context. Its main weakness, however, is one which has not been addressed by this paper at all, that is, how much capital does an insurance company need to continue in business for the foreseeable future?

Insurance company managers, unlike their industrial company counterparts, have very little understanding of their underlying capital requirement. I agree with the authors, in § 5.3.2, that management often behave as if capital is limited. However, I go further and state that this behaviour

is consistent with the lack of understanding of the capital requirement of the business as a whole. Therefore, the consequences of any decision cannot be measured objectively. The authors' model of 'mini firms', presented in §6.2.1, underestimates the complexity of the capital issue. That model, along with the appraised value model, lean towards the uses of capital and identifying where it might be located. They do not attempt to quantify capital required and thus do not really permit informed decisions. Consequently, I do not necessarily agree with the authors that the actuarial profit test provides sufficient guidance on dynamic solvency to allow any but the most high level of explanation of changes in capital consumption over time. In particular, the principle of value additivity, in Appendix A.4, does not necessarily hold, because it over-simplifies the dynamics of the behaviour of capital within the various blocks of business, and the various insurance, reinsurance and economic cycles within which the company operates.

The authors, in their analysis, have adopted a narrow definition of the assets of the firm. In my experience, the primary assets of many insurance companies are their future reinsurance recoveries. The purchase of reinsurance is, in my opinion, no different from the purchase of any other asset, and should be part of the investment decision and analysis. Section 6.3.2 does not address this issue. The risk-adjusted yield from a company's reinsurance programme needs to be incorporated into any framework used to measure risk strategy. The information shortfall identified by the authors is particularly relevant in this context. Management might well be inadvertently increasing the value of the company to its shareholders by increasing the volatility of the outturn with their use of the reinsurance programme. I believe that any such increase or decrease to volatility and value should be explicit rather than implicit.

I agree with the authors that the economic argument against discounting what is considered to be 'locked-in capital' at a higher rate than the free capital is correct. All of the capital contained within an insurance undertaking is at risk of loss. Therefore, all capital should be considered at the same rate. The explicit COCA proposed by the authors is intrinsically a more valuable tool in explaining and understanding what, for many actuaries, has been put forward as an intuitive result.

Mr J. P. Ryan: I welcome papers utilising financial theory. Actuaries claim to be experts in finance, but actually do not spend much time in analysing financial theory. The option evaluation model is an interesting idea and a step forward in our understanding. It provides considerable insight into the way risks are shared between policyholders and shareholders. It provides an addition to the valuation toolkit of the non-life actuary. It should, of course, be recognised that it is a valuation approach and not a pricing approach. The actual price of an insurance company is determined by the market and not by a valuation model. However, this is no different to the valuation work undertaken in the traded options area or any other actuarial valuation model.

The authors use a number of oversimplified economic assumptions when applying their model. It is largely these oversimplified assumptions that give rise to some of the odd results in the paper. It is, perhaps, unfortunate that the authors did not go into more detail, as it tends to detract from their approach. The authors do point out most of these shortcomings. In particular, there is not unlimited capital in the real world, and the assumptions underlying the Black-Scholes model clearly do not apply. Not surprisingly, therefore, the conclusions that arise are suspect. This simplistic approach also accounts for their ambivalent attitude as to whether the additivity principle applies to cash flows or not. I do not believe that it does without some adjustment.

I think that the introduction of utility theory would be of value to the paper. Utility theory is not as fashionable now as it once was. However insurance is an unusual industry, in that capital is required only to support the underlying business, not for other purposes. Utility theory provides a framework of ranking some of the risks and provides some insight into the allocation of capital process. It can, therefore, add to our understanding of some of the issues raised in the paper.

I believe that the explanatory power of the authors' approach is easier in a financial strategic environment than in an operational environment. Their approach provides a better basis for evaluating projects. It can also distinguish between shareholder and policyholder interest. It provides a finance manager with a useful tool for evaluating projects. However, the so called appraised value approach used is better for explaining the operational issues and for setting goals for

line management. The authors tend to ignore the problems of implementation, and hence the actuarial input, to operational issues, especially in target setting. They refer, in § 3.4.1, to taking credit for value when it is created rather than when it emerges. I think it is unfair to non-life managers to imply that the profits arise automatically once the decision to go ahead with the project is taken. The profit emergence issue is one that is more appropriate to the life side, where conservative reserving does defer the emergence of profit. On the non-life side, the problem is actually generating the profits required.

Communication to operational managers is a major advantage of the appraisal approach. They are not concerned with the niceties of put options. The authors' approach is not one that will appeal to the average underwriting manager when discussing his or her target loss ratio. However, the underwriting manager can understand much of the appraised value approach and the need for a risk discount rate.

An example of the difficulty of implementing the authors' model in the operational area is the confusion they create for themselves over the discount required on shareholders' funds. The authors miss the point in Section 7.4.3, when they discuss valuing assets at a discount. Obviously, a pound coin is worth one pound. The market value of many investments can be readily determined. However, the investment trust phenomenon of shares standing at a discount to net asset value is a real one. Funds are at risk and shareholders lack control when funds are held within an investment trust rather than being under their direct control.

An extra £10m invested in an insurance company will not be worth an extra £10m to the shareholders, because of the risk of loss to the shareholders as well as their lack of control. If that extra £10m allows the company to write more attractive business, or even to improve its terms of trade because it is perceived to be a safer company, then the value of shareholders' interest could well go up by more than £10m, due to the anticipated extra profits. However, if no such extra business is going to be written, or the terms of trade are not going to improve because of increased policyholder security, then the value to the shareholder is diminished. The policyholders could perhaps be expected to make a compensating gain because of their greater security.

If we are in the unreal world of unlimited capital that the authors refer to, then it might be argued that shareholders do not have to worry about lack of control or risk of loss, because they can simply borrow more money for new projects without any problems. Anyone who has had any exposure to capital raising, from the largest corporate level down to the personal level, knows that that proposition is absurd.

Furthermore, the phenomenon of cost of capital or discount of net assets can be explained in the authors' terminology. If the company has too much capital and, therefore, does not need to raise the extra £10m to reduce risks to an acceptable level, then the value of the put option from the shareholders' viewpoint will decline; the company is now much less risky. On the other hand, if extra business with attractive returns is written to service the extra £10m, either the value of the put option will not decline or V_{GO} will increase to offset it. This approach can also lead to not taking a discount on excess capital.

Contrary to what the authors say, the appraised value approach does deal with debt overhang. Although Larner and I did not discuss it in detail in our paper (*J.I.A.*, **117**, 597), the debt overhang issue only really arises when the risk to the policyholder is sufficiently real to make it difficult to write business on attractive terms or to invite regulatory interference.

The authors' model provides us with a tool for evaluating risk discount rates and developing further valuation models of insurance companies. However, to do that it is necessary to use realistic, albeit complicated, assumptions, and not the oversimplified assumptions used in some of the examples. This is not a serious problem. Stochastic model offices are easy enough to put together. The Daykin/Hey model is one straightforward approach, and the mechanics of setting up a simple stochastic model on a PC were described in a paper that I wrote in 1984, 'Application of Simulation Techniques to Solvency Testing for a Non-Life Office' (*Transactions of the 22nd International Congress of Actuaries*, **3**, 269). I think that, using these stochastic tools, the authors' theoretical framework provides us with a strong way forward.

Mr J. A. Lowe: The first really useful thing the paper does is to bring into focus the difference between the value of the firm and the value of the investors' claims on the firm, and the second is to

observe the distinction between financial and operational decisions. Too often in the past actuaries have discounted cash flows willy nilly, and have just taken it as read that somehow this means something to someone, without really considering the framework in which they are making those calculations. The authors, by standing back and taking a critical look at what many actuaries have taken for granted, have cast a great deal of useful light on existing appraised value methodology. A third really useful thing appears in Section 2.2, where the authors look at the limitations of traditional appraised value frameworks as a management tool, and go on to point out that some of the previously cherished pearls of actuarial wisdom are, perhaps, somewhat lacking in economic content, which is again a useful contribution.

There are a couple of areas of the paper which could be expanded on. The first is the nature of the option pricing framework, illustrated in Figure 4.1. This shows the shareholder and policyholder payoffs, varying with end-of-period asset payoff X for a given settlement cost B. Thinking about what this meant, I twisted the diagram round to look at the payoffs as a function of B for a given X. This yields exactly the same profile for the policyholder; namely, debt less a put. However, the shareholder then has a put option on the settlement cost B rather than a call option on the end of period payoff X. Because the profile for the policyholder remains exactly the same, whichever way round the payoffs are viewed, the rest of the results in the paper that stem from this, such as the positive value of the put option and hence the positive adjustment for asymmetric payoffs, remains the same. Effectively, both X and B can vary, although they are directly and indirectly linked. If one looks at the payoffs, not just as a function of X for a given B, but as a function of both X and B, the shareholders' position would be a cross between a call on the end-of-period asset payoff and a put on the settlement cost.

Many people will have been lost by the option pricing diagram, and I appreciate the simple representation of the equity interest as a call on the net assets suffices to make the point about the nature of the various parties' claims on the firm. However, I would be interested to see how the results could be recast as a three-dimensional payoff, looking at the short- and long-term links between X and B.

Another area that could usefully be explored is the riskiness of different groups or generations of equity holder or policyholder. If I take, for example, a group of policyholders with a given set of cash flows upon which they have a claim, they will put a value on those cash flows according to their risk averseness or otherwise. A different group of policyholders with identical cash flows, but a different risk aversion, will put a different value on them. In an ideal world, the different groups of policyholders with different risk aversions will be charged different amounts. When you have discounted the value of both the cash flows at the correct risk discount rate the value would be the same. However, in the framework of the paper, the value of the equity holders' stake will be different for different groups of policyholders, with the same cash flows, but with different risk aversions. I would be interested to know how the riskiness of groups or generations of such policyholders in a firm could be reflected in the framework.

Professor G. Dickinson (a visitor): I have my own view on the operational value, as opposed to the conceptual value, of option pricing models when applied to insurance contracts or insurance liabilities, in explicit or embedded situations. The acid test on whether option pricing models are useful is, can they produce realistic values? I am not aware of any firm empirical evidence, in either the U.S.A. or the U.K., to show that they can. I have doubts about their ability to deliver in practice in non-life insurance, because the underlying claims distributions and timescales are so uncertain.

I now consider the well-established extrapolation in the insurance economics literature of viewing policyholders as if they were debtholders. Within the model there is an implicit put option that is being sold by policyholders to the shareholders at a price that reflects the risk which the policyholders would face in the event of liquidation. However, what happens if we take that model one step further and put it in the context of policyholder protection? The model would not be initially consistent if there is an external 100% guarantee given to the policyholders in the event of liquidation. In the U.K. this is not exactly the case, since under the Policyholders' Protection Act the

guarantees are less than 100%. However, the supply price of the put option from the policyholders to the shareholders will now be quite low, because the put option will need to reflect the risks that the policyholders face.

What is happening under the Policyholders' Protection Act is as follows. The shareholders and policyholders of other insurance companies are supplying a put option to the policyholders of the insurance company at no cost, which, in turn, allows them to supply the put option to its shareholders, at a minimal cost. The discussion in the paper on the risk sharing between policyholder and shareholder will thus change. Policyholders do not necessarily lose when shareholders exercise their put option in liquidation.

I like the attempt by the authors to apply the Stewart Myers growth-opportunities model. It is a decision-making model rather than one designed for profit control. As Mr Ryan said, the authors need to take their analysis further, and look at the correlation between the various classes of business over the underwriting cycle. The only coherent way in financial theory that one can assume cash flows as independent of each other in net present value calculations, if they are actually correlated, is if the risk premium in the discount risk consists only of systematic risk. If the shareholders demand a risk premium also for unsystematic risk, then one has to allow for the correlations between the cash flows.

I would argue that, in non-life insurance in particular, that there is a significant non-systematic risk, and that the shareholders will require compensation for this. Take, for example, catastrophic losses, such as windstorm, earthquake, etc., which, by definition, are uncorrelated with anything. They are random. Partial proof that unsystematic risk matters can be found in the supply price of reinsurance for catastrophic risks. Since the supply prices for such reinsurances are not zero, the shareholders of reinsurers are demanding a risk premium linked to unsystematic risk.

Mr A. D. Smith: I consider that this paper is a major intellectual step forward for the profession. I was particularly stimulated by the helpful analogy the authors have drawn between option pricing theory and insurance appraisals. In this paper, the theory is applied to 'a very simple example' (see Section 4.2). This led me to investigate whether these methods might be applied in a more realistic framework; and, if so, how?

Investment banks employ quantitative analysts (known as 'quants') to price and manage the risk of derivative books. Some of these derivative transactions are as complicated as a plausible model of a non-life insurer, so I worked with a group of quants to apply their option pricing methodology to generate appraised values for insurance companies. We found that, although the Black-Scholes formula was not always directly helpful, the underlying logic based on stochastic calculus and the absence of arbitrage was readily applicable. In § 1.1.5 the authors state that their framework 'is not intended to replace conventional appraised value methodology in a practical context'. This is unduly modest. It can be done; it is worth doing; we have done it; and the answers make sense.

There seems to be an actuarial tradition that every variation in risk must mean an adjustment in value, and that this adjustment in value arises because of an arbitrary wedge driven between investment return assumptions and discount rates. If an appraised value methodology aims at least to reproduce market values where they are known, then such a margin would be inappropriate. It follows that the assumed excess return for risk should be a self-cancelling assumption when discounting investment returns, and is therefore irrelevant. In particular, the implementation of CAPM, with its assumptions of market efficiency, is not only challenging, as the authors note in Section 7.2.3, but also in many cases unnecessary. Fortunately, many of the Mickey Mouse assumptions Mr Clarkson mentioned, which aid the explanation, are not strictly necessary. The authors' conclusions are far more robust than they seem at first sight. If the excess return for risk is self cancelling, then it is easier to calibrate all returns and discount rates from the fixed-interest yield curve, which must necessarily give the same answer as the more complex methods, provided they are implemented consistently. Some adjustment may, in principle, be required to mean cash flows not arising from investments, although, as the authors point out in § 7.2.2.8, insured risks are largely diversifiable, in which case no such adjustment would be required. This is the 'shadow probability space' approach discussed in § 7.2.12, which quants call the 'equivalent martingale measure'. In

practice, any difficulties in explaining this technique are far outweighed by the relative ease of practical application and computation.

The actuarial profession still has a very good reputation in the City; in particular, actuarial appraised values are well regarded by the financial community. Actuaries are seen (even by quants) as mathematical wizards. It is assumed, as a matter of course, that actuaries have a full grasp of stochastic calculus, martingales, all the complexities of derivative pricing, and more. Armed with these technical tools, the actuary should be a flawless manager. Unfortunately, this reputation has scant basis in fact. What a pity that, as the authors point out in § 7.3.1.3, a traditional appraised value is 'an exercise in arithmetic, not corporate management', and in § 2.2.1 is 'inert and passive'. The remedy the authors propose is to increase the theoretical content of appraised values. There is then some hope that the profession may live up to its good reputation for technical skills. The profession urgently needs educating before our exalted reputation crashes to the level of our abilities. This paper is an admirable first step. I hope that there is more to follow.

Mr G. G. Wells: My first comment relates to § 3.2.5, where my preference is to include renewals as part of V_A (that is, the embedded value), and certain types of 'natural' new business (for example, additional business arising on a group health scheme from salary or general premium increases). This approach, applied particularly to personal lines business, allows us to utilise the skills we have developed on the life side to non-life business which exhibits similar long-term characteristics (for example, motor business written through direct response insurers).

I am pleased to see the authors using and embracing the term 'profit test' in a non-life context. These techniques can be applied to non-life business, again particularly to personal lines business, by making suitable assumptions on the rate of renewal, etc.

In § 7.2.3.4 I agree with the authors that discounted cash flow (or profit testing) techniques are well suited to valuing V_A (the embedded value), but often have problems valuing V_{GO}. The problem with valuing V_{GO} is the subjective element inherent in any calculation. In a purchase situation, V_{GO} is, as we are all aware, largely a function of matching a willing buyer and willing seller at an agreed price. The traditional (or at least one) technique of determining V_{GO} is to value one year's new sales using profit-testing techniques and to apply a multiple to this value. The multiple reflects the combined effect of future sales, the future profitability of those sales and an appropriate risk discount rate (or rates) to apply up to the point of sale. Whilst this technique does have some appeal, it is highly geared to the multiplier chosen, which has to embrace, amongst other factors, where we are in both the economic and underwriting cycles, and the proposed future management course for the company. All in all, a very difficult item to judge, and one traditionally suited to, say, the investment banking fraternity?

Outside of the purchase/sale situation, I agree with the authors that actuarial appraised value techniques are not particularly well suited to assisting corporate management decisions.

The authors rightly identify the existence of the implicit option inherent in attempting to value ΔV_{GO}, which is clearly the case, and this does not lend itself readily to the multiplier approach. An alternative method of measuring corporate management decisions could, therefore, be to calculate the movement in V_A over each period of analysis. As the authors acknowledge, the use of profit-testing techniques do lend themselves to valuing V_A. Such an approach will give more stable and less subjective assessments than those based on appraised values.

Concerning the subject of locked-in assets, to the extent that free assets are needed to support the in-force and new business of the company, and a discount rate other than the after-tax rate is deemed appropriate for valuing such assets, their value to shareholders would differ from their face value.

Mr D. R. Campbell, F.F.A.: What I have to say is about the process of valuation of non-life companies. I hope this paper will start a period of renewed rigorous technical debate to establish a form of professional consensus on the valuation of non-life businesses. Much of the value of these exercises to our clients is as benchmarks of one company against another, or of one year against another; and to have value, these benchmarks must be broadly consistent. Now that the debate has

been taken to such a critical point, a consensus must be reached quickly to give security to practising actuaries and confidence to our clients.

The authors mention the purposes of the ultimate recipient of the valuation almost in passing. This to me is critical. The observer's perspective on the situation, be he a third party investor, a potential acquirer of the whole business or internal management, is critical to the selection of method and approach of valuation. Much of the heat generated in this debate may be attributable to different speakers identifying with different types of observers. For example, let us have a look at the locking-in adjustment. I find myself in the authors' camp when I look at the adjustment from the perspective of, say, a U.K. insurer evaluating another U.K. insurer for purchase. Similarly, I see no particular motive for the adjustment in the case of U.K. management benchmarking its own performance. However, if I were a U.K. retailer, perhaps in the business of cornflakes, or jumpers and underwear, would I not look at things in a different way? Would my perspective on the use of capital and the regulatory regime not lead me to make a reduction in value for locking in? So in certain circumstances only, I think a locking-in adjustment may make sense, though not, perhaps, for the reasons suggested in actuarial literature.

Mr D. H. Craighead: I am known as essentially a practical actuary. I always examine actual figures and what they mean and what I have seen in the market generally. The main difficulty in the valuation of a non-life insurance company, whether by means of appraised value methodology or otherwise, lies in the volatility of the results.

When considering the value of a large, direct writing office, a fair idea can be gleaned through a close knowledge of the market and of the likely trends of profit development, although the expectations can be ruined by unforeseen factors, such as losses on mortgage indemnity insurance. When considering an office underwriting London Market business, much greater difficulty exists.

I am somewhat surprised that no mention has been made of the possibility of a Monte Carlo type simulation, starting with an evaluation of a likely frequency distribution of the results, almost certainly with lower frequency, but higher quantum downwards. These fluctuations must be superimposed on an underwriting cycle which is also difficult to foresee. The calculations performed in that way should then be capable of showing the effect of runs covering a number of years forward, discounted to present value at a predetermined rate of interest, and performed many times to produce the resultant spread of the appraised values so calculated.

The particular difficulty with the London Market lies in the degree of volatility. Many offices in Lloyd's syndicates writing non-marine business showed ultimate loss ratios of under 50% for the 1986 year of account. Even the best underwriting resulted in heavy losses for the 1989 year of account. Those offices accepting higher risk business showed ultimate loss ratios of many times 100%.

A large general insurance company runs some degree of danger from showing underwriting losses at the bottom of an underwriting cycle. A London Market office runs the very real and proximate danger of insolvency from a disastrous year such as 1989, and no recovery is possible once the capital has been eroded and all possibility of a substantial profit resulting from a future upswing in premium rates lost. At that point, even large increases in premium rates are of no avail. That is why the capital market requires strong enticement before providing new risk capital for a general insurance venture.

This paper is very valuable in setting the groundwork of new ideas and in widening the frontiers of actuarial science. Nevertheless, it is written, to a large extent, using the jargon of the financial markets and the business schools, with the result that it is wordy and often appears to mean more than it really says. I still think that it would have been more concise, easier to understand and a good deal shorter if written in simple English. In saying so, it would have lost nothing of the depth of thought and would have shown a great deal more clarity.

Mr H. E. Clarke (closing the discussion): The authors have proposed a particular framework in putting forward a new process for calculating the value of a company and looking at the way it is

run. Do the various speakers consider that this is a reasonable framework? Do they think it is going to hold? Will it work? I think the most extreme point of view is that of Mr Clarkson, who thinks it is a load of rubbish. Mr Ryan, on the other hand, said that he thought the framework was too simple, but one can offset that by the thoughts of Mr Smith, who accepted it was simple, but also said that, despite its simplicity, it was, in fact, robust. Professor Dickinson wondered whether a model based on this framework would be capable of delivering in practice. Mr Smith appears to have done some further work in this area, and says it does work. Professor Meij was worried about a model which assumed that a company was being managed in such a way that bankruptcy was a real option. Mr Craighead also made that point. The jury of the various speakers is still out as to whether the framework does or does not hold.

The authors also put forward the question of what to discount. Traditional actuarial theory has always been that one discounts the emerging cash flow. That is the position in Anderson's paper (see the references in this paper) and the actuarial profession has gone forward from there. One discounts the emerging cash flows from the moment when the profits actually emerge as money distributed to whoever is to receive it. Several speakers continue to be in that camp. Mr Fine felt that strongly, and so did Mr Ryan.

The authors have put forward the concept that you look at when the profits are, in effect, created; that is, when the framework is put in place that will create the profits, which is when the new project is put in place. I do not think a great deal of support was found for this. One is faced with deciding what is a new project, and the problem which a number of people have raised: how to value V_{GO} as opposed to V_A? I have some sympathy with what the authors say in trying to separate between the net present value and goodwill. Goodwill is certainly not calculated by reference to all the business that is renewed after a certain point. There is a considerable hangover from the business already in force. The question is, how much of the new business that comes on is already there because you have the framework in place, and how much comes from a new project? it is not clear how much of the existing operational structure should be included in V_A as opposed to V_{GO}.

I expected that the locking-in adjustment would generate the most controversy, and I was right. Mr Lowe agreed that it was controversial. He also thought it was necessary. He viewed it as an increase to the liabilities and not a reduction in the assets. Mr Fine was very much a supporter of the locking-in adjustment, but he was not supporting it for the reasons given in the paper. The reasons given in the paper are that it constrains investment strategy and that there is a possibility of losing the money if things go wrong. Mr Fine's comments, with which I have some sympathy, are that the locking-in adjustment is there because you cannot take the money and invest it elsewhere, hence you are discounting the future cash flows at your assumed risk discount rates, and therefore they are worth less.

Mr Ryan said that, when you put new capital into a firm, how much it is worth depends on what you do with it. If you effectively do nothing, so you do not introduce any V_{GO}, it probably goes down in value because it could be lost in the event of a catastrophe. If you do something very positive and useful with it, it can be worth more than the money you put in, because you have used it to create additional positive cash flows.

There was a thread running through the comments about the difference between financial evaluation and operational control. Although the financial calculations seem to have been generally accepted, using the model for operational control was generally considered to be rather harder. This is partly because the model is so far being presented as a conceptual framework. The opener asked for examples. What is needed if this approach is to be taken forward is to have some real examples that can show you how the equations are worked through and how they will be applied in practice.

If there is going to be a step forward with this approach, someone—Mr Smith clearly wants to be volunteered, because he says he has done it—should present something which says how you actually work the calculations through, rather than saying we have something called V_{GO} and we have ΔV_{GO}. I have difficulty understanding these concepts in the abstract. However, it is a good framework, and so now someone needs to show how to do the calculation. One needs some examples to show how it works, to see whether the examples produce realistic results. If not, then the model is unlikely to work.

I have some sympathy with Mr Craighead's comments that a lot of this is not challenging the essential framework of the way we look at appraised values. It is a question of which cash flows we look at, when we recognise them, and how we discount them. It does not seem to me that we are making major changes to the framework. We should be able to evolve from our present position in the direction that this paper is pointing, if this is the way we wish to go.

The President (Mr L. J. Martin): We are very indebted to the authors for this thoroughly actuarial and broadly-based paper. It is a blend of theoretical research and practical applications—not to everybody's taste or liking, perhaps. It explores possible new ground in the application of actuarial techniques to general insurance. It illustrates how company managers, practical people, with the interests of shareholders and policyholders, and their own jobs, at heart, might apply those techniques to make strategic decisions—perhaps sometimes unexpected ones.

The paper is provocative and, frankly, brave. It demands our encouragement and support. It does not shrink from criticism of current thinking and approach, and, therefore, will itself derive criticism from both commercial and actuarial interests. It brings together thoughts and comments which apply to general insurance, to life assurance, appraised values and profit testing, option pricing, investments and derivatives. It is worthy of our consideration, our thoughts and our comments. It is a good and challenging paper, which I hope will be read and discussed by very many actuaries and non-actuaries for several years to come.

The paper is quite clearly the result of much thought and much hard work by the authors and we are indeed very indebted to them.

Mr M. Bride (replying): I am somewhat disappointed by the discussion. No one talked about non-life management. If you want to run a successful non-life insurance company, you need two things: a good strategy and a reasonable execution of that strategy. You do not need an excellent execution of that strategy—I do not think any company in the world has both an excellent strategy and an excellent execution.

In replying to some of the major points that have come up during the debate, I would like to frame them from this perspective. In order to develop a good strategy for an insurance company, one needs to understand what is happening in the company. This is why we have put forward this option pricing framework.

Many speakers have questioned which parts of this financial economic framework are robust and are applicable. I would say, particularly to Mr Clarkson and Mr Ryan, that the distinction between the value of an asset and contingent claims upon it is a fact, and the existence of option-like payoffs is also a fact. I totally agree that, when one tries to calculate figures for the value of a particular option, there are innumerable assumptions underlying the formulae. However, the intuitions of the framework in developing a strategy for an insurance company are very important.

One matter which seems to be a particular bone of contention is whether or not the shareholders of non-life insurance companies require to be rewarded only for diversifiable risk or for both diversifiable and non-diversifiable risk. I totally accept that, if it were the latter, then certain parts of our paper would require adjustment. I would ask those who explain the actions of non-life insurance companies under the assumption that the shareholders require reward for non-diversifiable risk, to focus on other issues, such as managers and agency relationships. Is it that the shareholders require reward for non-diversifiable risk, or is it the managers of those companies who do not like non-diversifiable risk? The latters' interests are almost 100% invested in their companies.

On this point, it is interesting to consider the catastrophe insurance companies that have recently been set up in Bermuda, using capital from pension funds. Those companies are writing what most insurance companies consider to be the most risky type of insurance business in the world—that is, catastrophe business. They are quite happy to lose their money. They know that, if the catastrophe comes along, they will lose their money, but that does not matter. In the meantime, they expect to make a huge profit.

There are certain problems with financial economic frameworks. For example, if you have two projects which provide positive net present values, which one do you choose? There is no simple

answer to this. Mr Ryan alluded to it. Mr Joseph pointed out that we made no treatment of reinsurance. Again, I accept that a fuller explanation in the paper would have taken into account the effects on a company that has both inwards and outwards reinsurance business. However, as Mr Craighead said, the paper was already extremely long, although I feel that being accused of using jargon by someone who has spent 30 years working in the London Market is somewhat surprising. Financial economics has its own vocabulary, that must be learnt by those who wish to use the theory as an analytical tool.

What we are trying to use our option pricing framework for is to facilitate the understanding of how one's company is working, and hence develop a strategy. Then we move on to how to execute that strategy. How do you make your company act effectively? Mr J. Lowe pointed out that you need to identify which parts of your company are adding value. Mr Ryan also alluded to this, to the extent that, just having decided to be in a class of business, does not provide any guarantee of making a profit. The whole process of insurance needs to be done well in order to execute a strategy successfully.

If we could put ourselves in the position of a U.K. insurance company, with the current appraised value, we cannot hope to manage the insurance cycle. How much business do we want to write? Which £10 m of premium are we not going to write next year? An appraised value that tells us that we will make £50 m profit if we write £100 m worth of business to a 78·2% loss ratio is not going to help us as a management tool. What is going to help us as a management tool is a set of figures that we can put in front of the underwriter that tells him or her, on a marginal basis, which policies should be written and which policies should not be written. This is where we seem to have been slightly misunderstood, judging by the comments made. In our dynamic consideration of the portfolio we were not aiming to place lists of option values in front of underwriters, rather to produce figures that might assist the management in evaluating different possible courses of action.

WRITTEN CONTRIBUTIONS

Mr S. J. B. Mehta: Key aspects of the paper which should help improve the profession's understanding of insurance, not just non-life insurance, business are the discussion of firm growth opportunities and the option pricing framework for corporate decision making. I do agree with the authors that actual cash flows rather than accounting conventions are fundamental. There is an increasing volume of statistical research into this question, and it would be useful at some point for the empirical evidence to be tabulated. The paper provides a good analysis of how locked-in assets can be valued in the context of an appraised value calculation which discounts individual cash flows at appropriate risk adjusted rates and allows for option pricing effects.

I do not agree with the authors that appraised values should not be used, since risk rates can be selected for individual cash flows and option pricing effects can be allowed for, on a numerical basis, within the appraised value calculation. Indeed, some of the ways in which this can be undertaken for life business are set out in my own paper, 'Allowing for Asset, Liability and Business Risk in the Valuation of a Life Office' (*J.I.A.* **119,** 385). This paper also discusses how option pricing effects determine whether locked-in assets are worth more or less than face value and the optimal levels of capitalisation. A profit test is theoretically justified, provided that separate discount rates are assessed for each of the cash flows making up profit, and provided that these cash flows are projected on a fully stochastic basis. Equivalently, a shadow probability space approach can be used. With this approach, the probabilities of risky events happening are modified, and then a risk-free rate is applied to determine value. An overall equivalent discount rate can then be assessed, if required, to communicate results.

The methodology outlined, in my view, brings valuation principles for non-life business up to date and into line with the latest techniques in use for appraising life business. A useful next step would be for a paper to be presented to the profession showing how some of the theory can be applied, using practical non-life examples. Perhaps this is something that the authors would consider.

The authors subsequently wrote: The comments of the speakers about our paper are testament to the

fact that the subject of financial economics continues to raise temperatures in the profession. Broadly speaking, contributors fell into two camps—the 'Ayes' and the 'Nays', both of whom were perhaps guilty, to varying degrees, of reading what they wanted to see in our paper, rather than what was actually there.

As far as the Ayes are concerned, to paraphrase part of our introductory remarks—if the management of a non-life insurer could be reduced to number crunching, then there would be no positive NPV projects. Thus, whilst we heartily encourage developments along the lines suggested by Mr J. Lowe and Mr Smith, we would also urge those wishing to understand the management of non-life insurance companies not to ignore the motivations of the people who work for them or with them.

We turn our attention, for the remainder of this response, to the Nays. We look at what we see as the three key areas of disagreement - financial economics, risk and reward and the 'Cost of Capital Adjustment' (COCA).

Mr Clarkson was a prominent Nay. One has the feeling that, once he had seen references to the classical contributions to financial economics, such as those of Modigliani & Miller (MM) and Black & Scholes (BS), he switched to automatic pilot and gaily flew straight past Sections 5, 6 and 7. He questioned various aspects of the work of MM, and the fact that observations of the real world are at odds with the behaviour anticipated in the financial world that they describe. This is precisely the point—MM explicitly recognise that their irrelevancy propositions do *not* hold in the real world, but that if classical assumptions of economic theory hold, then these propositions follow logically. So, if the irrelevancy propositions are inconsistent with real world observations, then one or more of the underlying economic assumptions must be untrue.

This line of reasoning is in the best traditions of scientific enquiry—a point which was lucidly made by Professor Meij. Over time, the initial work of MM, whose importance was recognised by the award of Nobel prizes to the authors, has been extended, first by MM themselves and then by others, by investigating the effect of relaxing each assumption. This line of reasoning has resulted in what is today a very good understanding of the effect of financing on the value of the firm. We were quite explicit when discussing the existence and implications of the differences between the real and MM worlds (refer to Section 5.2), and would wholeheartedly agree with the observations of several speakers that the MM world is hypothetical.

Since, for whatever reason, he has not detected that we distinguish between the real and MM worlds, Mr Clarkson suggests, in his closing comments, that we are advocating dangerously risky behaviour for managers. This is absolutely not the case. What we say is that, under a simple option model of corporate liabilities, there is an incentive for managers to increase risk in the mismatched sense. This incentive for management exists only if agency costs and the direct and indirect costs of bankruptcy are ignored. Of course, as we discuss at length in our paper, bankruptcy costs (that is, the impact of capital adequacy on the value of the firm) and agency costs are material in the real world. Furthermore, it is the option characteristics of the pay offs that are of primary interest to us and not, for example, pricing formulae such as the one of Black-Scholes.

We now turn to the question of risk. To our surprise, Professor Dickinson reiterated the traditional actuarial view that non-life insurance is a uniquely 'risky' industry, and that shareholders require compensation for diversifiable risk. It would be helpful if any of the several speakers who have expressed the same view, both in this discussion and on a number of other occasions, had some data to support their assertion. For our part, we believe that investors do hold broad portfolios in which insurance risk is diversified away. At 31 December 1993, in excess of two-thirds of the shares of companies in the multi-line and property-casualty sectors of the S&P 500, representing about 2% of the total index, were controlled by institutions, which generally follow prudently diversified investment strategies. The remaining third was held by private investors and others, and surely the same principles of prudent investment are followed by these investors. Furthermore, let us put the magnitude of potential insurance losses into the context of total stock market capitalisation.

The U.S. S&P 500 Stock Market Index had a total market capitalisation of U.S.$3,416 bn as at 31 January 1994. Suppose that a huge catastrophe (far in excess of Hurricane Andrew which gave rise

to worldwide insured losses of U.S.$16.5 bn, according to the Munich Re survey of natural disasters in 1993) were to result in insured losses of U.S.$20 bn to the companies in these sectors. This would represent just 0.6% of the total capitalisation of the market. Market movements of this magnitude happen daily for a multitude of reasons. Indeed, if such a catastrophe event were to occur, there would be a sudden wave of capital raising in the markets to restore financial strength and life would go on. However, what is undoubtedly true is that most managers do not have diversified portfolios, since they have a disproportionately high investment in the company for which they work. If one is searching for an explanation as to why managers behave after a certain observed fashion that is inconsistent with the owners holding diversified portfolios, then we believe that the answer lies in the understanding of the agency issues.

If, contrary to our belief, investors in insurance companies do require compensation for diversifiable risk, then the implications of this would be far reaching. Indeed, the Principle of Value Additivity (see Appendix A.4) would fail immediately and managers would face decisions of horrendous complexity. To put a value on a new project, a manager would have to re-evaluate all existing projects at the same time.

Correctly applied, the appraised value model should provide meaningful results irrespective of the assumptions made concerning the need to compensate owners for diversifiable risk. Having accepted that certain elements of our work rely upon the assumption that only non-diversifiable risk should be taken into account, we would still be interested to see a comparison of the appraised value, working in this framework, with our model. We believe that the differences between the two are not explained by the non-diversifiable risk debate, and that they can be investigated without necessarily reaching agreement on this question.

Turning to another controversial issue, the COCA is a good actuarial candidate for some scientific rigour. This is precisely why we set out an explicit framework in our paper, with supporting algebra. We strongly believe that it is in the interests of the profession to remove unnecessary conjecture and inconsistencies from the field of appraised values. A first step would be for actuaries with different opinions from our own on the cost of capital to support their position with algebraic derivations.

Mr S. Lowe said that the COCA should be treated as an uplift to the liabilities and not a reduction to the assets. We await clarification, hopefully in algebraic form, as to from where to where he believes the liabilities should be uplifted.

Mr Ryan seemed to put forward two quite separate defences for the COCA. The latter, with which we totally agree, is that the increase in value to shareholders of a capital injection is the difference between the increase in the value of the growth opportunities made available by the capital and the reduction in the value of the shareholders' put option. In Mr Ryan's parlance 'a company with too much capital' is one where additional capital opens up no new growth opportunities and, therefore, a capital injection results only in a reduction in the shareholders' put option. However, one could argue that the option will already have negligible value if the company already has this level of capital. This would be consistent with current appraised value methodology, whereby capital above a certain level (often measured as a percentage of premium income) is not considered to be locked in. However, it is by no means clear to us that the net movement in these two amounts is in any way quantified by the COCA adjustment term of the actuarial appraised value. As we demonstrated in Appendices C and D, this adjustment term is required when the 'wrong' discount rate is used to value the capital flows accruing to shareholders. By 'wrong', we mean that the discount rate used does not reflect the riskiness of capital flows accruing to shareholders, in the context of their investment portfolios.

Mr Ryan's other defence of the COCA centred on the phenomenon of investment trusts that trade below net asset value—his suggestion being that this is as a result of the loss of direct control over the assets. Assuming that this is a systematic occurrence, it would be interesting to hypothesise as to the possible causes. Following on from this, one could investigate whether any of these hypotheses would imply a COCA adjustment when valuing a general insurance operation.

Previous researchers have failed to recognise the COCA term for what it really is, and, instead, have attempted to justify the term on the grounds that, in principle, locked-in assets are worth less

than market value to shareholders. This is the cause of the confusion—not semantics, as Mr S. Lowe suggests.

On the more fundamental question of what locked-in assets are worth to shareholders, we can split actuarial arguments into two camps:

(i) those that revolve around shareholder control over capital and distributability of earnings, and
(ii) other arguments, which often relate to capital adequacy and the risk of loss from insurance.

Our views on the distributability argument are set out in §7.4.3.9 *et seq.* So far as the other arguments are concerned, we strongly believe that an option framework and clearly stated algebraic valuation principles are essential for an unambiguous debate.

As Mr Campbell noted, there is a tendency for people to align themselves with either managers, policyholders or shareholders, and the option framework neatly models the interrelationship of different claims on the firm. One of the problems with the locked-in asset debate is that one is focusing on just one component of shareholders' equity in isolation. This is potentially confusing, since the next question is then: what are the other components worth? Hence our discomfort with Mr S. Lowe's comments which focus on just one component in isolation.

The actuarial profession needs to adopt a more scientific financial approach that can connect its research with the mainstream. A bridge needs to be made between appraised value research and the wider world of financial economics, so that ideas can travel to and fro across it. This was the spirit in which our paper was written, and we hope that others will build on it.

Following the discussion of MM, readers should still have the idea of the existence of conceptual and real worlds fresh in their minds, and we should like to present a second application. There is the real U.K. general insurance industry. There is also a conceptual industry in which actuaries at Staple Inn debate the finer points of management techniques. One implication of the actuaries' understanding of general insurance management is that they are influential in the management of the industry in the conceptual world. As with the MM world, it is incorrect assumptions that must be the source of differences between it and the real world. Given that actuaries are not influential in the management of the real industry, some of the assumptions made in their hypothetical management world must be incorrect. We believe that the problems lie with the appraised value model, and in our paper we have suggested areas that we believe should be scrutinised—assuming, of course, that the profession wishes to enter the real world of general insurance management. That decision we leave entirely to the individuals concerned.

Were the answer to be that they are interested, then we suggest that the Institute should follow the lead of the Casualty Actuarial Society and introduce a basic course on financial economics into the examination syllabus, to prepare actuaries for this substantial literature.